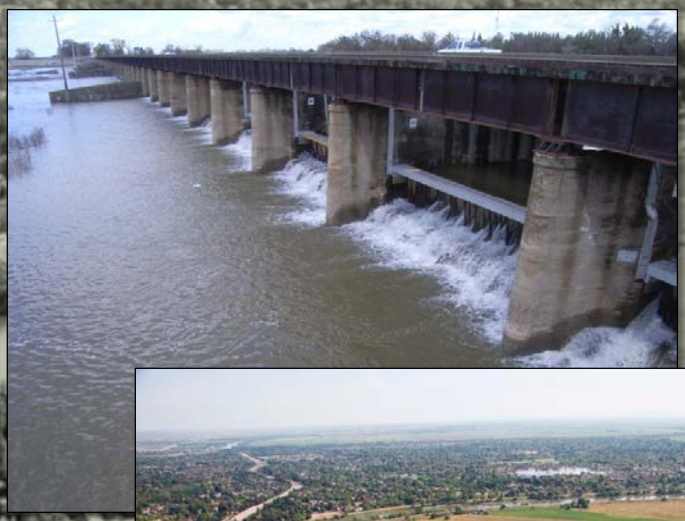
American River Watershed

Common Features
General Reevaluation Report



Final Report

December 2015

SAFCA
Sacramento Area Flood Control Agency

CENTRAL VALLEY FLOOD PROTECTION BOARD
PUBLIC SAFETY WITH FLOOD PROTECTION STATE OF CALIFORNIA

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:

Sacramento Weir during operation

Sacramento River facing south near the Pocket and Little Pocket neighborhoods

High flows on the American River at the Highway 160 overcrossing

Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Final Report

U.S. Army Corps of Engineers
Sacramento District

December 2015

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AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

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LIST OF ACRONYMS

ARN ..... American River North

ARS ..... American River South

ASA(CW) ..... Assistant Secretary of the Army for Civil Works

CDFG ..... California Department of Fish and Game

CEQA ..... California Environmental Quality Act

CERCLA ..... Comprehensive Environmental Response, Compensation, and Liability Act

CFR ..... Code of Federal Regulations

cfs ..... Cubic Feet per Second

CVFPP ..... Central Valley Flood Protection Plan

CVIFMS ..... Central Valley Integrated Flood Management Study

DPR ..... Detailed Project Report

DWR ..... California Department of Water Resources

EIR ..... Environmental Impact Report

EIS ..... Environmental Impact Statement

EO ..... Executive Order

ER ..... Engineering Regulation

ERR ..... Economic Reevaluation Report

ESA ..... Endangered Species Act

ETL ..... Engineering Technical Letter

EWDAA ..... Energy and Water Development Appropriations Act

FAA ..... Federal Aviation Administration

FEIS ..... Final Environmental Impact Statement

FEMA ..... Federal Emergency Management Agency

Framework ..... Central Valley Flood System Improvement Framework

FRM ..... Flood Risk Management

GAO ..... General Accounting Office

GRR ..... General Reevaluation Report

IDC ..... Interest during Construction

JFP ..... Folsom Dam Joint Federal Project

LCM ..... Life Cycle Management

LPP ..... Locally Preferred Plan

MCDC ..... Magpie Creek Diversion Channel

MOA ..... Memorandum of Agreement

MSL ..... Mean Sea Level

NAT ..... Natomas Basin

NBCHP ..... Natomas Basin Habitat Conservation Plan

NCC ..... Natomas Cross Canal

NED ..... National Economic Development

NEMDC ..... Natomas East Main Drain Canal

NEPA ..... National Environmental Policy Act

NGVD29 ..... National Geodetic Vertical Datum of 1929 .....

NMFS ..... National Marine Fisheries Service

NOI ..... Notice of Intent

NRHP ..... National Register of Historic Places

OMRR&R ..... Operation and Maintenance, Repair, Replacement and Rehabilitation

PAC ..... Post-Authorization Change Report

PED ..... Preconstruction Engineering and Design

PGCC ..... Pleasant Grove Creek Canal

PL ..... Public Law

RD ..... Reclamation District

RM ..... River Mile

ROD ..... Record of Decision

Sac Bank ..... Sacramento River Bank Protection Project

Sac Urban ..... Sacramento Urban Levee Improvement Project

SAFCA ..... Sacramento Area Flood Control Agency

SCB ..... Soil Cement Bentonite

SPF ..... Standard Project Flood

SR ..... State Route

SRA ..... Shaded Riverine Aquatic

SRFCP ..... Sacramento River Flood Control Project

USBR ..... United States Bureau of Reclamation

USFWS ..... U.S. Fish and Wildlife Service

VELB ..... Valley Elderberry Longhorn Beetle

WRDA ..... Water Resources Development Act

WRRDA ..... Water Resources Reform and Development Act

AMERICAN RIVER COMMON FEATURES PROJECT,

POST AUTHORIZATION CHANGE SUMMARY

INTRODUCTION

This post authorization change report has been prepared to document a general reevaluation study of the American River Common Features (ARCF) project for the City of Sacramento and surrounding areas, which is one of the most at risk areas for flooding in the United States due to its location at the confluence and within the floodplain of the American and Sacramento rivers. This General Reevaluation Report (GRR) addresses the flood risk management system for the American and Sacramento Rivers and five other smaller channels.

1. DESCRIPTION OF AUTHORIZED PROJECT

The authorized study is located in the general vicinity of the confluence of the Sacramento and American Rivers, and includes the City of Sacramento and surrounding areas. This consists of the north and south banks of the American River downstream of Folsom Dam, the Natomas Basin, the east bank of the Sacramento River and areas surrounding five other smaller waterways which are sources of potential flooding. Each area is at risk of flooding from multiple sources.

1.1 Authorized Project Features

The authorized project features were developed to work in conjunction with the authorized Folsom Dam modifications and the increased flow releases that would be anticipated. These features included seepage remediation along approximately 22 miles of the American River and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas. Additionally, the authorization includes construction of seepage remediation and levee raises along four stretches of the American River and construction of levee strengthening and raising of 5 miles of the Natomas Cross Canal levee in Natomas. The authorized project features are listed in Table PAC-1. The table also provides the authorization, project overview and status.

Table PAC-1: Common Features Project Work Sites and Status.

Item	Feature	Authorization, Overview, and Status
1	24 miles of slurry wall in the American River levees	Authorization: WRDA 1996. Overview: Approximately 24 miles of slurry wall for seepage and stability improvements in the levees along the lower American River. Status: approximately 20 miles of seepage cutoff wall, 0.15 miles of jet grout, and 0.20 miles of seepage berm constructed on the American River.
2	12 miles of levee improvements, Sacramento River east levee in Natomas.	Authorization: WRDA 1996. Overview: Approximately 12 miles of seepage, stability, and height levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal. Status: completed by SAFCA as part of Natomas Levee Improvement Project (NLIP).
3	3 telemetry streamflow gages u/s of Folsom Dam	Authorization: WRDA 1996. Overview: Installation of three telemetry stream flow gauges upstream from Folsom Dam and Reservoir. Status: complete.
4	Modification of the existing flood warning system	Authorization: WRDA 1996. Overview: Flood warning system modifications along Lower American River for the City of Sacramento. Status: completed by non-Federal sponsor.
5	Mayhew Levee upstream of the Mayhew Drain	Authorization: WRDA 1999. Overview: Seepage and stability improvements and raising by an average of 2.5 feet the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet and installing a closure structure on the Mayhew Drain to prevent the American River from backing up into the drain. Status: complete.
6	North Levee Raise Upstream of Howe Avenue	Authorization: WRDA 1999. Overview: Raising the right bank of the American River levee in the vicinity of Howe Avenue by an average of 1 foot. Status: complete.
7	5 miles of levee improvement, Natomas Cross Canal (NCC) south levee in Natomas	Authorization: WRDA 1999. Overview: Modifying the south levee of the NCC for a distance of 5 miles for seepage, stability, and to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River. Status: completed by SAFCA as part of NLIP.
8	5 miles of levee improvement, NCC north levee across from Natomas	Authorization: WRDA 1999. Overview: Modifying the north levee of the NCC for a distance of 5 miles for seepage, stability, and to ensure that the height of the levee is equivalent to the height of the south levee. Status: not complete. No sponsor identified to cost share this feature.
9	North Levee Strengthening between Natomas East Main Drainage Canal (NEMDC) and Business I-80	Authorization: WRDA 1999. Overview: Installing a slurry wall in the north levee of the American River from the east levee of the NEMDC upstream for a distance of approximately 1.2 miles. Status: Complete.

Item	Feature	Authorization, Overview, and Status
10	North Levee upstream of Watt Avenue (Jacobs Lane)	Authorization: WRDA 1999. Overview: Installing a slurry wall in the north levee of the American River in the vicinity of Jacob Lane north for a distance of approximately 1 mile to the upstream end of the existing levee. Status: Complete.
11	Pocket Geotech Reaches 2 and 9, and Pioneer Reservoir	Authorization: 2006 Post-Authorization Change. Overview: Installing a total of 3.6 miles of discontinuous slurry wall at two levee sites on Sacramento River in Pocket Area and installing six relief wells and collector drains and appurtenant features and landside berm on Sacramento River at levee toe in the Pioneer Reservoir area. Status: complete.
12	American River adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 2.0 miles of levee in place and install seepage cutoff wall through levee and foundation on Lower American River. Status: In design.
13	Sacramento River adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 18.3 miles of existing levee by construction of an adjacent levee, install 12.3 miles of deep seepage cutoff walls, and install 8.3 miles of seepage berm, all on east bank of Sacramento River below Natomas Cross Canal. Status: 13 miles of adjacent levee, 9 miles of deep seepage cutoff walls, and 4 miles of seepage berm constructed by SAFCA as part of NLIP. Remaining construction to be completed by Corps, and schedule is under development.
14	Pleasant Grove Creek Canal adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet on the Pleasant Grove Creek Canal. Status: Construction to be completed by Corps, and schedule is under development.
15	NEMDC adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 12.8 miles of existing levee and installation of 10.7 miles of soil bentonite cutoff wall on NEMDC. Status: Lowest 5 miles under design for construction in 2017. Remaining construction to be completed by Corps and schedule is under development.
16	NCC adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 5.5 miles of existing levee in-place and install deep seepage cutoff walls on south bank of NCC. Status: Completed by SAFCA as part of NLIP with exception of 3 windows. Windows to be completed by Corps and schedule is under development

1.2 Authorized Local Cooperation Requirements

Authorized Local Cooperation includes requirements to:

- Provide lands, easements, and rights-of-way.
- Modify or relocate utilities, roads, bridges (except railroad bridges), and other facilities, where necessary for the construction of the project.
- Pay costs allocated to flood control to bring the total non-Federal share of flood control costs to 25 percent, as determined under Section 103(m) of the Water Resources Development Act (WRDA) of 1996, as amended.
- Bear all costs of operation, maintenance, repair, rehabilitation and replacement of flood control facilities.

2. AUTHORIZATION

The American River Common Features Project was authorized by Section 101(a) (1) of the Water Resources Development Act (WRDA) of 1996 (Pub. L. No. 104-303, § 101(a)(1), 110 Stat. 3658, 3662-3663 (1996)), as amended. Amendments to this authority are as follows: 1) Section 366 of WRDA of 1999 (Pub. L. 106-53, § 366, 113 Stat. 269, 319-20 (1999)); 2) Section 129 of the Energy and Water Development Appropriations Act (EWDAA) of 2004 (Pub. L. No. 108-137, §129, 117 Stat. 269, 1839 (2003)); 3) Section 130 of the Consolidated Appropriations Act (CAA) of 2008 (Pub. L. No. 110-161, § 130, 121 Stat. 1844, 1947 (2007)); and 4) Section 7002 of the Water Resources Reform and Development Act (WRRDA) of 2014 (Pub. L. No. 113-121, §7002,128 Stat. 1193, 1366 (2014)).

The project authorized in WRDA 1996 covers seepage and stability improvements identified in all candidate plans included in the 1996 Supplemental Information Report. Once the Folsom Dam Modification project was identified and authorized in WRDA 1999, the American River Common Features Project needed to be modified which is the basis for the WRDA 1999 amendment. The total construction cost and 902 limit was adjusted in the EWDAA 2004 amendment. Credit provisions for the non-Federal sponsor were modified in the CAA 2008 amendment. Additional features for the Natomas Basin were included in the WRRDA 2014 amendment. The current estimated cost of the authorized project not including the Natomas features is $320,700,000. The Natomas features current estimated cost is $1,147,280,000.

In 2006, several features were approved using the Chief of Engineers' discretionary authority. These features include installing a total of 3.6 miles of discontinuous slurry wall at nine levee sites on the Sacramento River beginning at Levee Mile 2.9 and ending at Levee Mile 10.3 in the Pocket Area and installing six relief wells and collector drains and appurtenant features and a landside berm on the Sacramento River levee toe in the Pioneer Reservoir area. The Pocket Area is between Interstate 5 and the east side of the Sacramento River, south of the confluence with the American River, near the

southern boundary of the Common Features project area. It extends from river mile 53.6 to 45.3. The name reflects the shape of the area. The Pioneer Reservoir project area is located adjacent to the Sacramento River in the City of Sacramento; just upstream of the Pioneer Bridge that U.S. Highway 50 uses to cross the Sacramento River. The project runs in a north-south direction and is bounded on the north by Capitol Mall, on the south by U.S. Highway 50, on the east by Pioneer Reservoir, and on the west by the Sacramento River.

The Chief's Report for the Natomas Interim General Reevaluation Report (GRR) was signed in December 2010. This report was prepared in order to authorize improvements to the levees surrounding the Natomas Basin while developing an overall GRR for the Common Features project, lessen risk in the Natomas Basin, to implement "no regrets" measures while developing the long-term strategy of flood risk management measures for the Sacramento metropolitan area, and to evaluate the sponsor's Natomas Levee Improvement Plan (NLIP) to establish the degree of Federal financial participation in this plan, building upon the Section 408 approved features being implemented by SAFCA.

3. FUNDING SINCE AUTHORIZATION

Since the project's authorization as part of WRDA 1996 and WRDA 1999, portions of the project have been implemented by the Corps of Engineers under a Project Cooperation Agreement (PCA) executed with the California Reclamation Board (now the Central Valley Flood Protection Board) in July 1998. Work sites are shown above in Table PAC-1.

A funding history, by fiscal year, is shown in Table PAC-2, History of Federal Funding, indicating the category in which funds have been appropriated and the items of work (listed in Table PAC-1) for which the funds have been utilized.

Table PAC-2: History of Federal and Non-Federal Funding.

Fiscal Year	Federal Funding				Non-Federal Funding	Use of Funds (Items listed in Table PAC-1)
	General Investigation	Construction General Appropriated	American Recovery and Reinvestment Act	Construction General Allocated (Actual)		
1996	$864,000					Completion of feasibility study
1997	$1,662,000					PED for Item 1
1998	$125,000	$9,400,000		$ 5,828,000	$1,418,000	PED for Item1
1999		$15,000,000		$ 6,738,000	$6,130,100	PED & Construction for Item 1
2000		$17,000,000		$ 13,179,000	$1,075,000	PED & Construction for Item 1
2001		$10,000,000		$ 26,622,000	$7,372,434	PED & Construction for Item 1
2002		$14,000,000		$16,322,000	$6,699,881	PED & Construction for Item 1
2003		$22,280,000		$13,499,900	$2,330,000	PED & Construction for Item 1
2004		$4,000,000		$4,908,000	$667,750	PED for Items 1 and 11; Construction of Item 1
2005		$5,000,000		$4,142,000	$808,643	PED Items 1, 5, and 11; Construction of Item 1
2006		$4,405,000		$4,361,000	$5,822,990	PED for Items 1 and 5; Construction Items 1, 11
2007		$19,400,000		$19,400,000	$0	PED Items 1, 5, and 10; Construction Items 1, 5
2008		$7,872,000		$9,372,000	$3,863,000	PED Items 1, 5, 6, 9, 10; Construction - 1, 5, 10
2009		$13,000,000	$13,700,000	$14,000,000	$4,206,670	PED Items 1, 5, 6, 9, 10; Construction - 1, 5, 10
2010		$6,300,000	$2,700,000	$7,330,000	$5,270,000	PED Items 1, 6, 9, 10; Construction Items 1, 5
2011		$15,000,000	($230,000)	$14,824,985	$9,400,000	PED Items 1, 6, 9, 10; Construction Items 1, 5
2012		$25,037,000	($111,405)	22,037,000	$0	PED Items 1,9,10 Construction Items 1,9,10
2013		$13,572,800		$13,572,800	$8,500,000	PED Items 1,9,10 Construction Items 1,9,10
2014		$25,538,000	($2,000)	$$26,108,000	$6,987,468	PED Items Construction Items
2015		$0		$0		PED Items Construction Items
Total	**$2,651,000**	**$226,804,800**	**$16,056,595**	**$196,136,685**	**$70,551,936**	

4. CHANGES IN SCOPE OF AUTHORIZED PROJECT

ER 1105-2-100, Appendix G, paragraph G-12 defines changes in scope as increases or decreases in the outputs for the authorized purposes of a project. Outputs are the project's physical effects which have associated benefits. Change in the degree of reduction in flood stages is a change in project outputs. In spite of previous and ongoing work to reduce the risk of flooding in the study area, the Sacramento Metropolitan area remains one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the American or Sacramento Rivers will stress the network of levees protecting the study area to the point that levees could fail. The effects of such a levee failure would be catastrophic since the inundated area is highly urbanized and the flooding would be up to 20 feet deep. The scope of the authorized project is not adequate to cost-effectively address the residual flood risk for the greater Sacramento area. Therefore, the current GRR recommends a significant increase in the scope of the authorized project. The recommended changes in the authorized project scope are discussed in Table PAC -3 and in Table PAC-4.

Table PAC-3: Changes in Scope of the Authorized Project.

Location	Authorized Project	GRR Recommended Plan
American River	22 miles of seepage and stability levee improvements	11 miles of rock erosion protection to convey flows from Folsom reservoir
Sacramento River	12 miles of levee improvements in Natomas	9 miles of levee improvements in the city of Sacramento to reduce probability of levee failure
	5 miles of levee modifications to the Natomas Cross Canal	
Tributaries	None	4 miles of seepage and stability improvements and 7.5 miles of levee raises to reduce probability of levee failure
Sacramento Bypass	None	Widen Sacramento Weir and bypass to divert increased flows to bypass to reduce the water surface elevation in the Sacramento River

The Sacramento Area Flood Control Agency (SAFCA) has submitted a notice to USACE that they intend to request a Section 408 permission to modify a portion of the Federally authorized flood management system within the study area. SAFCA has indicated that the Section 408 permission will include improvements to portions of the Sacramento River East Levee, the Arcade Creek North and South Levees and the NEMDC East Levee to address identified levee seepage and embankment and foundation stability problems. The Section 408 permission would also include bank protection improvements along several segments of the Sacramento River East Levee totaling approximately 3,000 feet to address erosion that is undermining the stability of the waterside slope of the levee. Further, the Section 408 permission will include the removal of high hazard levee vegetation and encroachments along portions of the American River North and South Levees, the Sacramento River East Levee, the Arcade Creek North and South Levees, Dry Creek North Levee, Robla Creek South Levee and the NEMDC East Levee, as well as implementation of a conservation strategy that would compensate for the effects of the levee

improvements on fish and wildlife habitat and includes an integrated flood conveyance and habitat improvement plan for managing vegetation in the NEMDC. It is further anticipated that SAFCA would seek Section 221 credit approval for the portions of the ARCF project they construct after release of this draft GRR but prior to authorization.

Table PAC-4: Changes in the Authorized Project.

Location	Authorized Features	Recommended New Features
Lower American River	Modify 12 miles of north bank levee on American River to reduce chance of seepage through the existing levee. (WRDA 1996) Construct slurry wall down centerline of existing levee to better withstand hydraulic forces during higher water stages	Rock bank protection and launchable rock trenches to address erosion problems along 4 miles of the American River north bank levees
	Modify 12 miles of south bank levee on American River to reduce chance of seepage through the existing levee. (WRDA 1996) Construct slurry wall down centerline of existing levee to better withstand hydraulic forces during higher water stages	Rock bank protection and launchable rock trenches to address erosion problems along 7 miles of the American River south bank levees
	Install 3 telemetry stream flow gauges upstream of Folsom Reservoir (WRDA 1996)	None.
	Modification to the flood warning system along the Lower American River for the city of Sacramento. (WRDA1996)	None.
	Raise left bank non-Federal levee upstream of Mayhew Drain for a distance of 4,500 feet by average of 2.5 feet. (WRDA 1999) Raise right bank of American River levee from 1,500 feet upstream to 4,000 feet downstream of Howe Ave Bridge by average of 1 foot. (WRDA 1999) Install gates at existing Mayhew Drain culvert and pumps to prevent backup of floodwater on land side of gates. (WRDA 1999) Install slurry wall in north levee of American River from east levee of NEMDC upstream for approx. 1.2 miles. (WRDA 1999) Install slurry wall in north levee of American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to end of existing levee.(WRDA 1999) Widen 2 miles of levee in place and install seepage cutoff wall through levee and foundation on the Lower American River adjacent to Natomas basin. (WRRDA 2014)	None.
Natomas – Sacramento River	Modify 12 miles of levee on east (left) bank of Sac River below NCC. (WRDA 1996) Widen 18.3 miles of existing levee by construction of an adjacent levee, install 12.3	None.

Location	Authorized Features	Recommended New Features
	miles of deep seepage cutoff walls, and install 8.3 miles of seepage berm, all on east bank of Sac River below NCC (WRRDA 2014).	
Natomas – Pleasant Grove Creek Canal	Widen existing levee in place and install soil bentonite cutoff wall that ranges between 65 and 70 feet deep (WRRDA 2014).	None.
Natomas - Natomas East Main Drain	Widening of 12.8 miles of the existing levee and installation of 10.7 miles of soil bentonite cutoff wall (WRRDA 2014).	None.
Natomas – Natomas Cross Canal	Modify south levee of Natomas Cross Canal for 5 miles and ensure levee provides consistent level of protection as provided on east bank of Sac River. (WRDA 1999) Widening of 5.5 miles of existing levee using in-place construction and install deep seepage cutoff walls on south bank of Natomas Cross Canal (WRRDA 2014).	None.
	Modify north levee of NCC for 5 miles in parity with south levee. (WRDA 1999)	None
Pioneer Site – Sacramento River	At RM 58.5 – left bank of Sacramento River: Seepage berm 5 feet from ground level and 500 feet long with relief wells(a total of six) on both the north and south end of the berm (Chief's Discretionary Authority)	None
Pocket Area Sites – Sacramento River	Strengthen levee with slurry wall down centerline of levee at Pocket Site 2 – approx. 0.3 miles (RM 52.1-52.4)and Pocket Site 9 – approx. 0.3 miles (RM 45.5-45.7) (Chief's Discretionary Authority)	None
Sacramento River		Construct about 9 miles of slurry cutoff walls to address levee seepage and stability problems and about 10 miles of rock bank protection to address erosion problems along east levee, as well as about 2.5 miles of geotextile stabilized slope and 2 miles of slope flattening to address levee stability and less than 1 mile of levee raise.
NEMDC		Construct 1.5 miles of slurry cutoff wall.
Arcade Creek		Construct 2.6 miles of slurry cutoff wall, raise 4 miles of floodwall and remove ditch on landside toe.
Magpie Creek		Purchase floodplain easement, raise 2,100 feet of levee and construct 1,000 feet of new levee.
Sacramento Weir and Bypass		Widen Weir and Bypass by 1,500 feet to reduce the water surface elevation in the Sacramento River and allow more water to flow into the Bypass system

5. CHANGES IN PROJECT PURPOSE

There are no changes in the project purpose. Flood risk management is the single project purpose for both the authorized project and the reevaluation study.

6. CHANGES IN LOCAL COOPERATION REQUIREMENTS

As indicated above, the non-Federal sponsor for the project is the CVFPB. SAFCA has a Local Cooperation Agreement with the CVFPB.

The project was originally authorized with cost sharing of 75% Federal and 25% non-Federal specifically named in the legislation. Conventional cost sharing under the requirements of WRDA 1986 as amended for flood risk management projects is 65% Federal and 35% non-Federal. The ASA (CW) has approved a waiver to recommend the Locally Preferred Plan (LPP) with the stipulation that the non-Federal share would include 100 % of the LPP increment above the NED costs. Applying these requirements, the Federal portion of the estimated total first cost of the LPP would be about 55.7% and the non-Federal share would be about 44.3%.

The State of California and SAFCA have expressed the desire for implementing the project and sponsoring project construction in accordance with the items of local cooperation that are set forth in the recommendations chapter. The non-Federal sponsors have certified that they are financially capable of participating in the tentatively selected plan.

7. CHANGE IN LOCATION OF PROJECT

There is no change in the project location.

8. DESIGN CHANGES

The draft report describes the recommended design changes. These design changes consist of construction of cutoff walls that are significantly deeper than originally envisioned. In addition, compliance with Engineer Technical Letter (ETL) 1110-2-583 (Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures) regarding vegetation, encroachments and access will be achieved through a combination of construction actions associated with implementation of the recommended plan and formal agreements (such as a Systemwide Improvement Framework, known as a SWIF as well as a vegetation variance).[1] These changes are shown in Table PAC-5.

[1] WRRDA 2014 (Pub. L. No. 113-121) contains language that will affect the guidelines presented in ETL 1110-2-583; implementation guidance is expected within one year

Table PAC -5: Design Changes.

Feature	Authorized Project	GRR Recommended Plan
Erosion Protection	none	Need for erosion protection was previously not well understood. Analysis informed the need for 11 miles on the American and 10 miles on the Sacramento River due to high velocities
Seepage and Stability	Shallow cutoff walls were designed to address levee through seepage.	Additional analysis showed problems with deep underseepage under the levees requiring much deeper and more expensive cutoff walls
Overtopping	Need for levee raises identified along the American River	Additional needs for levee raises identified along the Sacramento River and the Tributaries
Sacramento Bypass	None	This feature addresses overtopping concerns by diverting flows into the bypass and thereby lowering the water surface elevation in the Sacramento River.

9. CHANGES IN TOTAL PROJECT FIRST COSTS

Table PAC-6, Authorized Project First Cost, is a tabulation of the comprehensive project authorized by Congress and the authorized project updated to current price levels. Table PAC-7, Project First Cost, is a comparison of the estimated cost for the recommended plan and the authorized project updated to current price levels.

Table PAC-6: Previously Authorized Project First Cost ($1,000s).

Construction Item	WRDA 1996/1999 Features			Natomas PACR Authorized Cost (WRRDA 2014) [4]	Total Current Estimate Authorized Cost[5]
	Authorized Cost (2004) [1]	Reported to Congress (2010) [2]	Current Project Cost Estimate (2014) [3]		
Lands and Damages	$5,750	$17,173	$15,668	$235,522	$251,190
Relocations	$460	$381	$381	$118,967	$119,348
Fish & Wildlife Facilities	$1,730	$2,075	$3,952	$18,956	$22,908
Levees & Floodwalls	$153,760	$169,497	$189,075	$396,462	$585,537
Pumping Plants	$0	$0	$0	$56,884	$56,884
Cultural Resource Data Recovery	$750	$1,190	$0	$6,701	$6,701
Subtotal	**$162,450**	**$190,316**	**$209,076**	**$833,492**	**$1,042,568**
Planning Engineering & Design (PED)	$35,380	$71,604	$96,953	$152,609	$249,562
Construction Management	$7,170	$16,060	$14,671	$161,179	$175,850
Total Costs	**$205,000**	**$277,980**	**$320,700**	**$1,147,280**	**$1,467,980**

[1] Authorized Cost is as reflected in the 2002 American River Watershed Project (Common Features), CA, Second Addendum to the Supplemental Information Report and authorized by Congress in 2004 (EWDAA). This is the last authorization by Congress for the WRDA 1996/1999 features. Authorized costs are in October 2001 prices.

[2] The Authorized Cost, adjusted for inflation, and last reported to Congress was in 2010 in the Natomas PACR. October 2010 prices.

[3] The Authorized Cost, adjusted for inflation to 2014 price level is $320,700,000.

[4]The recommended plan contained in the Natomas PACR was authorized by WRRDA 2014 (Pub. L. No. 113-121). This GRR assumes the features described in the Natomas PACR are constructed.

5 Natomas PACR Authorized Cost Estimate (totaling $1,147,280,000) plus the current Project Cost Estimate for the WRDA 1996/1999 Authorized Project (totaling $320,700,000) for a total of $1,467,980,000.

Table PAC-7: Combined Previously Authorized and GRR Recommended Project First Cost ($1,000s).

Construction Item	Total Current Estimate Authorized Cost[1]	GRR Recommended Plan[3]	Combined Plans [2]
Lands and Damages	$251,190	$95,8629	$347,052
Relocations	$119,348	$158,437	$277,785
Fish & Wildlife Facilities	$22,908	$96,220	$119,128
Roads, Railroads, & Bridges	$0	$25,798	$25,798
Levees & Floodwalls	$585,537	$465,656	$1,051,193
Pumping Plants	$56,884	$0	$56,884
Floodway Control and Diversion Structure	$0	$54,401	$54,401
Bank Stabilization	$0	$381,220	$381,220
Cultural Resource Data Recovery	$6,701	$8,237	$14,938
Subtotal	$1,042,568	$1,285,831	$2,328,399
Planning Engineering & Design (PED)	$249,562	$186,551	$436,113
Construction Management	$175,850	$93,368	$269,218
Total Costs	**$1,467,980**	**$1,565,750**	**$3,033,730**

[1]Includes the costs reported in Table PAC-6. .

[2] Combined Plans reflects the American River Common Features Project GRR as reported in this document (totaling $1,596,649,000) plus the current Project Cost Estimate displayed in Table PAC-6 for the Authorized Project (totaling $1,467,980,000) for a total of $3,064,629,000

[3] The total first cost presented here is the project first cost column from the Certified Cost TPCS.

The changes in cost are a result of the following findings and recommendations:

1. Sacramento River: Previous estimates for the authorized project assumed shallow cutoff walls would address the levee seepage and stability problems. It has since been determined that much deeper (and more expensive) cutoff walls will be required to address the problem that is comprised of not only levee through seepage, but deep underseepage as well. Additional erosion protection has also been identified. The levee is also very steep in certain areas and will require slope stabilization and flattening that was not included in previous estimates. Finally, about 1 mile of new levee raise will be needed that was not previously recommended.
2. American River: The extent of the erosion problem was not well understood when the documents for the earlier authorized projects were being prepared. A subsequent erosion analysis has been used to develop the current recommendation of 11 miles of erosion protection along the American River.
3. Eastside Tributaries: Deep slurry cutoff walls are recommended to address levee seepage and stability problems that were not previously included as well as levee raises to address potential overtopping of floodwaters along the NEMDC, Arcade Creek, and Dry Creek levees.
4. Sacramento Bypass: the previously authorized project does not include this feature.

10. CHANGES IN PROJECT BENEFITS

Table PAC-8 shows a comparison of the benefits given in the project document, the benefits last reported to Congress, and the benefits based on reevaluations that have been done to support the recommended changes to the project. The evaluation of benefits has been limited to those that would accrue to structures and contents and do not include other benefit categories at this time, such as savings in emergency costs. An extensive structure inventory was conducted and non-residential content valuations were developed using depth-percent damage curves. Other updated data that helped refine the benefit calculations included the number of sources of flooding (American River, Sacramento River, Natomas East Main Drainage Canal, Arcade Creek and Dry/Robla Creeks) used to estimate flood risk, the consequence area considered, the levee fragility curves (geotechnical), the Folsom Dam routings (hydrology) and the rating curves and Floodplains (hydraulics).

Table PAC-8: Benefit Comparison ($1,000s).

	WRDA 1996/1999 Features			Authorized Natomas PACR Benefits (WRRDA 2014)	GRR Recommended Plan
	Authorized Project Benefits(2004) [1]	Benefits last Reported to Congress (2010)	Current Project Benefits (2014)		
Benefits	$42,300	$59,500	$59,500	$443,000	$502,500

[1] Benefits for the Authorized Project reflects the 2001 Limited Reevaluation Report, and authorized by Congress in 2004 (EWDAA) which is the last authorization by Congress for the WRDA 1996/1999 features, adjusted for inflation to 2014 along with the recommended plan contained in the Natomas GRR which was authorized by WRRDA 2014 (Pub. L. No. 113-121).

11. BENEFIT-COST RATIO

Table PAC-9 shows the benefit-to-cost ratio of the Recommended Plan. It also shows a comparison of the benefit-cost ratios for the Recommended Plan and the authorized project updated to current price levels and the current discount rate. The estimated total annual benefits are calculated at a discount rate of 3.375 percent, over a 50-year period of economic evaluation.

Table PAC-9: Benefit – Cost Ratio.

	WRDA 1996/1999 Features			Authorized Natomas PACR (WRRDA 2014)	Total Project
	Authorized Project (2004)	Project last Reported to Congress (2010)	Project Updated to Current Price Levels (2014)		
Benefit-Cost Ratio	**NA**	**4.0**	**NA**	**7.6**	**8.6**

12. CHANGES IN COST ALLOCATION

There are no changes in cost allocation for the project. All costs are allocated to the flood risk management project purpose for both the Recommended and Authorized projects.

13. CHANGES IN COST APPORTIONMENT

Table PAC-10, Changes in Cost Apportionment, shows the Federal and non-Federal costs of the authorized project and the recommended plan at current price levels Table PAC-11, Funding Requirements, shows the Federal and non-Federal costs of the recommended project at current price levels. For those areas along the lower American River, the improvements authorized in WRDA 1996 and WRDA 1999, the cost share is 75% Federal and 25% non-Federal. For those areas in the Natomas Basin, the improvements authorized in WRRDA 2014, the cost share is 65% Federal and 35% non-Federal. The Recommended Plan from this GRR is a Locally Preferred Plan (LPP). USACE has received a policy waiver from the ASA(CW) to recommend this LPP with the stipulation that Federal participation be limited to 65% of the NED plan. Therefore, the cost apportionment of the Recommended Plan would be approximately 55.7% Federal and 44.3% non-Federal.

Table PAC-10: Changes in Cost Apportionment ($1,000s, Oct. 2015 Price Levels).

Item	Federal Cost	Non-Federal Cost	Total Cost
Authorized Common Features Project (includes WRDA 1996, WRDA 1999, and EWDAA 2004)			
Construction	$193,027	$0	$193,027
LERRD	$2,263	$13,786	$16,049
PED	$96,953	$0	$96,953
Construction Management	$14,671	$0	$14,671
Subtotal	$306,914	$13,786	$320,700
Minimum 5% cash contribution	-$16,035	$16,035	
Additional cash contribution	-$50,354	$50,354	
Subtotal FRM First Cost	$240,525	$80,175	$320,700
Percent of Total FRM	75.0%	25.0%	
Cultural Resources Data Recovery	$0	$0	$0
Total FRM First Cost	$240,525	$80,175	$320,700
Authorized Common Features Project (includes WRRDA 2014)			
Construction	$472,302	$0	$472,302
LERRD	$19,572	$334,917	$354,489
PED	$132,370	$20,239	$152,609
Construction Management	$153,240	$7,939	$161,179
Subtotal	$777,484	$363,095	$1,140,579
Minimum 5% cash contribution	-$57,029	$57,029	
Additional cash contribution	$0	$0	
Subtotal FRM First Cost	$720,455	$420,124	$1,140,579
Percent of Total FRM	63.2%	36.8%	
Cultural Resources Data Recovery	$6,701	$0	$6,701
Total FRM First Cost	$727,156	$420,124	$1,147,280
GRR Recommended Plan			
Construction	$1,023,295	$0	$1,023,295
LERRD	$8,975	$245,324	$254,299
PED	$186,551	$0	$186,551
Construction Management	$93,368	$0	$93,368
Subtotal	$1,312,189	$245,324	$1,557,513
Minimum 5% cash contribution	-$77,876	$77,876	
Additional cash contribution	-$366,072	$366,072	
Subtotal FRM First Cost	$868,241	$689,272	$1,557,513
Percent of Total FRM	55.7%	44.3%	
Cultural Resources Data Recovery	$8,237	$0	$8,237
Total FRM First Cost	$876,478	$689,272	$1,565,750
Combined Common Features Projects[1]			
Construction	$1,688,624	$0	$1,688,624
LERRD	$30,810	$594,027	$624,837
PED	$415,874	$20,239	$436,113
Construction Management	$261,279	$7,939	$269,218
Subtotal	$2,396,587	$622,205	$3,018,792
Minimum 5% cash contribution	-$150,940	$150,940	
Additional cash contribution	-$416,426	$416,426	
Subtotal FRM First Cost	$1,829,221	$1,189,571	$3,018,792
Percent of Total FRM	60.6%	39.4%	
Cultural Resources Data Recovery	$14,938	$0	$14,938
Total FRM First Cost	$1,844,159	$1,189,571	$3,033,730

[1]Costs shown for informational purposes only and not for establishing Section 902 limit.

Table PAC-11: Federal Appropriations Funding Requirements ($1,000s).

	Federal Appropriations
Authorized Common Features Protect (includes WRDA 1996, WRDA 1999, & WRRDA 2014)	$967,681
GRR Recommended Plan	$876,478
Total Appropriations	$1,844,159

14. ENVIRONMENTAL CONSIDERATIONS IN RECOMMENDED CHANGES

The effects to the environment have been considered throughout the planning phase of the project and opportunities have been evaluated to reduce effects to resources within the project area. A vegetation variance will be sought for the project, which will allow vegetation to stay on the lower half of the waterside levee slope. The waterside vegetation is valuable Shaded Riverine Aquatic Habitat (SRA) habitat for many State and Federally listed fish species, and provides habitat for the Federally threatened Western yellow-billed cuckoo and the State-listed Swainson's hawk. Although mitigation for State listed species is not necessarily required for a Federal project, these impacts also affect Federally listed species and would be required under Section 7 Endangered Species Act (ESA) consultation with National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). During the design phase of the project opportunities will be taken to choose a design that will minimize effects to the American River Parkway where feasible. The Parkway provides habitat for the Federally threatened valley elderberry longhorn beetle and Western yellow-billed cuckoo.

Additionally, in order to avoid jeopardizing the Federally listed green sturgeon, a number of additional measures have been incorporated in the project per the terms of the NMFS Biological Opinion to include modeling, monitoring, and mitigation for this species. The details of this effort are included in the NMFS Biological Opinion in Appendix J of the EIS/EIR, and in the Mitigation and Monitoring Plan in Appendix I of the EIS/EIR. Additionally, Table 4-3 of the GRR presents the habitat mitigation required by the Biological Opinions and recommended by the Fish and Wildlife Coordination Act Report and the costs associated with that mitigation.

Additionally, air quality emissions associated with construction of the project would be above *de minimus* levels, however, the implementation of mitigation measures will reduce the emissions to less than significant levels. There is also the potential for significant effects to local residents from increased noise during construction. In order to mitigate for these effects, USACE would coordinate with local residents and implement Best Management Practices (BMPs) to reduce noise effects.

The recommended plan would require discharge of fill material into Waters of the U.S., therefore a Section 404(b)(1) analysis has been conducted and appropriate mitigation measures have been identified. The 404(b)(1) Analysis is included as Appendix E of the EIS. A Section 401 water quality

certification will be requested from the Central Valley Regional Water Quality Control Board during the design phase of the project. In addition, construction of the project would require a National Pollutant Discharge Elimination System permit and a Stormwater Pollution Protection Plan, which would be acquired prior to construction. With the completion of these requirements this project would be in full compliance with the Clean Water Act.

In accordance with 36 CFR § 800, the regulations implementing Section 106 of the NHPA, USACE has determined that the ARCF GRR will likely result in adverse effects to historic properties. In order to take into account the effects of the proposed undertaking on historic properties, USACE has executed a Programmatic Agreement (PA). USACE has consulted with interested parties, the SHPO, the ACHP, DWR, the CVFPP, SAFCA, and American Indian tribes and individuals in the development of the PA. The PA was sent to potentially interested Native Americans, requesting their comments and interest in signing the PA as concurring parties. All comments from all parties were considered in the development of the PA. The PA was executed by signature from USACE and the SHPO on September 10, 2015; as a result, USACE is in compliance with Section 106. The PA is included in Appendix C of the EIS.

The recommended plan would also require the acquisition of properties for construction and flood control easements, resulting in the conversion of agricultural lands to flood control easements. The project would comply with the Relocation Assistance and Real Property Acquisition Policies Act to mitigate for these effects.

15. PUBLIC INVOLVEMENT

The USACE published a Notice of Intent (NOI) to prepare the American River Common Features General Reevaluation Report (GRR) EIS in the Federal Register (Vol. 73, No. 41) on February 29, 2008. On November 5, 2009, SAFCA issued a Notice of Preparation (NOP) for the EIS/EIR.
The draft GRR was circulated for public comment on March 13, 2015 and a series of Public Workshops were held during the public comment period. Public input was taken into consideration and the comments received are included as an appendix to the EIS/EIR. Additional information on public involvement is located in Chapter 6 of the GRR and in the accompanying EIS/EIR.

16. HISTORY OF PROJECT

The history of the American River Common Features study can be described as an evolution of the understanding of the extent of the flood problem. The flood management system was sized in response to several large flood events in the early 1900s. Since that time, the study area has experienced approximately eight significant storm events, three of which were larger than those early storms. More recent flood events have exposed the potential for both levee through- and under-seepage; prior to the 1997 flood event, under-seepage was not well understood nor thought to be a probably mode of levee failure. Additionally, an erosion analysis was conducted for the American River which raised concerns with regards to the potential for an erosion induced levee failure. This additional experience with these

later flood events and the analysis conducted with regards to through- and under-seepage and erosion have shown us the probability of a levee failure is far worse than previously thought.

In February 1986, the Sacramento area experienced a very large storm event which rapidly filled Folsom reservoir just upstream from the city of Sacramento. Because of the rapid inflow, the Dam operators agreed that the release from Folsom Dam needed to be raised above the objective release of 115,000 cfs to manage the risk. The release from Folsom Dam was increased to 134,000 cfs. This flow was picked to balance the risk between having to shortly thereafter make a larger release than 134,000 cfs and causing further risk to the levees versus managing the risk of a dam failure. This flow seriously stressed the American River levees and came dangerously close to causing levee failures into the City of Sacramento.

After the flood of 1986, Congress directed the Corps to investigate the feasibility of reducing the flooding risk of the City of Sacramento. The Corps completed that feasibility study in 1991. The recommended plan in this study was a concrete gravity flood detention dam at the Auburn Dam location along with levee improvements downstream of Folsom Dam. Due to environmental and cost concerns, Congress chose not to authorize the detention dam and instead directed the Corps to supplement the analysis of flood control options considered in the 1991 study. This supplemental study was completed in 1996.

The additional analyses requested by Congress were presented in the Supplemental Information Report American River Watershed Project, California, dated March 1996. This report also recommended a concrete gravity flood detention dam at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were “common” to all candidate plans in the report and that there was a Federal interest in participating in these “common features.” Thus, the American River Common Features Project was authorized and a decision on Auburn Dam was once again deferred to a later date.

Congress authorized improvements for Folsom Dam in 1999. By doing this, improvements to levees downstream of Folsom Dam could be fine-tuned to work closely with the Folsom Dam improvements being discussed by Congress. The improvements being discussed for Folsom Dam involved control of a 200-year flood event with a peak release of 160,000 cfs. Therefore, the Common Features project was modified by WRDA 1999 to include additional necessary features for the American River so that it could safely convey an emergency release of 160,000 cfs. Also authorized in WRDA 1999 was the Folsom Dam Modifications project (modifications of the existing outlets of Folsom Dam), which would allow for higher releases from Folsom Dam earlier in flood events. At the same time, Congress also directed the Corps to review additional modifications to the flood storage of Folsom Dam, indicating that Congress was looking at maximizing the use of Folsom Dam for flood damage reduction prior to consideration of any additional storage on the American River. The Folsom Dam Raise project was subsequently authorized by Congress in the Energy and Water Development Appropriations Act for 2004.

Major construction components for Common Features in the WRDA 1996 authorization include construction of seepage remediation along approximately 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas. Major construction components for Common Features in the WRDA 1999 authorization include construction of seepage remediation and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5 miles of Natomas Cross Canal levee in Natomas. Note that there are other construction components for both WRDA 1996 and 1999 that are not described here.

All American River features authorized in WRDA 1996 and 1999 will be completed by fall 2015. Natomas features authorized in WRDA 1996 and 1999 were deferred. The reason for this deferral is described in the following paragraphs.

Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5 and on both the north and south bank of the American River. Seepage on the Sacramento River was so extensive that Congress soon after the 1986 flood event funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport. At the time, only seepage through the levees was considered to be the seepage problem affecting the City of Sacramento.

After construction of the Sac Urban project, geotechnical evaluation of levees in the vicinity of the City of Sacramento showed that deep underseepage was of concern. Shortly thereafter, the Sacramento Valley experienced a flood event in 1997. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was to be expected because remediation had yet to be constructed, but the occurrence of significant seepage on the Sacramento River in the reach remediated as part of the Sac Urban project was alarming and confirmed that deep underseepage was also of significant concern (this conclusion was also later confirmed by the levee seepage task force in 2003).

As a result of this conclusion, seepage remediation on the American River (then in the late 1990s in the design phase) would need to be designed to remediate both through- and deep underseepage. This additional effort led to considerable cost increases over what was originally authorized by Congress and has led to two increases in the authorized cost for the Common Features project. WRDA 1999 increased the cost when it added components to $91.9 million from the original $56 million authorized in 1996. The Energy and Water Development Appropriations Act 2004 (Pub. L. No. 108-137) increased the authorized cost to $205 million. The report to Congress recommending this increase recognized that significant additional work was going to be needed in Natomas and would result in additional authorized cost increases which would be the subject of a future report.

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress throughout the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a reevaluation study would be required for at least the Natomas Basin portion of the Common Features project. However, for a variety of reasons, this reevaluation was not begun until 2006.

At approximately the same time that the revaluation study was beginning for Common Features, the Folsom Dam Post Authorization Change report (PAC) was being completed by the Sacramento District. Results of this study, and the follow-on Economic Reevaluation Report (ERR) for Folsom Dam improvements, showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to truly capture the benefits of the Folsom Dam projects. These levee issues consisted primarily of erosion concerns on the American River and seepage, stability, erosion, and height issues on the Sacramento River below the American River. However, the full extent of these levee issues was not known. (With the construction of the Sac Urban project, it was thought that the seepage and stability problems had been addressed. However, the 1997 flood event proved otherwise.) Because of this, it was realized that additional reevaluation studies were also needed to include the additional two basins comprising the City of Sacramento, as well as the Natomas Basin. Natomas features were analyzed in the Natomas PACR completed in 2010. The recommendations included in that report were authorized in WRRDA 2014 and design work has begun.

1 - STUDY INFORMATION

This chapter provides basic background for the reevaluation of the American River Common Features (ARCF or Common Features) Project. It also lists the steps in the Federal planning process and relates them to the organization of this report.

1.1 PURPOSE AND SCOPE

This report presents the findings of a general reevaluation study of the authorized Common Features Project. The study was conducted to determine whether there is a Federal interest in modifying the authorized project for flood risk reduction in the Greater Sacramento Area at the confluence of the Sacramento River and the American River. Flooding in the City of Sacramento and surrounding urban areas would have devastating economic, social, political, and demographic consequences for the region, and for the State of California as a whole. The existing levees are not capable of safely passing large flood flows on the American River and the Sacramento River. This study proposes additional measures to reduce the risk of flooding in the Sacramento area. These measures are evaluated in the context of current and planned flood risk reduction measures elsewhere in the watersheds of both rivers.

The Common Features Project is one of several flood risk management projects authorized within the American River Watershed in Northern California. The project is also within the greater Sacramento River Watershed, and is part of an overall flood management system in place in the Sacramento Valley since the early 1900s, known as the Sacramento River Flood Control Project. The Sacramento River Flood Control Project extends from the river's mouth near Collinsville in the Sacramento-San Joaquin Delta to near Chico Landing in the northern Sacramento Valley. Approximately 980 miles of levee construction were involved in the project, providing flood protection to roughly 800,000 acres of highly productive agricultural lands, the cities of Sacramento, West Sacramento, Yuba City, and Marysville, as well as to numerous other small communities. Although the Sacramento River Flood Control Project levees were often constructed of poor materials such as dredged river soils that would not meet today's engineering standards, the levees are still relied upon to provide flood protection during major storms to over 2 million people in approximately 50 communities with an estimated $39 billion in urban and agricultural development.

1.2 STUDY AUTHORITY

The basic authority for the Corps to study water resource related issues in the American and Sacramento Rivers is Section 209 of the Flood Control Act of 1962 (Pub. L. No. 87-875, § 209, 76 Stat. 1180, 1196-98 (1962)), which authorizes studies for flood control in northern California.

This report was prepared as a general reevaluation study of the American River Common Features Project, which was authorized by Section 101(a) (1) of the Water Resources Development Act (WRDA) of

1996 (Pub. L. No. 104-303, § 101(a)(1), 110 Stat. 3658, 3662-3663 (1996)), as amended. Amendments to this authority are as follows: 1) Section 366 of WRDA of 1999 (Pub. L. 106-53, § 366, 113 Stat. 269, 319-20 (1999)); 2) Section 129 of the Energy and Water Development Appropriations Act (EWDAA) of 2004 (Pub. L. No. 108-137, §129, 117 Stat. 269, 1839 (2003)); 3) Section 130 of the Consolidated Appropriations Act (CAA) of 2008 (Pub. L. No. 110-161, § 130, 121 Stat. 1844, 1947 (2007)); and 4) Section 7002 of the Water Resources Reform and Development Act (WRRDA) of 2014 (Pub. L. No. 113-121, §7002,128 Stat. 1193, 1366 (2014)).

The project authorized in WRDA 1996 covers seepage and stability improvements identified in all candidate plans included in the 1996 Supplemental Information Report. Once the Folsom Dam Modification project was identified and authorized in WRDA 1999, the American River Common Features Project needed to be modified which is the basis for the WRDA 1999 amendment. The total construction cost and 902 limit was adjusted in the EWDAA 2004 amendment. Credit provisions for the non-Federal sponsor were modified in the CAA 2008 amendment. And additional features for the Natomas Basin were included in the WRRDA 2014 amendment. The current estimated cost of the authorized project not including the Natomas features is $320,700,000. The Natomas features current estimated cost is $1,147,280,000. Pertinent sections of these Congressional authorizations are provided below.

1.2.1 Water Resources Development Act of 1996 (P. L. 104-303)

Section 101(a)(1) authorized the American River Watershed , California project, as follows:

> *(A) IN GENERAL. The project for flood damage reduction, American and Sacramento Rivers, California: Report of the Chief of Engineers, dated June 27, 1996, at a total cost of $56,900,000, with an estimated Federal cost of $42,675,000 and an estimated non-Federal cost of $14,225,000, consisting of*
>
> > *(i) approximately 24 miles of slurry wall in the levees along the lower American River;*
> >
> > *(ii) approximately 12 miles of levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal;*
> >
> > *(iii) 3 telemeter stream flow gauges upstream from the Folsom Reservoir; and*
> >
> > *(iv) modifications to the flood warning system along the Lower American River.*
>
> *(B) CREDIT TOWARD NON-FEDERAL SHARE. The non-Federal interest shall receive credit toward the non-Federal share of project costs for expenses that the non-Federal interest incurs for design or construction of any authorized project feature, including credit for work commenced before the date of execution of a cooperation*

agreement for the affected feature. The amount of the credit shall be determined by the Secretary.

(C) [Interim Operation of Folsom Dam and Reservoir – Omitted]

(D) OTHER COSTS. The non-Federal interest shall be responsible for

(i) all operation, maintenance, repair, replacement, and rehabilitation costs associated with the improvements carried out under this paragraph; and

(ii) 25 percent of the costs incurred for the variable flood control operation of the Folsom Dam and Reservoir during the 4-year period beginning on the date of the enactment of the Act and 100 percent of such costs thereafter.

1.2.2 Water Resources Development Act of 1999 (Pub. L. 106-53)

Section 366 of WRDA 1999 modified the Common Features Project to include:

(1) Raising the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet by an average of 2.5 feet.

(2) Raising the right bank of the American River levee from 1,500 feet upstream to 4,000 feet downstream of the Howe Avenue Bridge by an average of 1 foot.

(3) Modifying the south levee of the Natomas Cross Canal for a distance of 5 miles to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River.

(4) Modifying the north levee of the Natomas Cross Canal for a distance of 5 miles to ensure that the height of the levee is equivalent to the height of the south levee as authorized by paragraph (3).

(5) Installing gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates.

(6) Installing a slurry wall in the north levee of the American River from the east levee of the Natomas east Main Drain upstream for a distance of approximately 1.2 miles.

(7) Installing a slurry wall in the north levee of the American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to the end of the existing levee.

(b) COST LIMITATIONS. Section 101(a)(1)(A) of the Water Resources Development Act of 1996 (110 Stat. 3662) is amended by striking "at a total cost of" and all that follows through "$14,225,000," and inserting the following: "at a total cost of

$91,900,000, with an estimated Federal cost of $68,925,000 and an estimated non-Federal cost of $22,975,000,"

(c) COST SHARING. For the purposes of Section 103 of the Water Resources Development Act of 1986 (33 U.S.C. 2213), the modifications authorized by this section shall be subject to the same cost sharing in effect for the project for flood damage reduction, American and Sacramento Rivers, California, authorized by Section 101(a)(1) of the Water Resources Development Act of 1996 (110 Stat. 3662).

1.2.3 Energy and Water Development Appropriations Act of 2004 (Pub. L. 108-137)

Section 129 of the Energy and Water Development Appropriations Act of 2004 provided the following authorization:

The project for flood damage reduction, American and Sacramento Rivers, California, authorized by section 101(a)(1) of the Water Resources Development Act of 1996 (110 Stat.3662–3663) and modified by section 366 of the Water Resources Development Act of 1999 (113 Stat. 319–320), is further modified to direct the Secretary to carry out the project, at a total cost of $205,000,000.

1.2.4 Chief of Engineers' Discretionary Authority

In 2006 it was determined that several additional levee stabilization features would be required. Since the location of these features were within the project area, and necessary for the project as authorized to function as intended, they were approved under the Chief of Engineers' discretionary authority[1] : These features are as follows:

- 3.6 miles of discontinuous slurry wall at nine levee sites beginning at Levee Mile 2.9 and ending at Levee Mile 10.3 on the Sacramento River in the Pocket Area extending from river mile 53.6 to 45.3. The levee sites are located between Interstate 5 and the east side of the Sacramento River, south of the confluence with the American River, near the southern boundary of the Common Features project area.
- Six relief wells, collector drains and appurtenant features, and a landside berm on the levee toe on the Sacramento River in the Pioneer Reservoir area. The Pioneer Reservoir project area is located adjacent to the Sacramento River in the City of Sacramento; just upstream of the Pioneer Bridge (U.S. Highway 50). The project runs in a north-south direction and is bounded on the north by Capitol Mall, on the south by U.S. Highway 50, on the east by Pioneer Reservoir, and on the west by the Sacramento River.

[1] USACE, 2006

1.2.5 Consolidated Appropriations Act of 2008 (Pub. L. 110-161)

Section 130 of the Consolidated Appropriations Act of 2008 provided the following authorization:

> *AMERICAN AND SACRAMENTO RIVERS, CALIFORNIA. Section 101(a)(1)(B) of the Water Resources Development Act of 1996 (Public Law 104–303: 110 Stat. 3662) is modified to read as follows:*
>
> *''(B) CREDIT TOWARD NON-FEDERAL SHARE.—The non-Federal interest shall receive credit toward the non-Federal share of project costs for expenses that the non-Federal interest incurs for design or construction of any authorized project feature, including credit for work commenced before the date of execution of a cooperation agreement for the affected feature. The amount of the credit shall be determined by the Secretary.''*

1.2.6 Water Resources Reform and Development Act of 2014 (Pub. L. 113-121)

The Natomas PACR was approved in December 2010 with a Chief's Report and transmitted to Congress. Recommendations included in the NPACR were authorized by the Water Resources Reform and Development Act of 2014 (WRRDA 2014) (Pub. L. No. 113-121, § 7002, 128 Stat. 1193, 1366 (2014)). Levee overtopping concerns were analyzed but recommendations on this issue were deferred to this ARCF GRR. The seepage and stability work authorized by WRRDA 2014 has not been reevaluated in this document.

1.3 LOCATION AND DESCRIPTION OF THE STUDY AREA

1.3.1 Location

The study area is located within the Sacramento and American River Watersheds, with the focus being on the vicinity of the confluence of these two rivers where they meet within the City of Sacramento (Figure 1-1). The project area includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; approximately 18 miles of the east bank of the Sacramento River immediately downstream of the Natomas Cross Canal (NCC) to the confluence with the American River; and approximately 5 miles of the north and south bank of the NCC immediately upstream of the confluence with the Sacramento River. The study area also includes the improvements to the Natomas East Main Drainage Canal (NEMDC) and Pleasant Grove Creek Canal (PGCC). These features collect flows from Pleasant Grove Creek, Dry Creek, Robla Creek, and Arcade Creek (collectively referred to as the east side tributaries). The study area also includes approximately 14 miles of levees along the east bank of the Sacramento River downstream from the American River to just below the town of Freeport, at which point those levees tie into the Morrison Creek Beach Lake Levee which protects the south side of Sacramento.

The study area has been divided into three subareas that correspond to basins defined by either levees or high ground:

- Natomas Basin (NAT) - The Natomas Basin is located in the northern portion of the project area. The basin is bordered by the Sacramento River to the west, the NCC to the north, the NEMDC and PGCC to the east, and the American River to the south.
- American River North Basin (ARN) – This area is located north of the American River and east of the Natomas Basin. The basin is bordered by the NEMDC to the west and the American River to the south.
- American River South Basin (ARS) – This area is located south of the American River. It is bounded on the north by the American River and on the west by the Sacramento River. This basin includes downtown Sacramento and surrounding neighborhoods.

1.3.2 Watershed Setting

The study area is located at the southern end of the Sacramento River Basin (Figure 1-2). The Sacramento River is the largest river and watershed system in California and transports 31% of the state's total surface runoff. The upper watershed is drained by three rivers; the upper Sacramento River, the McCloud River, and the Pit River, which join at Lake Shasta, a 4.5 million acre foot reservoir formed by Shasta Dam. The Sacramento River then flows south through the northern Central Valley of California. The Sacramento River watershed covers an area of approximately 27,000 square miles. Major tributaries of the Sacramento River include the Feather River, the Yuba River, and the American River.

The American River watershed covers approximately 2,100 square miles northeast of the City of Sacramento and includes portions of Placer County, El Dorado County, Alpine County, and Sacramento County. The major flood risk reduction structure on the American River is Folsom Dam, which impounds Folsom Lake. Streams flowing into Folsom Lake include the north, south, and middle forks of the American River. At their confluence in the Sacramento area, the Sacramento River and American River floodplains cover approximately 110,000 acres and include most of the developed portions of the City of Sacramento.

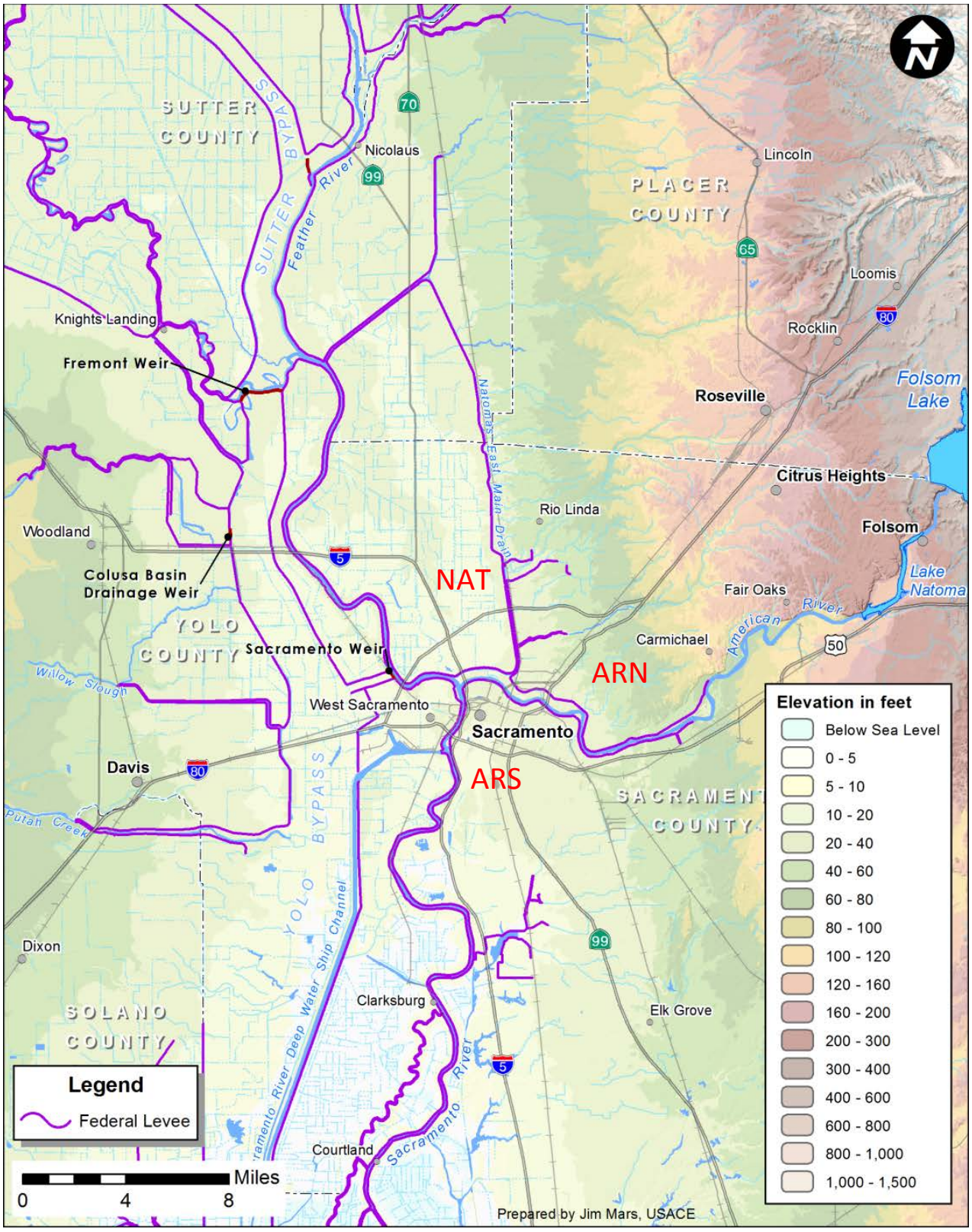

Figure 1-1: Study Area at the Confluence of the Sacramento and American Rivers.

Figure 1-2: Location of the Study Area within the Sacramento River Watershed.

1.3.3 Physical Setting of the Study Area

The study area is located in the Central Valley of California, west of the Sierra Nevada Mountains. The elevation of the study area ranges from approximately 5 feet above mean sea level (MSL) near the town of Freeport to approximately 400 feet MSL near Folsom Dam, with the majority of the study area lower than 100 feet MSL. The study area is geologically part of the Great Valley geomorphic province of California. The valley is filled with materials eroded from the surrounding mountains and deposited by streams and rivers. Most of the soils are recent alluvial floodplain soils consisting of unconsolidated deposits of clay, silt, and sand that occurred as floodplain deposits.

The climate of the study area is Mediterranean, characterized by cool, wet winters and hot, dry summers. In the valley portions of Sacramento County, approximately 85 percent of the annual rainfall occurs between October and March; approximately 95 percent falls between October and April. The City of Sacramento's average annual rainfall is approximately 18 inches. The mean annual temperature in Sacramento is 61ºF. January is generally the coldest month with a mean low temperature of 37.8 ºF and an average high temperature of 53.3 ºF. July is the hottest month with an average high temperature of 92.9 ºF and an average low of 58.2 ºF. High temperatures commonly exceed 100 ºF.

The Sierra Nevada mountains rise above 14,000 feet (MSL) and are the first major barrier crossed by cyclonic storm systems moving east from the Pacific Ocean. Consequently, precipitation in the Sierra Nevada Mountains typically exceeds 30 inches per year[2], with most of this falling as snow. The largest flood events in the Sacramento area typically result from winter rain-on-snow events caused by atmospheric rivers, week-long, heavy precipitation events known as a "Pineapple Express" because the moisture originates over the tropical Pacific Ocean.

1.3.4 Land Use and Development

The study area consists primarily of agriculture and urban land uses. The primary urbanized area is the City of Sacramento, with suburban cities such as Rancho Cordova, Carmichael, and Folsom located in the eastern portion of Sacramento County and Elk Grove located in the southern portion of the county.

Reducing flood risk in the Sacramento area is the primary purpose of the Common Features project. The City of Sacramento is the capital of California, a state that by itself has the eighth largest economy in the world[3] and a population of 38 million[4]. Many state offices, including the State Capital building, are located in downtown Sacramento in areas that could be affected by flood events. Flooding could disrupt government services, affect emergency services and disrupt transportation corridors. The major highways in the study area include Interstate 5, Interstate 80, U.S. Highway 50, and U.S. Highway 99.

[2] For example, Tahoe City averages 31.46 inches of precipitation per year (Western Regional Climate Center, COOP data for Tahoe City, online at: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca8758, accessed 26 February 2013).
[3] http://data.worldbank.org/data-catalog/GDP-ranking-table, updated 01 July 2015.
[4] United States Census : http://quickfacts.census.gov/qfd/states/06000.html.

The Garden Highway parallels the Sacramento River on the western side of the study area. Union Pacific Railroad and Burlington Northern Santa Fe (BNSF) Railroad carry freight on two main line railroad tracks that run through the Sacramento area. AMTRAK also serves the Sacramento area. This service includes the Capital Corridor route that connects Sacramento with the San Francisco Bay area.

The Natomas Basin is completely surrounded by levees; most development is located in the southern part of the Natomas basin, with most of the rest of the basin devoted to agriculture. Land use within the Natomas Basin includes commercial, medium- and low-density residential, public recreation, open space, educational, and municipal facilities. The Natomas Basin currently has an estimated population of 100,000. Sacramento International Airport is located in the western portion of the Natomas Basin, north of Interstate 5 and west of U.S. Highway 99.

Natomas experienced very rapid development between 1998, when the area was removed from the Federal Emergency Management Agency (FEMA) 100-year regulatory floodplain, and 2008 when Natomas was subsequently remapped back into the FEMA 100-year flood plain. Urban development came to a halt at this time as a result of the floodplain designation which required that new construction be built with a first floor elevation above the base flood elevation. This elevation is roughly 20 to 30 feet above ground level in the Natomas Basin. When combined with the downturn in the economy and associated lack of demand for new construction, a de-facto building moratorium was in effect.

As further described in Section 2.8.7 (Future Development in the Floodplain), the Sacramento Area Flood Control Agency (SAFCA) in cooperation with the State of California has constructed urgently needed improvements to address seepage problems in the Natomas Basin levees as part of the Natomas Levee Improvement Program (NLIP). Levee improvements constructed as part of the NLIP program, along with the authorized improvements in the Natomas PACR have allowed the local governmental agencies to jointly apply for a Physical Map Revision (PMR) to replace the Zone AE (FEMA 100-year regulatory floodplain) with the A99 Zone designation, which removes the requirement for the first floor elevation to be constructed above the base flood elevation. FEMA has determined that adequate progress has been made on the flood protection system project to warrant a change in zone designation to Zone A99 as defined by Paragraphs 61.12(b) of the National Flood Insurance Program (NFIP) regulations.

The population within the 0.5% (1/200) Annual Chance Exceedance (ACE) floodplain of the ARN Basin is approximately 60,000 people. Interstate 80 is located in this area, as well as the Cal Expo Fairgrounds, which is the site of the California State Fair. In addition to the American River, several streams including Dry Creek, Robla Creek, Arcade Creek, Magpie Creek, and the NEMDC contribute to flooding problems in this area.

The population within the 0.5% (1/200) ACE floodplain of the ARS Basin is approximately 440,000 people. The Capitol is located in the downtown area of Sacramento, within this basin. Interstate 5 and U.S . Highway 99 cross this Basin. In addition to concentrated areas of government, residential, and

business use, the area is also home to Sacramento State University, the Sacramento Executive Airport, and the Sacramento Zoo.

1.3.5 Ecological Setting

Five habitat types dominate the study area: wetlands, riparian forest, aquatic, shaded riverine aquatic (SRA), and ruderal herbaceous and nonnative grassland. The study area is within the Pacific Flyway migratory bird route, the westernmost of North America's four flyways. Urbanization over the years has constrained vegetation to limited areas and consequently has inhibited the diversity and range of wildlife in the Sacramento region. Wildlife is restricted predominantly to the American River Parkway corridor and the less-developed regions adjacent to the levees along the Sacramento River (Figure 1-3).

Figure 1-3: Floodwaters in Discovery Park, at the Confluence of the American and Sacramento Rivers.

The banks and overflow areas of the American River are dominated by riparian forest and an extensive network of freshwater forested/shrub and freshwater SRA, and grasslands. In addition, the American River Parkway corridor provides nearly continuous, narrow riparian woodland from Folsom Dam to the confluence of the American River and Sacramento River.

Along the Sacramento River in the ARS Basin, riparian vegetation occurs in narrow, fragmented stretches (Figure 1-4). SRA habitat has been declining due to loss resulting from levee system maintenance, erosion, and emergency rock placement to prevent levee failure during high flood events.

Figure 1-4: Typical Levee Section along the Sacramento River.

1.4 BACKGROUND AND PROJECT HISTORY

1.4.1 The Sacramento River Flood Control Project

Development of flood management features in the Sacramento Valley began around 1850. Up until the flood of 1909, all flood management activities focused on confining flow to the main rivers. This was a trial and error period with frequent levee failures, including failures in the 1909 event. After this event, the State of California and the Federal Government decided the bypass system was needed. The State approved the bypass system and the overall Sacramento River Flood Control Project (SRFCP) in 1911 and the Federal Government authorized it in 1917. The bypass system and overflow weirs were then constructed over the next 15 years.

The flood of 1909 and a flood that occurred in 1907 were the only significant flood events for which detailed streamflow gage data was available. Initial design of the State and Federally authorized flood

control system was developed around the floods of 1907 and 1909. In 1927, a new flood of record occurred for a portion of the Sacramento River system. The larger magnitude flow on these reaches was incorporated into the overall design of the entire flood control system. The entire Sacramento River Flood Control Project was completed in the mid 1950s (Figure 1-5).

The Sacramento River's bypass system starts approximately 100 miles above the Natomas basin where flow spills out of the Sacramento River to the east upstream of the project levees and into the Butte Basin. Flow in the Butte Basin feeds into the Sutter Bypass. The Sutter Bypass then flows into and across the Sacramento River and is then called the Yolo Bypass. The Fremont Weir sits at the very upper limit of the Yolo Bypass and controls when flow starts to spill into the Yolo Bypass. Continuing downstream, the Yolo Bypass passes just to the west of the city of West Sacramento.

Further down the Sacramento River in the city of Sacramento, the American River comes into the Sacramento River from the east. The Sacramento Weir and Bypass is located approximately three miles upstream of the American River. The primary purpose of the Sacramento Weir and Bypass is to divert flows from the American River to the Yolo Bypass.

Below the greater Sacramento urban area, the Yolo Bypass and the Sacramento River come back together near the town of Rio Vista. Combined flow then continues out to San Francisco Bay and the Pacific Ocean.

Throughout the SRFCP, the frequency at which flow starts to divert from the Sacramento River to the bypass system varies between a 33% (1/3) ACE to a 20% (1/5) ACE flood event.

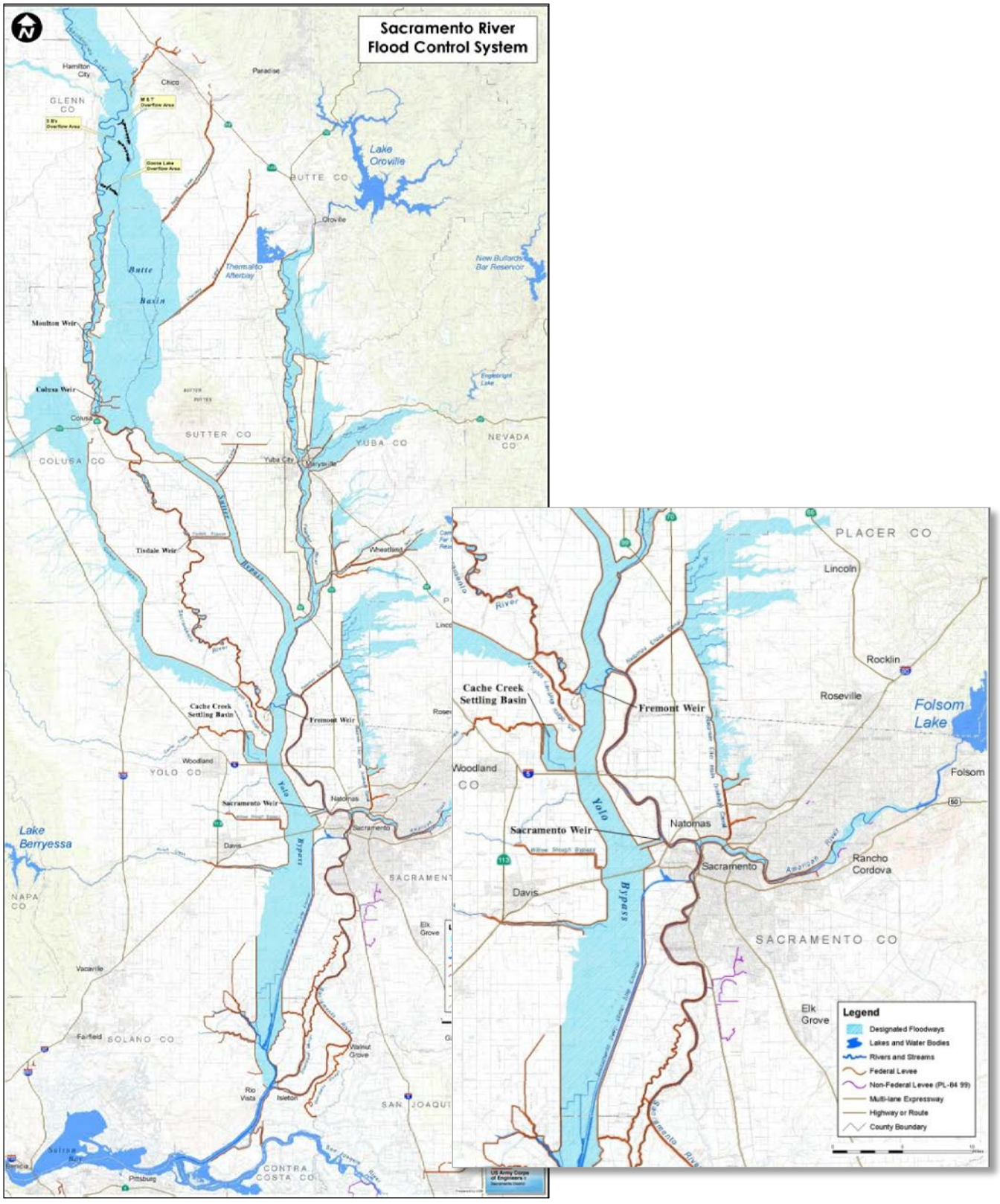

Figure 1-5: Features of the Sacramento River Flood Control System.

Locations where flow is allowed to spill from the Sacramento River into the bypass system include three overflow locations upstream of the project levees, and five weirs within the project levees including Moulton Weir, Colusa Weir, Tisdale Weir, Fremont Weir, and Sacramento Weir (Figure 1-1). The Sacramento Weir is shown in Figure 1-8.

Flow from these weirs (or overflow locations) enters the Butte Basin, the Sutter Bypass, the Yolo Bypass, the Tisdale Bypass, or the Sacramento Bypass. Flows from the Feather River and the American River are also diverted into the bypass system near where they intersect the Sacramento River. The bypass system directly receives outflows from many smaller tributaries.

The Sacramento River Flood Control Project, including the portion within the greater Sacramento urban area, was constructed using either a clamshell dredge or a suction dredge retrieving material from the adjacent river and piling it up along the levee alignment. Figure 1-6 and Figure 1-7 show typical levee construction by both clamshell dredge and suction dredge methodology.

Figure 1-6: Typical Suction Dredge Levee Construction on the Sacramento River System.

The material dredged from the adjacent river was predominately sand with very little silt that tends to be non-cohesive. Additionally, the land on which the levees were constructed tended to be materials similar to the material dredged from the adjacent river. These materials are very poor for levee safety. Water is able to freely move through and under the levee causing severe seepage problems. Water seeping through the levee tends to carry levee material with it, weakening the levee. Additionally, in much of the study area, the levees have narrower crown widths and steeper side slopes than are specified under current engineering standards. In some locations, the waterside slope is steeper than 2 to 1 and the landside slope approaches 1 to 1, which coupled with the nature of the levee fill material, causes a significant stability issue as well.

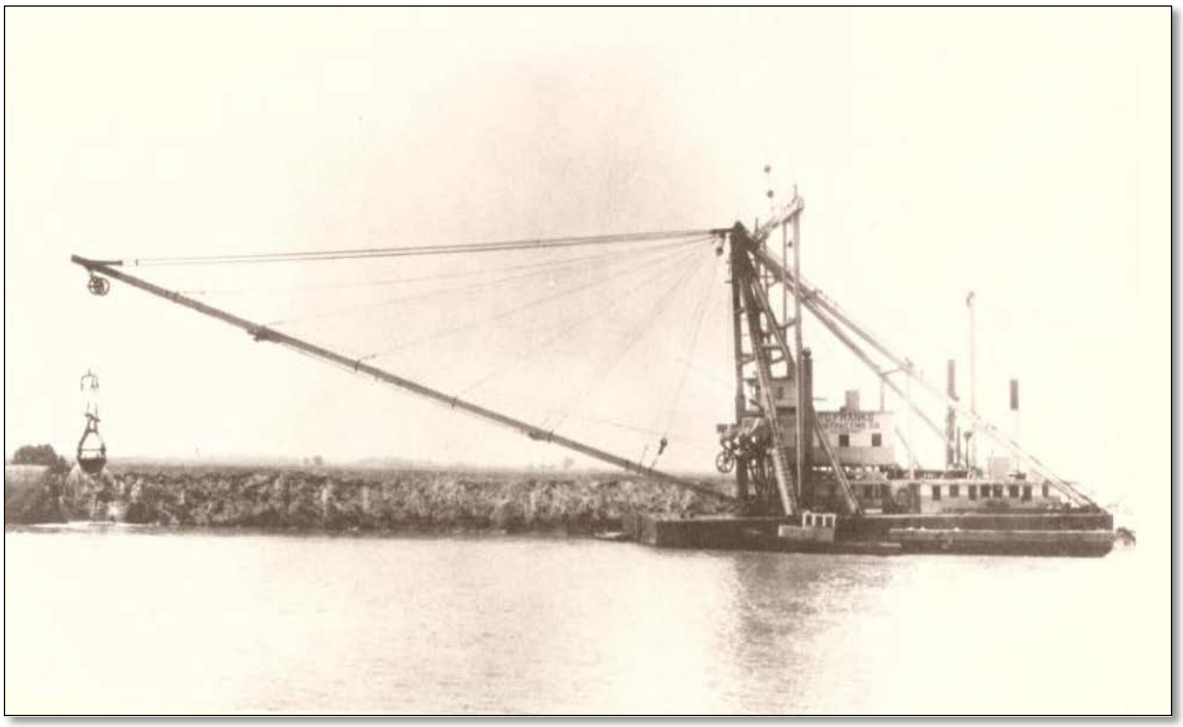

Figure 1-7: Typical Clamshell Dredge Levee Construction on the Sacramento River System.

In addition to the inherent seepage and stability issues of the levees and levee foundations, the potential for erosion induced levee failure is significant. In many cases, the levees were built somewhat set back from the main channel of the adjacent river. Over the course of about a hundred years, much of the waterside berm left during initial construction has eroded away. This occurred because flow was confined between the levees to much higher stages and velocities than would have occurred prior to the levee construction. In some locations, 100 feet of berm has eroded away making it necessary to armor the waterside levee slope to stop additional erosion into the levee foundation and undermining of the levee.

The Fremont Weir is perhaps the most significant overflow location in the system because it controls the distribution of flows between the Sacramento River and the Yolo Bypass downstream. The Sacramento River crosses from the center of the Sacramento Valley toward the east near the north end of the Natomas Basin. Because the river crosses the valley, the bypass system had to be constructed such that it crossed the river. The Fremont Weir forces flow up to the 3- to 5-year frequency event to stay in the river and allows flow to spill to the Yolo Bypass once this frequency is exceeded.

The Sacramento Weir was completed in 1916. It is the only weir that is manually operated – all others overflow on their own, powered by gravity. It is located along the right bank of the Sacramento River approximately 3 miles upstream from the confluence with the American River. Its primary purpose is to protect the City of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The weir limits flood stages (water surface elevations) in the Sacramento River to project design levels through the Sacramento/West Sacramento area. Downstream of the Sacramento Weir, the design flood capacity of the American River is 5,000 cfs higher than that of the Sacramento River. Flows from the American River channel during a major flood event often exceed the capacity of the Sacramento River downstream of the confluence. When this occurs, floodwaters flow upstream from the mouth of the American River to the Sacramento Weir.

Figure 1-8: The Sacramento Weir.

The project design capacity of the weir is 112,000 cfs. It is currently 1,920 feet long and consists of 48 gates to divert floodwaters to the west through the 2 mile-long Sacramento Bypass to the Yolo Bypass. Each gate has 38 vertical wooden plank "needles" (4 inches thick by 1 foot wide by 6 feet long). Though the weir crest elevation is 27.25 feet NAVD88[5], the weir gates are not opened until the river reaches 30.0 feet NAVD88 at the I Street gage and the river is forecasted to continue rising. This gage is about 1,000 feet upstream from the I Street Bridge and about 3,500 feet downstream from the mouth of the American River. The number of gates to be opened is determined by the National Weather Service /Department of Water Resources (DWR) river forecasting team based on meeting either of two criteria: (1) to prevent the stage at the I Street gage from exceeding 29 feet, or (2) to hold the stage at the downstream end of the weir to 30.0 feet (DWR, 2010). The weir gates are then closed as rapidly as practicable once the stage at the weir drops below 27.5 feet. This provides "flushing" flows to re-suspend sediment deposited in the Sacramento River between the Sacramento Weir and the American River during the low flow periods when the weir is open during the peak of the flood event (DWR, 2010).

Upstream Dams

Folsom Dam and much of the north levee of the American River were authorized by Congress under the American River Basin Development Act (Pub. L. No. 81–356, 63 Stat. 852 (1949)). Folsom Dam was designed with a flood control space that could accommodate the Standard Project Flood (SPF).

Construction of Folsom Dam was nearing completion in 1955 when a new flood of record was experienced that caused the objective release for Folsom Dam to occur. The term “objective release” refers to the flow release that balances the need to create enough flood storage space in the reservoir and, to the extent possible, minimizes negative downstream flood effects. Reassessment of the hydrology for Folsom Dam including information from the 1955 flood event showed that downstream areas, including the City of Sacramento, had considerably less flood protection than previously understood, despite the construction of Folsom Dam and of the extensive SRFCP flood control systems. The need for additional flood storage upstream of Folsom Dam, led to a proposal for a flood control dam near the town of Auburn on the North Fork of the American River. For a more comprehensive background on the history of Folsom Dam, refer to the 1991 “American River Watershed Investigation” (USACE 1991), the 1974 “Amendment to the Final Environmental Statement and Supplement on Auburn-Folsom South Unit, American River Division, Central Valley Project-California, Volume 2” (USBR 1974), and the 1982 “A Preliminary Study of Flood Control Alternatives on the Lower American River” (DWR 1982) reports.

Construction of Auburn Dam was authorized by Congress under the Auburn-Folsom South Authorization Act, Pub. L. No. 89-161, 79 Stat. 615 (1965). However, construction on the dam was halted in 1976 when earthquake activity near Oroville Dam north of Auburn suggested a system of faults in the western Sierra Nevada Mountains. A U.S. Geological Survey (USGS) investigation identified a fault close to the Auburn Dam site, which led to a reassessment of the dam’s design. No decision on the redesign was

[5] North American Vertical Datum of 1988

made and the completed cofferdam and diversion tunnel remained unaltered until 1986, when a new flood of record washed out the cofferdam and very nearly caused catastrophic flooding in Sacramento.

Without Auburn Dam, Folsom Dam remains the only flood water retention structure on the American River. The objective release of Folsom Dam is 115,000 cubic feet per second (cfs). After the 1986 flood event, an emergency release provision of 160,000 cfs was added. Since construction of Folsom Dam, the objective flow rate has been met in 1955, 1964, 1986, and 1997, and each time considerable levee repair was required after the event. For the 1964 flood event, flood-fighting efforts were required to prevent levees from failing. In 1986, rapid filling of Folsom Lake led to releases of 134,000 cfs. This release was required to balance risk to the downstream levees versus managing the risk of dam failure. This flow stressed the American River levees and came dangerously close to causing levee failures in the City of Sacramento. Conditions at Folsom Dam came close to requiring larger releases to be made and possible operation of the emergency flood gates at flows in excess of 152,000 cfs, which would likely have flooded Sacramento. The storm subsided slightly before this action was required.

1.4.2 The Common Features Project

Following the 1986 flood, Congress directed the Corps to investigate additional means for reducing flood risk to the City of Sacramento. The Corps completed a feasibility study in 1991, recommending a concrete gravity flood detention dam at the Auburn Dam site and levee improvements downstream of Folsom Dam[6]. Congress, in the Defense Appropriations Act of 1993 (Pub. L. No. 102-396, § 9159, 106 Stat. 1876, 1944-46 [1992]), then directed the Corps to conduct supplemental analysis of the flood control options considered in the 1991 study.

The resulting *Supplemental Information Report, American River Watershed Project, California* (March 1996) outlined three plans to achieve flood risk reduction, including the Folsom Modification Plan, the Stepped Release Plan and the Detention Dam Plan, which was identified as the NED Plan. Ultimately the Detention Dam Plan recommendation was deferred. However, in recognition of the significant flood hazard potential facing the greater Sacramento area, the Chief's Report recommended implementation of several incrementally justified elements common to the final candidate plans, including stabilization of 24 miles of levees along the lower American River, strengthening and raising about 12 miles of levees on the east side of the Sacramento River and implementation of the telemeter inflow gage system and emergency flood warning system. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features". Thus, the American River Common Features Project was authorized in WRDA 1996 (Pub. L. No. 103-303, §101[a][1]). Meanwhile, improvements to levees protecting the NAT Basin and the ARN basin across from the NAT Basin had been authorized in the Defense Appropriations Act of 1993 (Pub. L. No. 102-396 § 9159, 106 Stat. 1876, 1944-1946 (1992)). The Sacramento Area Flood Control Agency (SAFCA) constructed these latter improvements between 1995 and 1998 for which they received both credit and reimbursement.

[6] USACE, 1991.

In WRDA 1999, Congress authorized physical modifications to Folsom Dam as well as additional studies for flood control. Section 101 of WRDA 1999, authorized the Folsom Dam Modification Project to modify the existing outlets to allow for higher releases earlier in flood events. At the same time, Congress also directed the Corps in Section 566 of WRDA 1999 to review additional modifications to the flood storage of Folsom Dam to maximize the use of Folsom Dam for flood damage reduction. The Folsom Dam Raise Project was subsequently authorized by Congress in the EWDAA of 2004.

Section 366 of WRDA 1999 authorized modifications to the Common Features project authorized in WRDA 1996. These modifications included construction of slurry walls to reduce seepage, levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of the NCC levee in the NAT Basin. Additional construction components authorized by WRDA 1996 and WRDA 1999 are described in Chapter 5.

All American River features authorized in WRDA 1996 and 1999 have either been constructed by the Corps of Engineers or are in construction with a scheduled completion by the summer of 2015. Design and construction have been undertaken under a Project Cooperation Agreement with the Central Valley Flood Protection Board (CVFPB) that was executed July 13, 1998, and has been amended five times. Cost sharing for these features is 75% Federal and 25% non-Federal.

Features in the Natomas Basin that were authorized in WRDA 1996 and 1999 were deferred pending further study. Following the flood of 1986, significant seepage was experienced on the Sacramento River from the Verona river gauge (upstream end of Natomas) at River Mile (RM) 79 to the town of Freeport at RM 45.5 and on both the north and south bank of the American River. Seepage on the Sacramento River was so extensive that soon after the 1986 flood event, Congress funded levee improvements as part of the EWDAA of 1987 for the Sacramento River Flood Control System Evaluation, Sacramento Urban Area, Phase I (Sac Urban Project). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas down to the town of Freeport (approximately 20 miles) and a stability berm from Verona to Powerline Road (approximately 32 miles). At the time, seepage through the levees was considered to be the only significant seepage problem affecting the City of Sacramento.

After construction of the Sac Urban Project, the Sacramento Valley experienced a flood event in 1997. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was expected because the levee improvements had not yet been constructed. However, the occurrence of significant seepage on the Sacramento River in the reach improved as part of the Sac Urban Project confirmed that deep underseepage was a significant concern in this area. This led to a geotechnical evaluation of levees in the vicinity of the City of Sacramento which showed that deep underseepage was of concern; a conclusion later confirmed by the Levee Seepage Task Force in 2003[7].

[7] USACE, 2003

Following the recognition of deep underseepage as a major concern, seepage reduction measures on the American River needed to be redesigned to reduce both through and deep underseepage. The redesign led to considerable cost increases over what was originally authorized by Congress: increasing project costs to $91.9 million from the originally-authorized $56 million under WRDA 1999, and to $205 million under the EWDAA of 2004.

Because of the considerable cost increase of reducing the seepage problem on the American River, almost all funds appropriated by Congress for the project in the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the NAT Basin. Combining this with the recognition that all work in the NAT Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a reevaluation study would be required for the Common Features project. Congress was notified in 2004 that, as a result of the underseepage concerns, additional authorized cost increases would be required for study, design, and construction of levee improvements in the NAT Basin.

While the reevaluation study was beginning for the Common Features project, the Folsom Dam Post Authorization Change report (PAC) was being completed[8]. The results of this study showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to realize the planned benefits of the Folsom Dam projects. These levee problems were expected to consist primarily of erosion concerns on the American River and seepage, stability, erosion, and overtopping problems on the Sacramento River below the confluence with the American River. Because the full extent of these levee problems was not known, it was understood that additional reevaluation studies needed to include the two remaining basins comprising the City of Sacramento: ARN and ARS.

In December 2010, the Natomas Basin Post Authorization Change Report (PACR) and Interim General Reevaluation Report (GRR) was completed. That document focused on the problems associated with the existing levees in the Natomas Basin and recommended improving levee performance by addressing seepage and stability problems, but it did not address measures to raise the height of the levees. The recommendations included in the Natomas Interim GRR were authorized in WRRDA 2014. Measures to raise the height of the Natomas Basin levees are addressed in this report.
Table 1-1 summarizes the Authorized Project Features.

[8] USACE, 2007

Table 1-1: Authorized Project Features.

WRDA 1996 Authorization
Install approximately 24 miles of slurry walls along the lower American River
Install approximately 12 miles of levee modifications along east bank of Sacramento River downstream from NCC
Install three telemeter stream gauges upstream from Folsom Reservoir
Modify the flood warning system on the American River
WRDA 1999 Authorization
Raise left bank of non-Federal levee upstream of Mayhew Drain for distance of 4,500 feet by average of 2.5 feet
Raise the right bank of the American River levee from 1,500 feet upstream to 4,000 feet downstream of the Howe Avenue Bridge by an average of 1 foot
Modify the south levee of the NCC for a distance of 5 miles to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River.
Modify the north levee of the NCC for a distance of 5 miles to ensure that the height of the levee is equivalent to the height of the south levee as authorized
Install gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates
Install a slurry wall in the north levee of the American River from the east levee of the NEMDC upstream for a distance of approximately 1.2 miles
Install a slurry wall in the north levee of the American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to the end of the existing levee
EWDAA 2004
Increased authorized project cost to $205 million
2006 Chief's Discretionary Authority
Install a total of 3.6 miles of discontinuous slurry wall at nine levee sites beginning at Levee Mile 2.9 and ending at Levee Mile 10.3 on the Sacramento River in the Pocket Area
Install six relief wells, collector drains and appurtenant features, and a landside berm on the levee toe on the Sacramento River in the Pioneer Reservoir area
WRRDA 2014
Widen 2.0 miles of levee in place and install seepage cutoff wall through levee and foundation on the Lower American River
Widen 18.3 miles of existing levee by construction of an adjacent levee, install 12.3 miles of deep seepage cutoff walls, and install 8.3 miles of seepage berm, all on east bank of Sacramento River below Natomas Cross Canal
Widen the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet on the Pleasant Grove Creek Canal
Widen 12.8 miles of existing levee and installation of 10.7 miles of soil bentonite cutoff wall on NEMDC
Widen 5.5 miles of existing levee in-place and install deep seepage cutoff walls on south bank of NCC

*For the purposes of this report, it is assumed that the authorized features included in the Natomas PAC Report are in place.

1.4.3 Authorized Project Features Summary

Project features, as they have evolved through subsequent authorizations, are presented in Table 1-1 and an economic summary of the authorized plan is presented in Table 1-2. The project features associated with the 2010 Natomas PACR are assumed to be in place as part of the future without-project condition. Therefore, they are included in these tables.

Table 1-2: Economic Summary of the Authorized Plan ($1,000s)[1*]

ESTIMATE OF FIRST COSTS ($000)[1]*			
ITEM	**FEDERAL**	**NON-FEDERAL**	**TOTAL**
Total First Cost	986,257	481,723	1,467,980
Interest During Construction			131,000
Total Investment Cost			1,598,980
Interest and Amortization			53,275
OMRR&R			5,180
Total Annual Costs			58,455
AVERAGE ANNUAL BENEFITS			
Total Annual Benefits			502,500
NET ANNUAL BENEFITS			444,045
BENEFIT TO COST RATIO			8.6

Notes:

[1] Based on October 2014 price levels, 3.375% interest rate, and 50-year period of analysis.

1.4.4 American River Common Features GRR

Based on the recognition of underseepage concerns, this GRR assesses the 92 miles of levees that provide flood risk management to the Sacramento area but that have not been designated for improvements under previous Common Features authorizations. These include the east side tributary levees along Dry Creek, Robla Creek, and Arcade Creeks, the east bank of the NEMDC, and the east bank of the Sacramento River levees downstream from the confluence of the American and Sacramento Rivers down to just below the town of Freeport. In addition, based on the modifications that are occurring at Folsom Dam and the effects of targeted releases down the American River, erosion concerns along the American River are evaluated. Also, levee raises for Natomas Basin have been assessed since they were not a part of the Natomas PACR. This GRR does not include any changes to the recommendations contained in the 2010 Natomas PACR.

1.5 WATERSHED PLANNING

1.5.1 Past and Current Related Studies and Programs

The Common Features Project is one of several flood risk management projects authorized within the American River Watershed in Northern California. The project is also within the greater Sacramento River Watershed, and is part of an overall flood management system in place in the Sacramento Valley since the early 1900s known as the Sacramento River Flood Control Project. Currently, there are more than a dozen authorized projects being studied or implemented by the Corps within the Sacramento River watershed and tributaries (Figure 1-9). The complexity of the engineering, environmental, and political issues requires a systems and watershed approach for all associated efforts with other local, State, and Federal agencies. The following are brief descriptions of some of the major programs and projects in Northern California and the Sacramento River Watershed that are directly influencing and are being coordinated with the Common Features Project efforts.

American River Watershed Program

Three authorized projects make up the American River Watershed Program. One of these is the Common Features project, the subject of this report. The other two are the Folsom Modification Project and the Folsom Dam Raise Project. The Folsom Modification Project primarily includes features to improve the efficiency and effectiveness of the existing flood control outlet works at Folsom Dam and flood control storage in Folsom Reservoir. The Folsom Dam Raise Project is intended to be constructed following the Folsom Modification Project. The Folsom Dam Raise Project primarily includes enlarging the flood control storage space in Folsom Reservoir, features to meet the United States Bureau of Reclamation's (USBR) objective of passing the Probable Maximum Flood, and features to help restore the ecosystem downstream from Folsom Dam. The Folsom Modification and Folsom Dam Raise projects, in combination with the authorized Common Features elements and recommendations in this GRR for features downstream from the dam, are expected to reduce the flood risk to Sacramento. With the American River Watershed Program, there is an emphasis on considering the individual projects on an integrated basis. The EWDAA of 2006 directed the Corps and USBR to collaborate on flood damage reduction and dam safety at Folsom Dam.

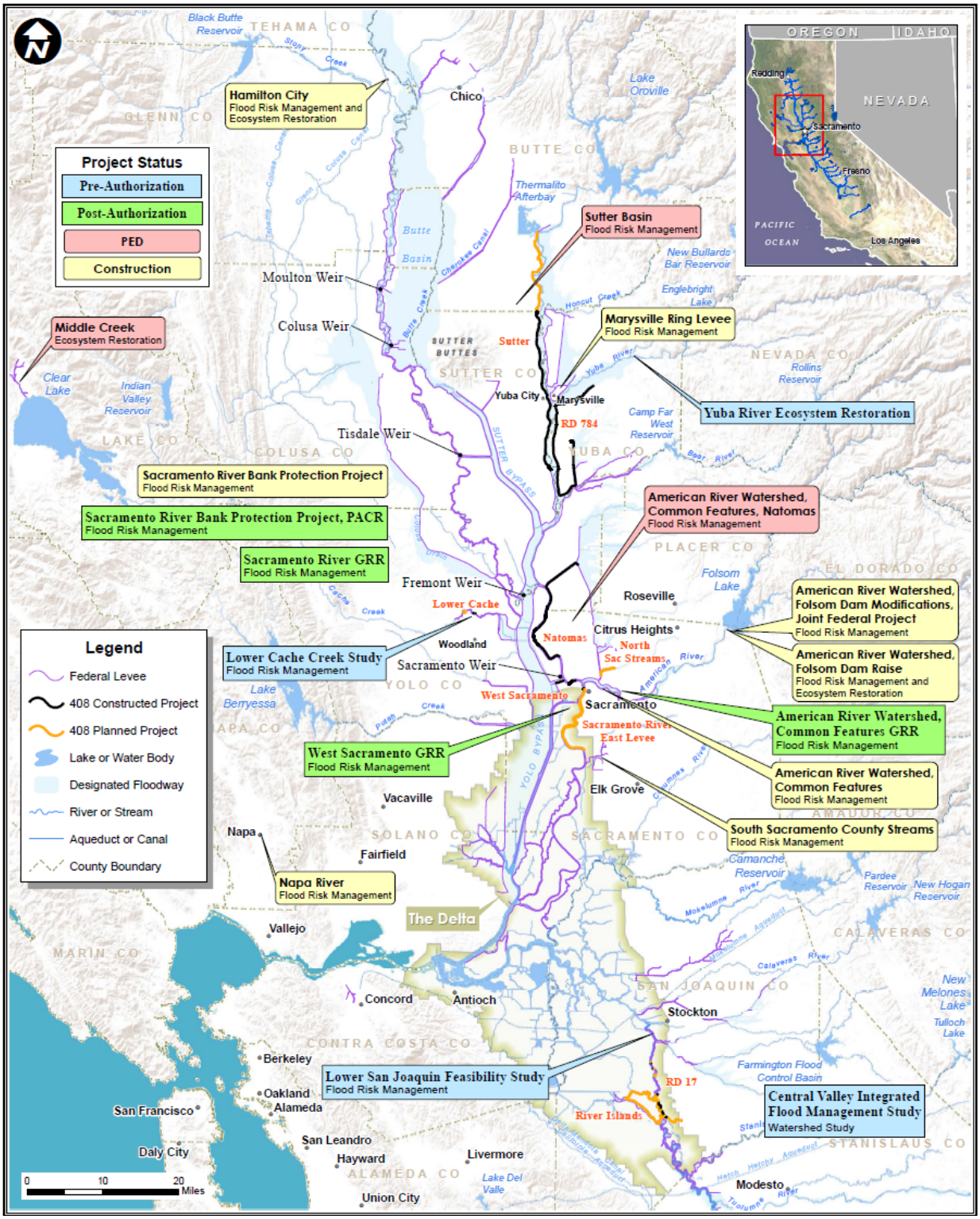

Figure 1-9: Studies and Projects within the Sacramento River Watershed.

Natomas Levee Improvement Program (NLIP)

Under the Natomas Levee Improvement Program (NLIP), SAFCA, in cooperation with the California Department of Water Resources and the Central Valley Flood Protection Board, has constructed urgently needed improvements to address seepage problems in the Natomas Basin levees. Specifically, these include levee improvements for the south levee on the NCC and the east levee of the Sacramento River from the NCC to near Powerline Road. These improvements were authorized as part of the WRDA 96/99 and WRRDA 2014 authorizations for the Common Features project. NLIP achieves the targeted flood risk reduction objectives in a manner that is consistent with current Federal engineering and environmental standards. The Corps has provided extensive technical support for this effort. These levee improvements were permitted under Section 408 (33 U.S.C. § 408) and were approved for potential credit under provisions of Section 104 of WRDA 1986 by the Office of the Assistant Secretary of the Army for Civil Works ASA(CW). The features constructed by SAFCA and the State under NLIP were incorporated into the previously discussed Natomas PACR and are currently the subject of an Integral Determination Report to evaluate the associated level of Federal interest.

Delta Stewardship Council and Delta Plan Delta CALFED Program (Formerly Delta CALFED Program)

The 1,300 square miles of the Sacramento-San Joaquin River Delta are the hub of California's water delivery system that redistributes runoff from over 40 percent of California's landmass to farms and to more than two-thirds of the state's population. By the 1990s, water quality issues in the Delta made it no longer reliable as a water supply source and led to its failure as an ecosystem to sustain many species of concern. CALFED, a multi-agency team representing agricultural, environmental, urban, fishery, water supply and business interests, is committed to adopting mutually acceptable water quality standards and to developing long-term strategies addressing fish and wildlife, water supply reliability, levee stability, and water quality needs in the Delta. CALFED determined that the Delta levee system is critical to all CALFED objectives. The Corps is the Federal lead for the program..

The purpose of CALFED's three-phase program is to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. Phase 1 was completed in September 1996, identifying three preliminary categories of solutions for Delta water conveyance. Phase II was completed with the publication of the Final Programmatic Environmental Impact Report/ Environmental Impact Statement (EIR/EIS) and signing of the Record of Decision (ROD) on August 28, 2000. The ROD was adopted as a joint Federal-State guiding document and defined the programmatic plan. The CALFED Program is now in Phase III, implementation of the preferred alternative. Authorization for the CALFED Levee Stability Program is contained in Section 103(f)(3) of the Water Supply, Reliability, and Environmental Improvement Act (Pub. L. No. 108-361, § 103(f)(3), 118 Stat. 1681, 1695-96 [2004]). This authorization was subsequently amended by Section 3015 of the WRDA of 2007 (Pub. L. No. 110-114, § 3015, 121 Stat. 1041, 1109-10 [2007]) and Section 210 of the FY 2010 Energy and Water Appropriations Act (Pub. L. No. 111-85, § 210, 123 Stat. 2845, 2860 [2009]).

The Delta Reform Act (California Water Code Section 85212) created the Delta Stewardship Council as an independent agency of the State and charged the Council "to develop, adopt, and commence implementation of the Delta Plan." The Delta Plan is a comprehensive, long term management plan for the Delta. It creates legally enforceable regulatory policies as well as non binding recommendations to further the State's coequal goals for the Delta: Improve statewide water supply reliability, and protect and enhance the unique agricultural, cultural, and recreation characteristics of the Delta. The Delta Plan was adopted on May 16, 2013 and its regulatory policies became effective on September 1, 2013.

Sacramento River Flood Control Project

Congress authorized the Sacramento River Flood Control Project in 1917, which adopted the system of locally built levees as Federal levees, and authorized the construction of additional levees, bypasses, overflow weirs, and pumping facilities. The Sacramento River Flood Control Project extends from the river's mouth near Collinsville in the Sacramento-San Joaquin Delta to near Chico Landing in the northern Sacramento Valley. Approximately 980 miles of levee construction were involved in the project, providing flood protection to roughly 800,000 acres of highly productive agricultural lands, the cities of Sacramento, West Sacramento, Yuba City, and Marysville, as well as to numerous other small communities. Although the Sacramento River Flood Control Project levees were often constructed of poor materials such as dredged river soils that would not meet today's engineering standards, the levees are still relied upon to provide flood protection during major storms to over 2 million people in approximately 50 communities with an estimated $39 billion in urban and agricultural development.

Sacramento River Bank Protection Project

Erosive forces on the Sacramento River have weakened the 100 year-old levees of the Sacramento River Flood Control Project. In response to requests from the State of California, Congress authorized the Sacramento River Bank Protection Project in two phases to maintain the integrity of these levees and other flood control facilities. Phase I of the Sacramento River Bank Protection Project started in 1960 and was completed in 1975 with the installation of 480,000 lineal feet of rock revetment bank protection. Phase II was authorized by Congress in 1975 and provided for an additional 405,000 lineal feet of bank protection. To date, approximately 390,000 lineal feet of Phase II have been completed with continued construction planned. WRDA 2007 authorized an additional 80,000 lineal feet of bank protection before the completion of Phase II

Central Valley Flood Protection Plan and Central Valley Integrated Flood Management Study

The Central Valley Flood Protection Act of 2008 (CVFPA), passed by the California legislature as Senate Bill (SB) 5, directs local flood risk management efforts. The CVFPA, along with other companion legislation, required the Central Valley Flood Protection Board to adopt the Central Valley Flood Protection Plan (CVFPP) by July 2012.

The CVFPP contains system wide plans to address flood risk management (FRM) issues in the Central Valley of California, which includes the Sacramento and San Joaquin River Basins. The Corps is conducting a parallel planning process, the Central Valley Integrated Flood Management Study (CVIFMS). CVIFMS is a next phase of the Sacramento and San Joaquin River Basins, California Comprehensive Study. The CVIFMS complements the CVFPP process with a multi-objective watershed study focused on integrated water resource management for flood risk management, ecosystem restoration, and other water resource purposes. The CVFPP and CVIFMS both strive to identify long-range projects to reduce the flood risk within the Sacramento and San Joaquin River basins, while restoring and protecting the riparian and floodplain ecosystems. They will provide a framework for a management plan that can be effectively implemented and supported by local, state, and Federal agencies.

The Final CVFPP was released in June 2012; the CVFPP will be updated every five years. The CVFPP identifies the State's vision for modernizing the State Plan of Flood Control (SPFC) facilities to address current challenges and future trends. The recommended approach for improving flood management is known as the State Systemwide Investment Approach (SSIA) which sets forth a strategy for responsibly meeting the State's objectives to improve public safety, ecosystem conditions, and economic sustainability (DWR 2012). The goals of the CVFPP are as follows:

<u>CVFPP Primary Goal</u>

- Improve Flood Risk Management – Reduce the chance of flooding, and damages once flooding occurs, and improve public safety, preparedness, and emergency response through the following:
    - *Identifying, recommending and implementing structural projects and actions that benefit lands currently receiving benefits from facilities of the SPFC.*
    - *Formulate standards, criteria and guidelines to facilitate implementation of structural and non-structural actions for protecting urban areas and other lands of the Sacramento and San Joaquin river basins and the Delta.*

<u>CVFPP Supporting Goals</u>

- Improve Operations and Maintenance – reduce system-wide maintenance and repair requirements by modifying the flood management systems in ways that are compatible with natural processes and adjust, coordinate and streamline regulatory and institutional standards, funding, and practices for operations and maintenance, including significant repair.
- Promote Ecosystem Functions – Integrate the recovery and restoration of key physical processes, self sustaining ecological functions, native habitats, and species into flood management system improvements.

- Improve Institutional Support – Develop stable institutional structures, coordination protocols, and financial frameworks that enable effective and adaptive integrated flood management (designs, operations and maintenance, permitting, preparedness, response, recovery and land use and development planning).
- Promote Multi-Benefit Projects – Describe flood management projects and actions that also contribute to broader integrated water management objectives identified through other programs.

The physical features are organized into regional and system elements, including: urban, small community and rural agricultural improvements projects to achieve local and regional benefits, and system improvements that provide cross-regional benefits and improve the function and performance of the SPFC. System elements include weir and bypass system expansion, flood system structures, and operational changes of reservoirs, weirs and bypasses.

The CVFPP proposes improvements to urban (population 10,000 or more) levees to achieve protection from, at a minimum, a 0.5% (200-year event) ACE flood. The CVFPP states that since many of the existing levees in urban areas are often located immediately adjacent to houses and businesses, few opportunities exist for setting back levees or making improvements that enlarge levee footprints. Therefore, reconstruction of existing urban levees is generally the method for increasing flood risk management. The State is already supporting many urban levee improvement projects, including ARCF and West Sacramento, through the Early Implementation Program, now known as the High Risk Area Flood Risk Reduction Program. These programs provide a means for the State, with local sponsor support, to address critical levee concerns in urban areas.

As presented in the CVFPP, the key benefits of implementing the recommendations identified in the CVFPP, compared with current conditions, are the following:

- 67% reduction in expected annual damages.
- Construction to increase economic output by $900 million and generate over 6,500 jobs annually.
- Avoided business losses to increase long term economic output by over $100 million.
- 49% reduction in life risk.
- 10,000 acres of new habitat and 25,000 acres of habitat-compatible crops.
- Sustainable rural-agricultural lifestyle.
- Resiliency and adaptation to future changes.

After release of the Final CVFPP in June 2012, the State initiated two basin-wide feasibility studies (in the Sacramento Basin and in the San Joaquin Basins). These State feasibility studies will examine the measures and alternatives considered in the 2012 CVFPP to determine their feasibility. A legislatively

mandated update to the CVFPP is due in 2017. This update is focused on potential modifications to the bypass and weir components of the existing State Plan of Flood Control (SPFC) as well as environmental conservation measures in conjunction with any proposed modifications. Improvements to the conveyance system, such as widening the Sacramento Weir and Bypass, would provide greater system flexibility and resiliency in accommodating future hydrologic changes in the project area, including those due to climate change.

Because the majority of the Central Valley flood risk management facilities and most of the SPFC facilities are part of the State-Federal flood management system, any modifications or additions to this system requires Federal participation and approval through USACE. Major improvements or modifications to the SPFC will require a feasibility study to be used by Federal decision makers and Congress to authorize new projects or project modifications, and appropriate funds.

CVIFMS is a watershed study focused on the Sacramento River watershed and will evaluate water resources problems including flood risk management, ecosystem restoration, and water supply. Resulting recommendations from the watershed study would be published in a watershed plan but would not result in any construction. Based on the findings and recommendations of CVIFMS, it is anticipated that several regional feasibility studies would be initiated. When completed, the feasibility studies would determine Federal interest in implementing elements of the CVFPP and identify non-Federal responsibilities for improvement to the system.

Lower Sacramento/Delta North Regional Plan

One outgrowth of the CVFPP was the creation of six regional flood management planning areas in the Central Valley. They were established to promote a grassroots approach for the preparation of a regional multi-objective plan by encouraging flood management agencies in each region to include cities, counties, emergency responders and other important stakeholders in their collaborative efforts to resolve longstanding flood risk management issues.

The Lower Sacramento/ Delta North Regional Flood Management Plan (RFMP) study area encompasses portions of Yolo, Solano, Sacramento and Sutter Counties. It will establish the flood management vision and a prioritized list of flood risk reduction actions including expansion of both the Fremont and Sacramento Weirs and widening of the Yolo and Sacramento Bypasses. These modifications, in concert with improvements to Folsom Dam, will lower flood stages in the Sacramento River downstream of the Fremont Weir, in the tributary channels around the Natomas Basin, in the American River, Feather River, and Sutter Bypass channels upstream of the Fremont Weir, and in the Yolo Bypass itself. The regional partners believe that these actions would also provide new regularly inundated floodplain that could be managed to improve fish rearing and passage as part of an overall framework that includes agricultural sustainability and other objectives.

FloodSAFE California

FloodSAFE California is a strategic initiative of the State of California to improve flood protection and public safety. The FloodSAFE program is designed to accomplish five broad goals: reduce the chance of flooding; reduce the consequences of flooding; sustain economic growth; protect and enhance ecosystems; and, promote sustainability. The California Department of Water Resources (DWR) is leading FloodSAFE. Success of the FloodSAFE program depends on active participation from many key partners, such as Governor's Office of Emergency Services, CVFPB, the California Department of Fish and Wildlife (CDFW (formerly known as the California Department of Fish and Game)), the Corps, the Federal Emergency Management Agency (FEMA), the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), tribal entities, and many local sponsors and other stakeholders. One of the products of the FloodSAFE program is the Statewide Flood Risk Report.

SAFCA Development Impact Fee

In 2008, SAFCA approved a Development Impact Fee on all new development within the 200-year flood plain to offset potential increases in expected annual damage as a result of a flood. The fee anticipates additional risk with new development, and offsets that risk with enhanced flood protection. SAFCA has the authority to impose the fee under the Sacramento Area Flood Control Act of 1990, but the collecting agencies must have approved collection of the fee. Collecting agencies include the City of Sacramento, the County of Sacramento, and the County of Sutter. SAFCA expects that the fee will raise $148 million. Fee collection began January 1, 2009. The revenue generated by the fee program will be used to finance a continuing flood risk reduction program for the Natomas Basin and the Lower American and Sacramento rivers that will consist of waterside and landside levee strengthening, acquisition of agricultural easements, and improved system operation.

Public Law 84-99 Eligibility Retention and Flood System Improvement Framework

In the aftermath of Hurricane Katrina, the Corps began to place heightened emphasis on removing woody vegetation from flood control works and replacing the removed vegetation with sod (see also Engineer Technical Letter (ETL) 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures). In central California, the situation is atypical because dry conditions make it nearly impossible to maintain a sod cover on most levees. Because of this, many levees have brush and trees that were preserved in an effort to provide erosion protection for the levees. Additionally, the vegetation on the levees provides important habitat.

1.5.2 Summary

The implementation of the projects at Folsom Dam, the evolving levee safety criteria, and other studies in the area all must be considered in establishing the future without-project condition. Additionally, the ongoing efforts toward development of a comprehensive plan of flood risk management in the Central

Valley make it all the more important that the Common Features Project work in conjunction with the development of the comprehensive CVFPP and CVIFMS. It is assumed that the American River Common Features Project would be an early implementation project of the overall State plan.

1.6 PLANNING PROCESS AND REPORT ORGANIZATION

The planning process consists of six major steps: (1) specification of water and related land resources problems and opportunities; (2) inventory, forecast and analysis of water and related land resources conditions within the study area; (3) formulation of alternative plans; (4) evaluation of the effects of the alternative plans; (5) comparison of the alternative plans; and, (6) selection of the recommended plan based upon the comparison of the alternative plans.

The chapters of this report relate to the six steps of the planning process as follows:

- Chapter 2, Problem Identification, covers the first step in the planning process (specification of water and related land resources problems and opportunities). It also covers the second step of the planning process (inventory and forecast). It establishes planning objectives and constraints for the reevaluation of the project.
- Chapter 3, Alternatives, is the heart of the report. It covers the third step in the planning process (formulation of alternatives) as well as the fourth step in the planning process (evaluation), the fifth step in the planning process (comparison), and the sixth step of the planning process (selection).
- Chapter 4, The Selected Plan, describes the selected plan resulting from the evaluation of alternatives.
- Chapter 5, Changes to the Common Features Project, integrates the reevaluated Common Features Project with the other previously recommended, authorized, and constructed portions of the project to describe the proposed changes to the authorized Common Features Project.
- Chapter 6, Public Involvement, Review, and Consultation, covers the public and agency participation in the study to date.
- Chapter 7, Recommendations, provides the recommendation for project reauthorization.

2 - PROBLEM IDENTIFICATION

This chapter presents the results of the first step of the planning process - the specification of water and related land resources problems and opportunities in the study area. The chapter concludes with the establishment of planning objectives and planning constraints, which are the basis for the formulation of alternative plans.

2.1 NATIONAL OBJECTIVE

In WRDA 2007, Congress passed statutory language (codified at 42 U.S.C. § 1962-3) that describes national water resources planning policy: "water resources projects should reflect national priorities, encourage economic development, and protect the environment by:

> (1) seeking to maximize sustainable economic development;
>
> (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and
>
> (3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems."

In consideration of the many competing demands for limited Federal resources, Federal investments in water resources should strive to maximize public benefits, with appropriate consideration of costs. Public benefits encompass environmental, economic, and social goals, include monetary and non-monetary effects and allow for the consideration of both quantified and non-quantified measures. Congress directs the Corps of Engineers to study various water resource related issues in compliance with the specific planning and technical requirements defined by regulations and law. Compliance with those regulations and law provide the tools to prioritize economic development, the wise use of floodplains, and the protection of the environment.

Benefits from plans for reducing flood hazards accrue primarily through the reduction in actual or potential damages to affected land uses. There are three primary benefit categories, reflecting three different responses to a flood hazard reduction plan. Inundation reduction benefits are the increases in net income generated by the affected land uses when the same land use pattern and intensity of use is assumed for with- and without-project conditions. Intensification benefits are increases in net income generated by intensified floodplain activities when the floodplain use is the same with and without the project but an activity (or activities) is more intense with the project. The third category of benefits is location benefits. If an activity is added to the floodplain because of a plan, the location benefit is the difference between aggregate net incomes (including economic rent) in the economically affected area with and without the project. The National Economic Development (NED) Plan is the plan that

reasonably maximizes benefits relative to cost. In general, the NED Plan will be formulated to protect existing development and vacant property that is interspersed with existing development.

2.2 PUBLIC CONCERNS

Public input was received through coordination with the sponsors, other agencies, and through public workshops. A discussion of public involvement is included in Chapter 6, Public Involvement, Review and Consultation. The public concerns that are related to the establishment of planning objectives and planning constraints are:

- Vegetation Removal: The Corps' Engineer Technical Letter (ETL) regarding vegetation on levees, ETL 1110-2-583, is a nationwide standard established because vegetation on levees can pose a risk to a levee's integrity. ETL 1110-2-583 causes much public concern due to the standard approach identified in that document requiring the removal of vegetation on levees and the resulting loss of riparian habitat. Much of the riparian habitat present in the Sacramento Valley was lost due to construction of the Sacramento River Flood Control Project and associated land reclamation. The remaining riparian areas along the rivers are important habitat for a number of Federal and State listed and endangered species, including several fish species and the Swainson's Hawk. Vegetation that is on and near levees along the project is part of this habitat. There is concern that additional vegetation removal will reduce the remaining habitat present in the Sacramento Valley. The GRR has identified several methods that would allow the vegetation on and near the levees to remain or be addressed over time if they don't pose an immediate risk to the integrity of the levee.
- Flood Insurance and Rates: FEMA certification of some of the levees within the City of Sacramento has expired. SAFCA is working on recertification to maintain the FEMA preferred rates. In order to meet this goal, SAFCA is focused on the necessary levee improvements to make them eligible for FEMA certification. In addition, the cost of flood insurance may be changing. FEMA is evaluating the cost of disaster recovery and the associated flood insurance rates needed to cover the cost of the program. The cost of flood insurance for non-certified leveed systems may be drastically increasing, significantly driving up the cost for flood insurance for non certified levee systems. There is concern that flood insurance may be required in the City of Sacramento and, if required concern about the cost of flood insurance rates..
- Real Estate and Encroachments: Since completion of the Sacramento River Flood Control Project (SRFCP), in certain reaches, development has occurred up to and, in some cases, directly on top of the levee. There are segments of levees within the study area where this has extensively occurred. There is concern that when the Corps begins to construct levee improvements, much of the real estate development and encroachments that have occurred up to and on top of the levees will have to be permanently removed to be in compliance with the Corps criteria. . Additionally there is concern that the land needed to widen the Sacramento Weir and Bypass will impact the rural property owners in and adjacent to the Yolo and

Sacramento Bypasses. Related to this, Yolo County is concerned about losing agricultural property and the effect that will have on property tax collections.

- Erosion Protection Armoring: Erosion protection usually involves placing rock revetment to counter the forces of flow and velocity to protect against a possible levee failure. There is concern about placing rock revetment in river environments because of the potential effects on native habitat, loss of recreational amenities, and the perceived loss of the aesthetic value of the natural environment.
- Timing of Levee Safety Criteria and the SWIF Process: There are various problems with levees that require improvements to reduce the flood risk to the City of Sacramento. These improvements include seepage cutoff barriers, bank protection, slope flattening, levee raising, vegetation and encroachment removal, and providing landside access. Associated with constructing some of these improvements is the need to acquire real estate. There is concern that the time that it takes to acquire the necessary real estate will slow down construction of features that have the greatest impact on reducing flood risk such as seepage cutoff barriers. Because of this, the sponsors and USACE are supportive of constructing features that require land acquisition over time under a System Wide Improvement Framework (SWIF) so that it doesn't delay construction of other features. This will allow the project to address the levee problems in a worst-first manner.
- California's Senate Bill 5 and 200 year Level of Protection: Senate Bill 5 requires urban areas to achieve a 200-year level of protection as defined in DWR Guidance (Urban Levee Design Criteria, 2012). There is concern that the Federal plan might not include improvements up to this 200-year State standard. While the State standard is not an objective of the GRR, USACE has coordinated closely with the sponsor during the plan formulation process to inform them of the anticipated plan performance. If the NED plan identified by USACE does not meet State Standards, the Sponsor may recommend a Locally Preferred Plan which could incrementally add additional features to meet this goal.

2.3 PROBLEMS

The Sacramento metropolitan area is one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the American or Sacramento Rivers will stress the network of levees protecting the study area to the point that levees could fail. The consequences of such a levee failure would be catastrophic because the inundated area is highly urbanized and the flooding could be up to 20 feet deep. This section describes the problems addressed by the GRR to reduce flood risk in the Sacramento metropolitan area. The following sections include a description of the flood risk in terms of the probability of flooding and the resulting consequences.

2.3.1 Problem: There is a high probability of flooding in the Sacramento Metropolitan Area

The Sacramento metropolitan area has a high probability of flooding because of its location within the floodplain at the confluence of two major rivers. Both of these rivers have large watersheds with very high potential runoff that has overwhelmed the existing flood management system in the past. The existing levee system was designed and built many years ago, before modern construction methods were employed. These levees were constructed close to the river to increase velocities in order to flush out hydraulic mining debris. This debris is essentially gone now but the high velocities associated with flood flows are eroding the levees that comprise the flood risk management for the study area. All of the factors that contribute to the high probability of flooding are discussed in more detail in the following sections.

Past Flood Events

Newspaper accounts and anecdotal evidence mention at least nine major floods prior to 1900, which prompted the construction of spoil bank levees across the flood plain. The modern flood control system originated with the SRFCP levees authorized in 1917, the Central Valley Project (including Shasta Dam), the completion of Folsom Dam in 1956, and the completion of Oroville Dam in 1967. In the time since Folsom Dam began operations, large floods on the American River have occurred in 1955, 1964, 1969, 1970, 1982, 1986, 1997, and 2006. The 1986 flood is the flood of record.

February 1986 Flood

In February 1986, a series of storms led to severe flooding in central and northern California. In many areas, precipitation from this 10-day storm delivered more than half of the normal annual precipitation for the area. The Sacramento River flood control system was overloaded and one reservoir in the system (Folsom Dam) was filled beyond its design capacity. Record flow releases from the reservoirs combined with flow from numerous unregulated tributaries to the Sacramento Valley produced river flows that exceeded the design capacity of downstream levees: water encroached into the design freeboard risking overtopping levees throughout the system including those protecting Sacramento. The timely cessation of the storm event prevented overtopping of the American River levees. At the runoff peak, approximately 134,000 cfs was released from Folsom Dam with an estimate of greater more than 600,000 cfs flowing past the Sacramento metropolitan area in either the Sacramento River or Yolo Bypass and out to the Sacramento Delta.

Emergency levee work and flood fighting prevented catastrophic flooding (Figure 2-1). However, the extended high water caused boils, slips, sloughing, seepage, flood flow erosion, and wave erosion that required emergency work to minimize or prevent further damage during the flood. Several levees upstream from Sacramento failed during this flood. At the conclusion of the storm, the Governor declared emergencies in 39 counties, with damages totaling more than $500 million. Sacramento County had damages estimated at $49 million (1986 dollars).

Figure 2-1: Slope Failures on the Landslide of the Levee and Seepage Exiting at the Levee Toe on the Garden Highway in Natomas during the 1986 Flood.

January 1997 Flood

In mid- to late-December 1996, heavy snow fell in the Sierra Nevada Mountains. This was followed by heavy precipitation on the western slope of the mountains. The rain began to fall on December 26, and from December 31 to January 3, an atmospheric river (locally known as a "Pineapple Express") brought approximately 30 inches of rain on the western slopes of the Sierra Nevada, in the process dumping more than half a year's worth of rain on Northern California in 10 days. In addition to the local rainfall, 50°F temperatures and rain in the Sierra Nevada melted the snowpack below 6,000 feet. The combination of record snowfall and record rain resulted in high stream flows around Sacramento. The Sacramento River peaked within half a foot of the 1986 record level. Folsom Lake experienced a peak inflow of 255,000 cfs and was able to control it to the objective release of 115,000 cfs. Upstream from Sacramento, outside of the study area, levees on the Feather River at Olivehurst and on the Sutter Bypass breached.

General Description of the Flood Flows

Flood flows from the north are split between the Sacramento River and the Yolo Bypass. Under the current design of the Sacramento River Flood Control Project, diversions to the Yolo Bypass at the Fremont Weir account for 70% of the Sacramento River flow in the vicinity of the Verona river gauge. The Sacramento River downstream of the Fremont Weir has a channel capacity of 110,000 cfs. This flow combines with the flow from the American River which joins the Sacramento River downstream of the Sacramento Bypass. Roughly half of the combined flow from the two rivers is diverted through the Sacramento Bypass to the Yolo Bypass and the other half remains in the Sacramento River.

Evaluation and determination of the extent of flooding due to levee overtopping and/or levee failure were performed with numerical floodplain models using FLO-2D. A full range of flood frequencies were analyzed and the associated floodplains were determined. Table 2-1 shows the area inundated in the event of a levee breach. Figure 2-2 shows the 200-year floodplains for the study area. The 200 year frequency was selected as a representative floodplain to depict the extent and depth of a very large flood event.

Table 2-1: Flood Plain Area.

Economic Impact Area	Total Acres	Total Square Miles
American River North	24,340	38.0
American River South	146,370	228.6
Natomas	53,570	83.7
TOTAL	224,280	350.3

Flood Management System Capacity

Evaluations of storms and floods of record indicate that critical flood-producing conditions in the project area will exist only during the winter season when there is a wet snowpack and a prolonged series of general storms occurring over the entire basin. Usually, storm precipitation amounts are distributed in the same general pattern as normal annual precipitation amounts. Major departures from this pattern do occur, however. Generally, a storm series will last from 2 to 5 days; however, some series have been longer (the 1986 storm lasted 10 days). During such periods, groundwater levels rise, infiltration capacities decline, and the natural and artificial storage within the basin is progressively filled.

Flood flows in the American River basin are rather frequent and of two general types: winter rain-on-snow floods and spring snowmelt floods. Historically, only flood flows resulting from intense winter rainfall over the foothills and mountains have caused serious flooding. Outside the winter season, storms are less severe, cover smaller portions of the basin at a time, and are so widely separated in time that existing basin flood control facilities are usually easily capable of controlling the runoff.

Prior to the construction of levees, the Sacramento River annually would overflow its banks flooding the primarily riparian and wetland habitats of the valley. After levee construction began under the SRFCP, flows were confined to the river in most areas. Before the bypass system was constructed, levee failures occurred frequently, flooding the previously “reclaimed” areas. After completion of the SRFCP system, which included the bypasses, levee failures still occurred, but only on the more severe flood events.

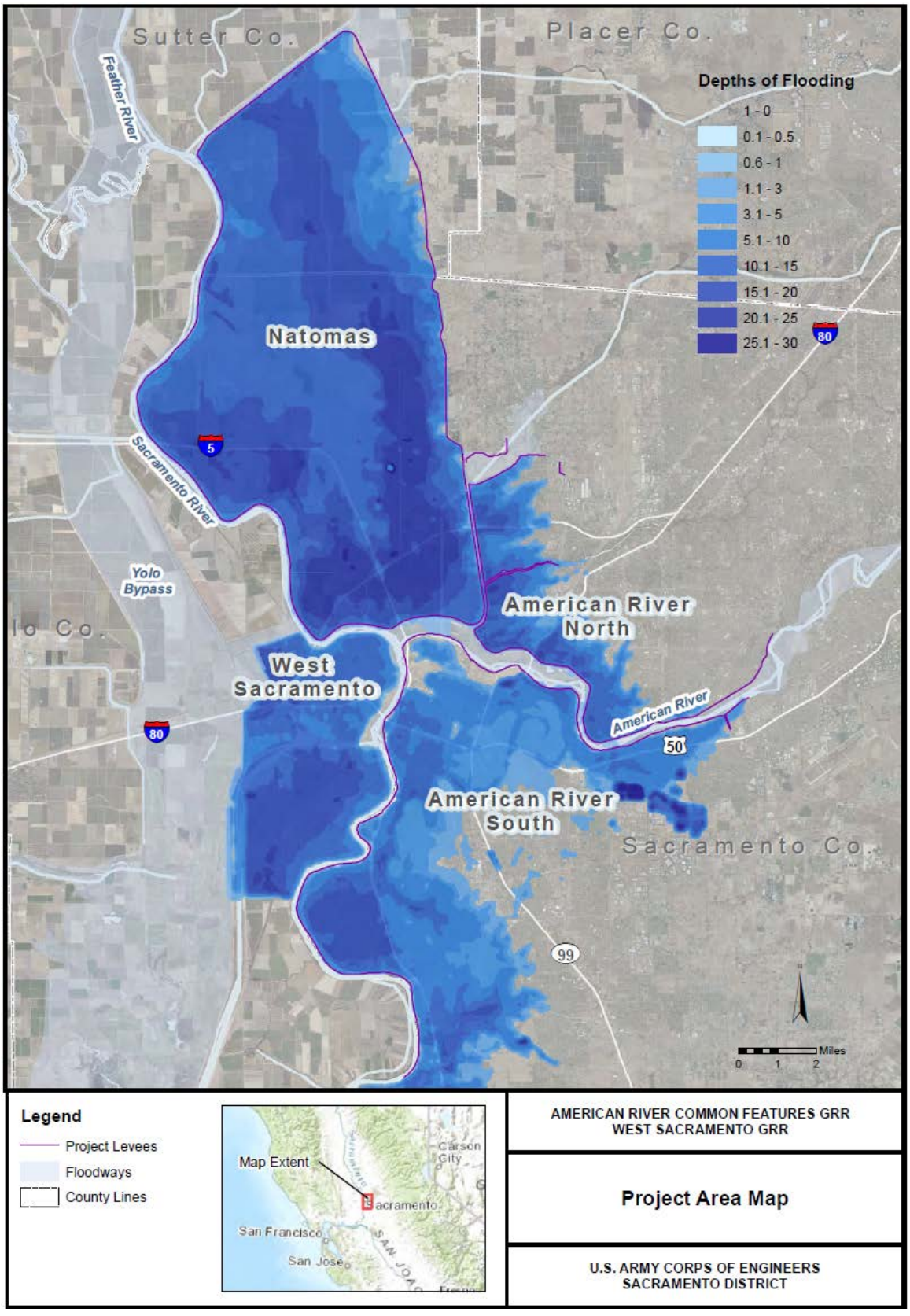

Figure 2-2: 1/200-Year ACE Flood Plains in the Sacramento Area.

The SRFCP was designed to pass the known flood of record, which at the time of Congressional authorization was the 1909 flood. During construction of the system, a new flood of record for a portion of the system occurred in 1927, which was incorporated into the overall system design. After completion of the Federal system in the 1950s, a new flood of record occurred in 1986, followed by the slightly smaller flood of January 1997. The flood of 1986 delivered more water to the leveed reaches than they were designed to carry. With the system fully loaded, levee failures occurred during both the 1986 and 1997 events as a result of geotechnical seepage and stability issues affecting many reaches of the overall system. On the American River, the four biggest floods occurred after completion of Folsom Dam and the SRFCP. In general, throughout the Sacramento Valley, climatology following the completion of the Federal system has been much wetter with more precipitation than the period that the original design of the system was based upon, and more flow is being delivered to the levee system than it was intended to safely carry. This along with the seepage and stability issues has resulted in large levee failures, with ensuing significant loss of property and some loss of life. Table 2-2 shows the design capacities for various locations in the river system and computed flows for a 100- and 200-year event for these same locations.

Table 2-2: Design Flows and Flood Flows in the Project Area.

Location	SRFCP Design Capacity(ft^3/sec)	100-year flood frequency flow (ft^3/sec)	200-year flood frequency flow (ft^3/sec)
Sacramento River (upstream of Sacramento Bypass)	107,000	120,000	130,000
Sacramento River (downstream of American River Confluence)	110,000	122,000	134,000
Sacramento Bypass	112,000	115,000	149,000
American River (Folsom Dam release)	115,000	115,000	160,000

*Assumes Folsom Dam improvements (JFP and dam raise) in place and operable.

Since the SRFCP was completed in the 1950s, only localized improvements have been completed. Most of the recent work consists of maintenance such as bank protection, and seepage and stability fixes to correct localized problems within reaches. Over this same period, many areas have seen substantial urban development. This urbanization has dramatically increased the consequences of levee failure in these areas. Since levee improvements have not kept pace with the rate of urban development, overall flood risk has drastically increased since completion of the SRFCP system in the 1950s.

Folsom Dam Operational Improvements

The existing configuration of Folsom Dam is such that the lower level outlets are at elevation 280 feet; the spillway sill is at elevation 418 feet, and the bottom of the 400,000 acre feet permanent flood

control pool is at elevation 427 feet. Because of this configuration, only 30,000 cfs can be released until the stage in the reservoir reaches the spillway. The objective release for Folsom Dam is 115,000 cfs. However, this amount of flow cannot be released until the stage is sufficiently high enough above the spillway to force it through the spillway. With this configuration and with the levees downstream of Folsom Dam only being able to reliably convey 115,000 cfs, the level of flood protection is relatively low as compared to other similar size cities throughout the country.

With the Folsom Dam Joint Federal Project (JFP), an auxiliary spillway is being constructed that will allow a flood release of 115,000 cfs at a much lower reservoir stage than with the existing spillway only, and allow for this release to be made for a longer duration than under current conditions. the JFP will allow dam operators to release larger quantities of water at lower reservoir stages and more efficiently utilize flood space in the reservoir. Operation of the JFP is to some degree dependent on the American River levees downstream of the dam being able to pass a flow release of 160,000cfs. At the time of the Folsom Post Authorization Change (PAC) report in 2007, assumptions were made based on the available information at the time, that the downstream improvements authorized by WRDA 1996 and 1999 would be in place and allow for the safe passage of the flow releases identified in the Folsom PAC report. However, as was noted in the Folsom PAC, an erosion study of the downstream channel was needed to provide more information on this subject. This study is now complete and it identifies the need for the erosion protection recommended in this GRR. Therefore, erosion protection to these levees would enable more optimal operation of the JFP. Further, the Probable Maximum Flood (PMF) can be passed through the reservoir and the JFP and Folsom Dam; however the peak release of the PMF is much larger than 160,000 cfs.

Conditions Affecting the Reliability of Levee Performance

In addition to the problems associated with the capacity of the American and Sacramento River system, investigations conducted by USACE and the State of California have identified issues with the levees built to reduce the flood risk in Sacramento. The foundation conditions and the non-engineered construction of some of these levees have resulted in issues associated with through-seepage, underseepage, and stability. The seepage and stability problems associated with the levees in many locations are so severe that these problems must be corrected before any other types of flood risk management measures can be considered. Reductions of flood levels on the order of several feet are not sufficient to offset the problems associated with seepage. Additionally, the levees were built very close to the riverbanks, with the result being that they are directly subjected to the erosive forces of the river. Because of the urban setting of these levees, many have issues with vegetation, encroachments, and a lack of access for maintenance and flood fighting. In addition, in some locations, the elevation of the top of the levee is not high enough to contain some large flow events. Figure 2-6 shows the locations of specific levee issues. These specific levee issues are discussed below.

Water surface elevations for various frequency events have been developed for the levees in the study area, along with levee performance curves for typical reaches. A typical levee performance curve is a composite curve combining an individual curve for seepage, stability, and judgment. The seepage and

stability curves are developed per standard quantitative analysis and are documented in the Geotechnical Attachment to the Engineering Appendix. The judgment curve reflects the risk of poor levee performance for erosion, encroachments, vegetation, utilities, and rodent burrows. For these factors, there is not a defined quantitative analytical method to determine the probability of poor levee performance. Therefore, engineering judgment is relied upon to identify the chance of poor performance at various water surface elevations for these factors.

USACE elicited expert opinion to develop the judgment portion of the levee performance curve. Geotechnical, hydraulic, and personnel responsible for O&M of various portions of the Sacramento River Flood Control Project (SRFCP) were included on this panel. Many of the experts involved had firsthand knowledge of the effects of erosion, encroachments, vegetation, utilities, and rodent burrows on the ability of the SRFCP to convey the 1986 and 1997 flood events. Based on their experience with these flood events and their experience with these individual topics within the judgment portion of the levee performance curve, the panel arrived at conclusions regarding the likely poor performance each of these topics causes at various water surface elevations. For each topic, the percent chance of poor performance curves were then combined into a composite judgment curve.

Seepage and Underseepage

The poor construction of most of the levees in the Sacramento area leads them to have problems with water seeping through the levees. The levees were constructed of material dredged from the river. Because of this, the embankment material consists of pervious sands and gravels that transmit water under flood conditions. This leads to the development of floodwater seepage through the levee embankment and eventually to damages to the levee. Internal erosion can cause piping of levee material from the embankment and landside slope failure. In addition, the area protected by the levee could be affected by excessive seepage of water from the river. During the 1986 floods, numerous areas of seepage through the levee leading to landside slope failures were observed. Figure 2-1 shows the effects of seepage under and through the levee.

Figure 2-3: Sandbag Ring Surrounds a Sand Boil on the Natomas Levee during the 2006 Flood.

In addition to seepage through the levees, the integrity of these levees is also potentially compromised by underseepage. Underseepage occurs when water seeps through permeable sand and gravel lenses underlying a levee. In the project area, numerous lenses lie under and cross beneath the existing levee system because the flood plain on which the levees are built is crisscrossed by former river channels, meanders, oxbows, and current and former point bars. Under high water stages, areas protected by levees can still flood because of underseepage through these highly permeable sand and gravel layers.

These layers are also easily eroded, and may cause the levee to collapse due to internal erosion, or piping. If the permeable sand layers in the foundation are covered by an impervious blanket, water pressure can develop at the base of the impervious blanket. If this pressure is suddenly released due to blanket failure or other cause, rapid piping will undermine the levee embankment, leading to failure. Such piping was observed in the Natomas levees after the 1986, 1997, and 2006 floods. The piping took the form of sand boils, which result when the seepage beneath the levee is fast enough to bring sand particles with it. This kind of internal erosion can undermine a levee and lead to instability and failure. Figure 2-3 shows a sand boil being treated with a sandbag ring during the 2006 flood. This flood was a 10-year frequency flood.

Levee Stability

During the 1986 floods, stability problems were observed during high water stages on both the landside and waterside slopes. The materials used to construct the levees were not selected for their suitability, rather they were chosen because of their availability as dredge material from the riverbed. The construction methods were also inadequate: the levee material was not compacted but was constructed with clamshells or dredged, with assorted objects such as dead trees indiscriminately buried in the levee embankments. Seepage through the levee embankment and underseepage through its foundation raises the water pore pressure at the landside levee toe leading to sloughing and sliding of the landside levee slope. Landside slope failures have been observed during high river stages in areas where impervious soils cover the sandy and gravelly layers in the levee foundation due to high gradients at the levee toe. These slope failures have also been observed in areas where water was seeping through the levee embankment above the toe of the levee.

Figure 2-4: Slope Stability Failure on the Natomas Levee during the 1986 Flood.

Levee Erosion

Because of the deposits of hydraulic mining debris that washed into the American and Sacramento River valleys, early levee builders constructed the flood control works by dredging material from the river beds and placing it on the bank near the river. This served several purposes. First, the resulting levees provided a degree of protection from flooding. Second, the strategy removed material from the river bed, causing the channel to convey more water. And finally, by placing the levees close to the river's edge, the river flow was confined, speeding its flow, and causing it to erode away the material that had been deposited by hydraulic mining, further increasing the river's channel capacity.

The levees continue to confine the flow into a relatively narrow channel, contributing to erosion and degradation of the river channel. However, most of the sediment deposited in the river channels has been depleted and the Sacramento River and the American River are sediment-starved. Additionally, on the American River, Folsom Dam blocks sedimentation from upstream sources. As a result, the energy of the flow contributes to erosion of riverbanks and levees along both rivers. Channel erosion and degradation could have detrimental effects on the levees by undercutting the foundation materials, particularly if the riverbank materials are easily erodible. The erosion of the riverbank adjacent to levee embankments may also increase underseepage through the foundation soils. It can also reduce the stability of the levee slopes by undermining the levee embankment and eroding the levees themselves. Significant erosion can lead to the failure of the levee.

Empirical evidence and prototype experience indicate that river bank erosion in the area can be both gradual and episodic. Some erosion occurs almost every year, with major losses occurring with large

flood events. A sedimentation analysis was not completed for this study. However, a sediment study of the Sacramento River from Colusa to Freeport is near completion under the Sacramento River Bank Protection Project[1]. The main objective of this sediment study was to investigate sediment transport processes and geomorphic trends along the lower Sacramento River and its major tributaries and distributaries. A HEC-6T sediment transport model was developed for the study reaches of the Sacramento, Feather, and American Rivers to estimate degradational or aggradational trends over the next 50 and 100 years.

For the entire study reach of the Sacramento River (RM 79-46), the average bed elevation decreases by 0.02 ft for the 50-year simulation period and decreases by 0.10 ft for the 100-year simulation period. Despite a few significant (on the order of feet) localized vertical adjustments in the channel geometry (mostly associated with infilling of deep pools and scour of elevated riffles), the study reach of the Sacramento River appears to have a slight degradational trend. The potential for lateral movement of the river is of greater concern due to the possibility for river bank and levee erosion in this narrow channel. Some rock erosion protection has been placed along the Sacramento River to protect the levees from erosion. Often this rock was placed using the reactive or passive approach such as part of ongoing maintenance activities or as part of the Sacramento River Bank Protection Project. While some recent designs and construction of rock erosion protection are expected to provide adequate localized erosion protection, other locations may not deliver the same performance during a flood event. Some previous rock erosion protection does not meet current design standards, is past its intended design life, and is in need of repair and/or replacement.

The "Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events[1"] determined that hardpan has been reached in part of the channel and is slowing degradation; however, the river is now eroding laterally. Some additional erosion of the channel bed is possible, however, this is considered to be a future risk beyond the 50 year period of analysis for this study. Erosion of the riverbank is occurring even at low flow conditions of 7,000 cfs. In some sections of the river velocities can reach 11 feet/second for flows of 115,000 cfs, and as high as 12 feet/second at flows of 160,000 cfs. This study concluded that flows of 145,000 cfs could cause damage and potentially cause a levee failure.

Levee Overtopping

Although the levees in the Sacramento area have not been overtopped in recent flood events, the 1986 event encroached upon the design freeboard and risked overtopping. It is possible, therefore, that a large enough flood event could occur that would overtop the levees on either the Sacramento or American River. Because the Sacramento area levees were not built to modern engineering standards, levee overtopping would potentially lead to failure of the levee and cause devastating flooding.

[1] USACE, 2012

Vegetation and Encroachments

In many locations in the study area, vegetation and encroachments exist on or near the levees. Various types of vegetation exist on the levees, including native vegetation, landscaping, and gardens. Additionally, many types of encroachments exist on or near these levees. These include houses, utilities, stairs, fences, outbuildings, retaining walls, and swimming pools. These are not isolated cases on the levees, but represent a large-scale, nearly ubiquitous condition. Many of the encroachments were granted permits for construction in the past, but some were built without any prior knowledge or approval from any governing agency.

Figure 2-5: Sacramento River near the Little Pocket and Pocket Neighborhoods.

Vegetation and encroachments on and adjacent to levees is problematic because:

- Levee visibility is reduced, making it challenging for maintenance and inspection crews to identify problems in levee integrity such as the presence of burrowing animals, cracks, slumping, and seepage.
- Levee accessibility is reduced as vegetation and encroachments can block access to the levee crest or landside of the levee for flood fighting and maintenance access purposes.
- Through-levee seepage can be initiated by the roots of riparian vegetation, which can also impair the general integrity of the levee.

- Wind throw of trees can produce large holes, gaps or weak spots in levees, displacing relatively large amounts of earth. This can affect the strength of the levee, or if on the waterside, increase the risk of scour.
- Slope stability is impaired when the roots of trees or other riparian vegetation accelerate erosion problems along levee toes, a particularly critical part of the levee in terms of slope stability.

Seismic Vulnerability of the Levees

The levees in the study area are considered intermittently loaded levees. An intermittently loaded levee is defined as one that does not experience a water surface elevation of 1 foot or higher above the elevation of the landside levee toe at least once a day for more than 36 days per year on average. Because the levees are considered intermittently loaded, it is not likely that a coincident flood and seismic event would occur and therefore, there are no seismic specific design measures taken into consideration during the levee improvement design process. Seismic failure of levees does not significantly contribute to the levee performance curve when compared to the risk associated with through and under seepage, stability, erosion, vegetation, utilities, encroachments, and animal activity.

Levee Problems at Specific Locations

Levee problems occur at many locations within the project area. With the exception of the Natomas Basin, it is convenient to describe the specific problems of the Sacramento area by organizing the discussion around the various bodies of water involved. Flooding problems and levee performance issues are found in relation to the following rivers and streams:

- Arcade Creek
- Dry and Robla Creeks
- Natomas East Main Drainage Canal
- Magpie Creek
- Sacramento River south of the American River
- American River

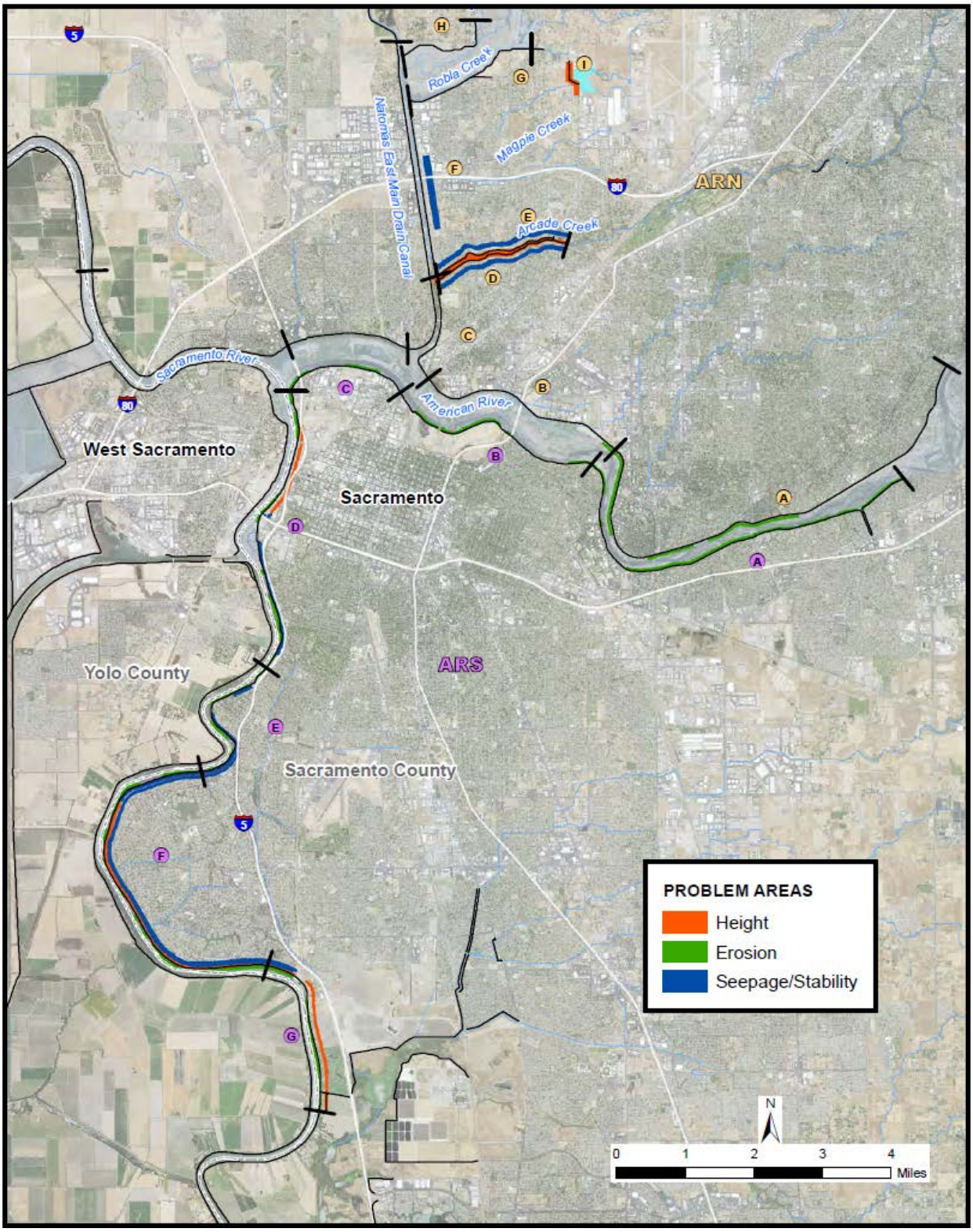

Figure 2-6: Problems at Specific Locations in the Study Area.

Natomas Basin

Once the improvements recommended in the Natomas PACR are implemented, levee overtopping will be the remaining major issue with the Natomas levees. The levee improvements recommended in the Natomas PACR leave residual average annual damages of $19 million. The annual exceedance probability is 0.015, or a 1-in-67 chance of overtopping in any given year. The State of California has adopted a standard level of protection for urban levees, that being 200-year flood level plus three feet. Although some levees were raised under NLIP, most Natomas Basin levees do not provide this level of protection. Since the PACR did not include a recommendation for levee raises, this GRR will evaluate whether or not there is a Federal interest in constructing levee raises If so, this GRR will evaluate how much credit to the local sponsor is warranted (pursuant to previous preliminary approvals under Section 104, WRDA 1986) for the levee raises they have already constructed. In addition to height, there are issues with encroachments and vegetation on the levees.

Arcade Creek

Arcade Creek (Figure 2-6) is located in the American River North (ARN) sub-basin. The key issues with the Arcade Creek levees are seepage and stability as a result of placement of the levees on deposits of pervious materials and construction with overly steep side slopes. The seepage and stability problem is exacerbated by a deep ditch on the landside levee toe of the levee. In addition, as previously described in this section under the description for "Flood Management System Capacity," the levees were only constructed tall enough to convey flows experienced prior to completion of the overall flood control system in the mid 1950s and have since been stressed with larger floods which have threatened overtopping in certain reaches. Vegetation and encroachments on or near the levee are issues for this reach as well.

Dry and Robla Creeks

The Dry and Robla Creek levees (Figure 2-6) are also in the American River North (ARN) sub-basin. As with Arcade Creek, conveyance limitations regarding height are likewise a problem.

Natomas East Main Drainage Canal

The east levee of the Natomas East Main Drainage Canal (Figure 2-6), located in the American River North (ARN) sub-basin, is constructed on top of an old stream bed. These gravelly stream deposits have led to seepage and stability issues with the levee. In addition, as with Arcade Creek, conveyance limitations regarding height are likewise a problem.

Magpie Creek

Magpie Creek is in the American River North (ARN) sub-basin (Figure 2-6). Magpie Creek is diverted into the Magpie Creek Diversion Channel (MCDC) to direct the flow of the creek northward, away from homes and businesses to Robla Creek. The flooding problems in this area consist primarily of flows that outflank or overtop the levee next to the MCDC and flow toward the historic channel of Magpie Creek. Floodwaters can overtop the existing left bank levee of the MCDC at approximately the 14-year event. Outflanking of the levee at Raley Boulevard currently occurs at a two-year event.

Sacramento River South

The Sacramento River east levee south of the American River is in the American River South (ARS) sub-basin (Figure 2-6). The levees in this area protect some of the most heavily populated areas of Sacramento. Deep underseepage is common in the area, and for some levees, steep side slopes have led to stability problems. In addition, woody vegetation, encroachments, and a lack of access for maintenance and flood fighting are significant problems in this area. Erosion is a concern because the levees are located very close to the river and in some areas. In addition, as with Arcade Creek, conveyance limitations regarding height are likewise a problem. Vegetation and encroachments on or near the levee are issues for this reach as well.

American River

The north levee along the American River is located in the ARN sub-basin while the south levee is located in the ARS sub-basin (Figure 2-6). These levees have been improved under the 1996 and 1999 authorization of the Common Features project. However, erosion remains a major issue along the American River. The Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events[2], evaluated the potential for erosion of grass-covered levees and overbanks in response to different stream discharges resulting from releases of various magnitudes from Folsom Dam. This study concluded that the river system is degrading under present operating conditions because the lower American River is starved of sediments by Folsom Dam and Nimbus Dam (a fish hatchery and diversion dam project just downstream of Folsom Dam). Hardpan has been reached in the channel bottom as far downstream as Guy West Bridge (river mile 7.0), and this hardpan is slowing further degradation. With the river starved for sediment and unable to further scour its channel; the river is now eroding laterally to satisfy its need for sediment. Erosion of the riverbank is occurring even at low flow conditions of 7,000 cfs, which was the peak flow from the 2003 runoff season. Ongoing erosion has scarred the channel banks leaving them susceptible to further erosion, especially during high flow events. Lateral erosion is further reducing the amount of berm separating the main channel from the levee. The loss of

[2] Ayers Associates, 2004. Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events, Report presented to the U.S. Army Corps of Engineers (July 2004).

vegetation on the berm and bank is leaving bare soil, which is more susceptible to erosion at a lower velocity than if the berm or bank was covered with vegetation.

Figure 2-7 shows the velocities for a discharge of 115,000 cfs which average about 6 to 8 ft/sec in the channel with maximum velocities ranging up to about 12 ft/sec. Figure 2-8 shows the velocities for a discharge of 160,000 cfs which average about 6 to 9 ft/sec in the channel with maximum velocities ranging up to about 13 ft/sec.

The relatively high velocities adjacent to the levees along the Lower American River shown in these figures highlight the potential for erosion. Additionally, the range of the computed velocities is of concern since the magnitude of the velocities is great enough to erode many of the relatively fine grained material present in the channel lining. The results of the analysis indicate that large discharge events are capable of eroding the material typically found along the Lower American River channel.

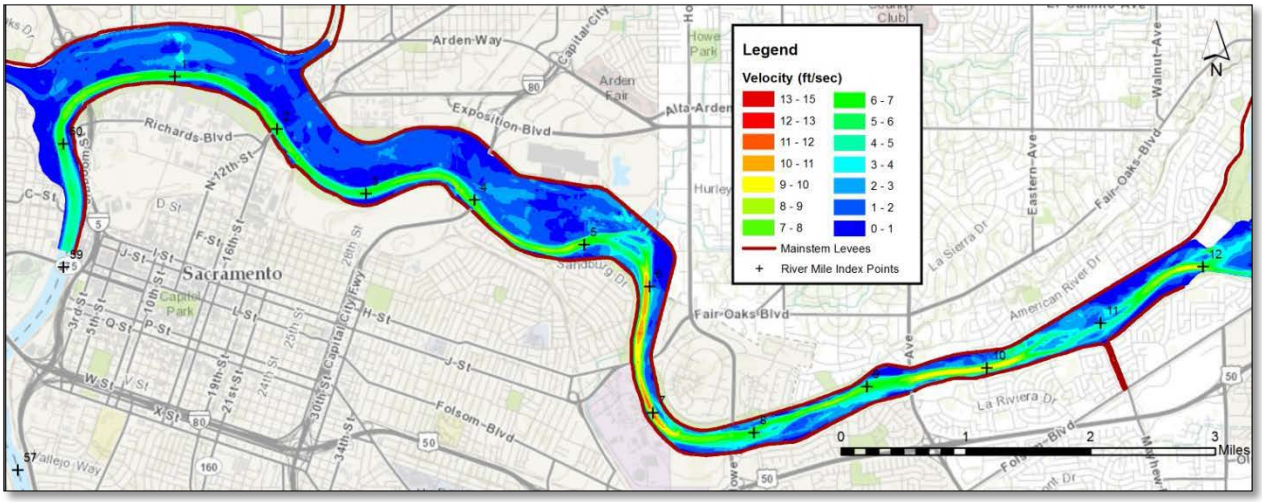

Figure: 2-7: Velocities in the Lower American River at a discharge of 115,000 cfs

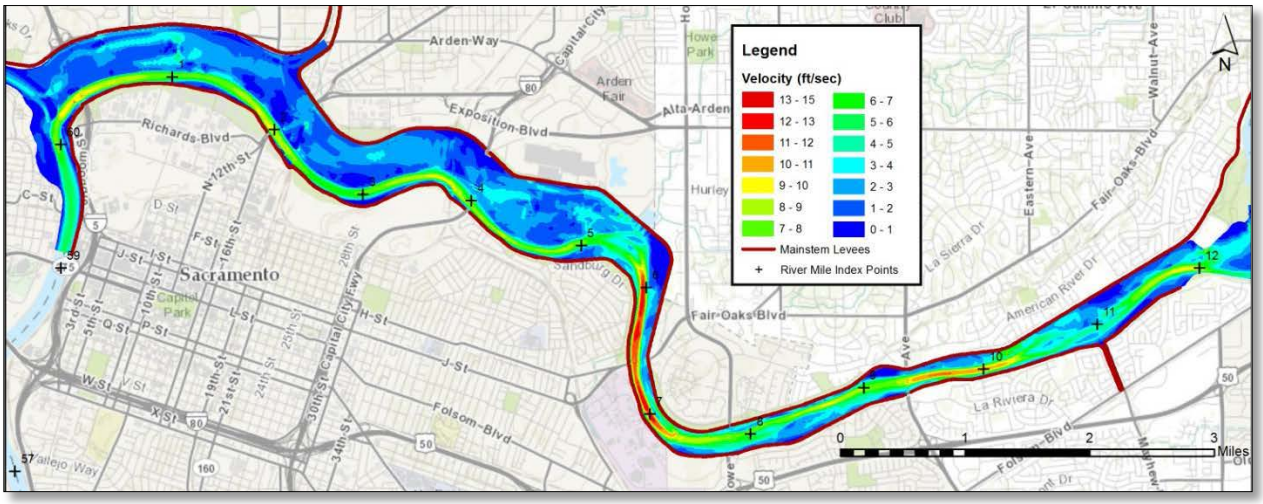

Figure 2-8: Velocities in the Lower American River at a discharge of 160,000 cfs

Figure 2-9 shows velocity contours in the area where erosion is greatest, between River Miles 6 and 7.5. As can be seen in Figure 2-9, velocities reach 11 ft/sec for flows of 115,000 cfs, and get as high as 14 ft/sec for 160,000 cfs. The study concluded that a flow of 145,000 cfs could cause damage at most of 12 identified priority sites, and could cause a levee failure to occur for at least one of the sites. Vegetation and encroachments on or near the levee are issues for this reach as well.

This reach of river represents the worst conditions regarding velocity (11 to 14 feet per second). Downstream and upstream of this reach, velocities for the same peak releases average in the 6 to 9 ft/sec range. Bare soil can withstand approximately 1.5 to 2.5 ft/sec. Soil with good turf cover can withstand between 3.5 to 8 ft/sec. The conditions of grass cover along the American River are not good and erosion occurs at velocities much less than the 11 to 14 fps in the River Miles 6 and 7.5 reach. This is illustrated by the fact that emergency erosion repairs have needed to occur as far downstream as near the Highway 160 bridges (River Mile 1.8) and as far upstream as between Watt Avenue and the Mayhew Drain (River Mile 10.2).

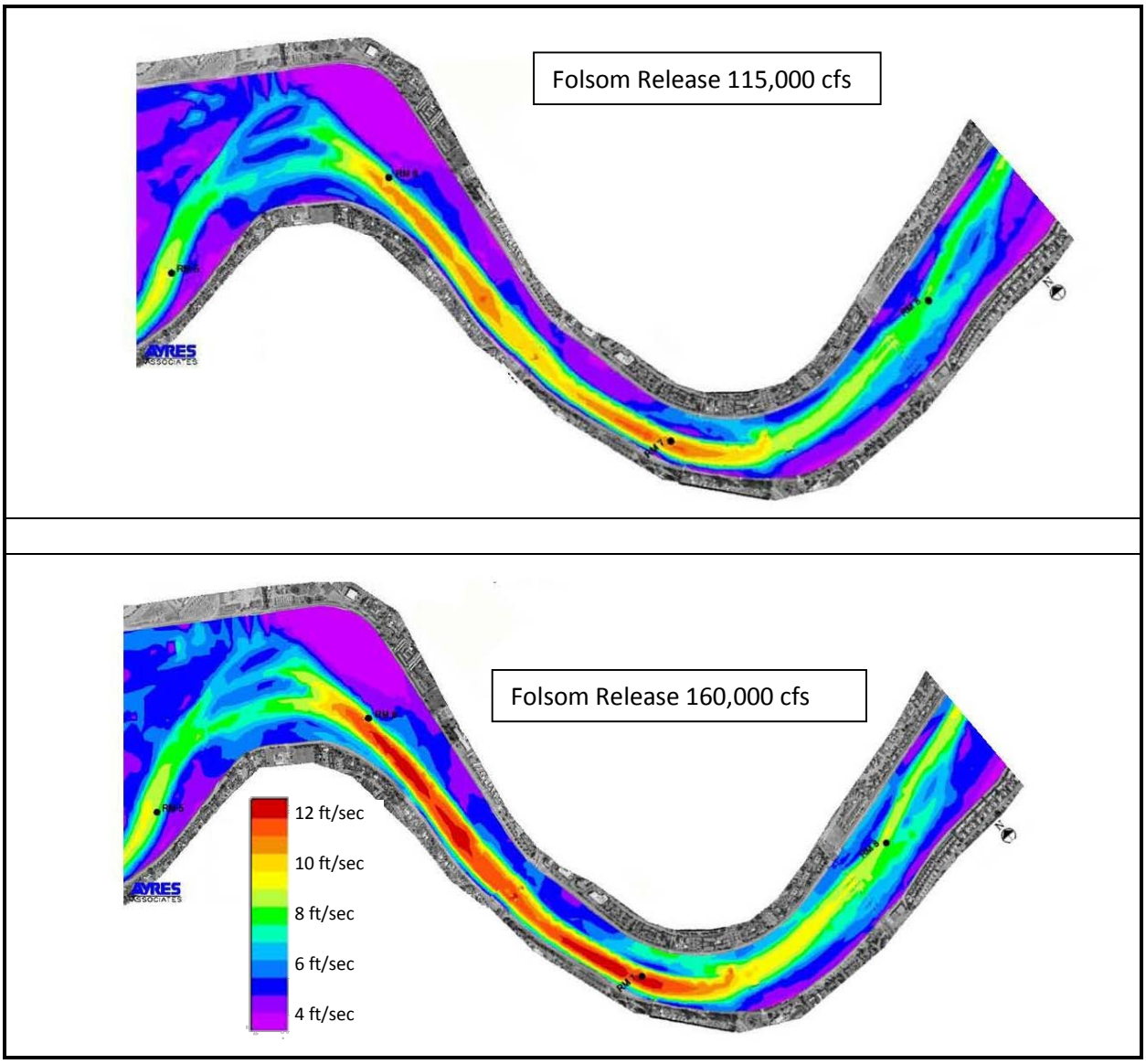

Figure 2-9: American River Velocity Contours.

2.3.2 Problem: the Potential Consequences of Flooding in the Study Area are Catastrophic

If flooding were to occur within the study area, the potential consequences would be catastrophic. The flooding would rapidly inundate a highly urbanized area with minimal warning or evacuation time. As the Capital of California, the Sacramento metropolitan area is the center of State government and many essential statewide services are located here. The study area is also at the crossroads of 4 major highway/interstate systems that would be impassable should a flood occur. The effects of flooding within the study area would be felt not only at the local level, but at the regional, State and National level as well.

Population at Risk

As depicted in Figure 2-2, a significant portion of the City of Sacramento and other portions of the study area are located within the 200-year flood plain (selected as representative flood event, coincident with flows from Folsom Dam). Life safety and population at risk information was taken from the USACE Levee Screening Tool (LST) for use in this study. The Levee Screening Tool supports the levee screening process by facilitating a preliminary assessment of the general condition and associated risks of levees in support of the USACE Levee Safety Program[3].

The overall data for life safety and life loss estimates can be found in Table 2-3. This information comes from a series of Levee Screening Tool Presentations by the Sacramento District on the three basins or systems (USACE, 2011, 2012a, and 2012b).

Table 2-3: Life Safety and Life Loss Information (from USACE's Levee Screening Tool).

	American River South	American River North	American River North, Small Streams	Natomas	Total
Population at Risk (Day)	350,000	58,500	15,500	77,000	501,000
Population at Risk (Night)	440,000	51,500	24,000	66,000	580,000
Loss of Life (Day)	500	170	80	670	1,400
Loss of Life (Night)	980	160	130	550	1,800

Health and Safety

Flooding in urban areas can cause serious health and safety problems for the affected population. In the three basins making up the study area, there are 500,000 residents at risk. Additionally, census data indicates that another 100,000 people work in the Sacramento area but do not live there. Significant numbers of people traverse the area via Interstate 5, Interstate 80, U.S. Highway 99 and U.S. Highway 50 every day. Data obtained from the California Department of Transportation shows that 185,000 vehicles pass through the Sacramento area in the north-south direction in an average 24-hour period. The number of vehicle occupants is estimated to be 270,000.

The most obvious threat to health and safety is the danger of drowning in flood waters. Swiftly flowing flood waters can easily overcome even good swimmers. If flooding occurs suddenly, people may become trapped in their homes, and drown. Additionally, when people attempt to drive through flood waters, their vehicles can be swept away in as little as two feet of water.

[3] Risk Characterization for Levees, USACE Levee Safety Program, April 2011.

In California's Central Valley, the risk of a large flood is seasonal. The majority of rainfall occurs in the October through March rainy season, making the area most vulnerable to winter floods. The temperature range in the rainy months is shown in Table 2-4.

Table 2-4: Average Temperature Range in the Rainy Season.

Month	Low (°F)	High (°F)
November	42.8	63.7
December	37.7	53.9
January	38.8	53.8
February	41.9	60.5
March	44.2	64.7

Standing or working in water that is cooler than 75°F (24°C) will remove body heat more rapidly than it can be replaced, resulting in hypothermia. Hypothermia (decreased body temperature) develops more slowly than the immediate effects of cold shock. Survival curves show that an adult dressed in average clothing may remain conscious for an hour in 40°F water and perhaps 2-3 hours in 50°F water. Physical activity such as swimming or other struggling in the water increases heat loss, reducing survival time to minutes. Without thermal protection, swimming is not possible and the victim, though conscious, is soon helpless. Without a life jacket, drowning is unavoidable.

During a flood, local water systems may become contaminated, either through the loss of power to a public water supply or if a private well is flooded. A variety of sources of contamination include animal and human waste, dead and decaying animals, or chemicals accidentally released during flooding. Water supply contamination can lead to a number of waterborne illnesses. Food exposed to floodwaters or stored without refrigeration during extended loss of power during flooding can lead to food-borne illnesses.

Wild animals and insects can become displaced from their natural habitats during flooding. Encounters with raccoons, opossums, and squirrels can result in bites that require medical attention or may lead to rabies. Dead animals can sometimes be found in homes after a flood, leading to odor and excessive flies. These carcasses can serve as reservoirs for disease-causing organisms. Bees, wasps, and hornets may have their nests disturbed by wind, rain, or flood waters. These insects can be very aggressive. Snakes will also have their nests disturbed by flooding, and are prone to seek shelter in abandoned homes, vehicles, furniture, and equipment.

Liquefied petroleum gas tanks and underground storage tanks can break away from their supports and float in flood waters, causing hazards from their released contents. Floods can damage fire protection systems, delay response times of emergency responders, and disrupt water distribution systems. All of these factors lead to increased danger from fires.

Buildings damaged by flooding can become contaminated with mold and fungi if they do not dry out quickly enough. These molds and fungi can pose serious health risks.

Workers who respond to flooded areas are at the most risk of illness, injury, or death. These workers include utility workers, law enforcement, emergency medical personnel, firefighters, and military and government personnel. According to the Occupational Safety and Health Administration, some of the hazards associated with working in flooded or recently flooded areas include: electrical hazards, hypothermia, structural instability, exhaustion, hazards associated with heavy equipment operation, drowning, biohazards, fire, musculoskeletal hazards, burns from fires caused by energized line contact or equipment failure, carbon monoxide, falls from heights, hazardous materials, and dehydration. After floodwaters have receded, debris cleanup would be a substantial undertaking. After the flooding in New Orleans resulting from Hurricane Katrina, debris removal included general household trash and personal belongings, construction and demolition debris, vegetative debris, household hazardous waste, white goods, and electronic waste. Curbside debris was in excess of 51 million cubic yards. There were nearly 900,000 units of white goods and over 600,000 units of electronic goods. More than 350,000 cars were abandoned.

Evacuation Routes

With much of the area within the 100-year flood plain, Sacramento County and the City of Sacramento have developed a comprehensive flood warning system and evacuation plan. The County of Sacramento has a FEMA Community Rating System (CRS) Class 3 rating on a 1-10 scale. This rating is based on Public Information, Mapping and Regulation, Flood Damage Reduction, and Flood Preparedness. The Class 3 rating is one of the top ratings in the State of California. Hypothetical flood depth, rescue, and evacuation area maps have been developed by the City and County of Sacramento for various hypothetical levee failure locations in the Sacramento area as part of the Flood Emergency Evacuation Plan. The hypothetical flood depth maps depict both the maximum flood depths and the elapsed time from levee failure until an area is inundated with floodwaters to a depth of 1 foot for different levee failure locations on the levees protecting Sacramento. Depending on the levee failure location, the elapsed time to get to flood depths over one foot can range from 6 minutes to 200 hours. A rescue area is defined as an area where the water has the potential of reaching a depth of at least one foot after 2 hours from the time of levee failure, depending on the location of the failure.

The primary urban centers in the region are located in the Natomas and American River South Basins. These communities are all located on or near the following major evacuation routes: Interstate 5, which is the main Interstate Highway on the West Coast of the United States, running north-south from Canada to Mexico. Within the study area, Interstate 5 runs across the Sacramento River, past the airport, across the American River at the confluence of the American and Sacramento Rivers, through Downtown Sacramento, and through Southwestern Sacramento. In a flooding event, depending on the levee breach location, portions of Interstate 5 could become impassable in 3 to 4 hours and access to the airport would be blocked in 2 to 3 days. Interstate 80 is a transcontinental east-west highway which runs from San Francisco, California to the East Coast. Within the study area, Interstate 80 crosses over

the Yolo Bypass and veers north, crossing the Sacramento River, and running through Natomas and American River North. Portions of Interstate 80, through the Natomas area, would become impassable in 8 to 12 hours depending on the levee breach location. California State Route 99 runs north-south through Natomas, North Sacramento, joins with Interstate 5 and crosses the American River, through Downtown Sacramento, and then through South Sacramento and continues south. Portions of California Route 99 would become impassible in the American River Basin South in 3 to 4 hours and impassible in 1 to 2 days in the Natomas Basin. U.S. Highway 50 runs east from West Sacramento, across the Sacramento River, and through Downtown Sacramento and continues to the Nevada state line. Portions of U.S. Highway 50 would become impassible in 4 to 8 hours in a flood event. These highways and interstates would likely be the primary evacuation routes in the event of a flood; however, these routes are subject to change since they are event-specific and official routes are established by the County Sheriff's office during an emergency.

Evacuation preparation can be made days in advance for predictable rain events. For example, a 0.2% ACE (1/500 year event) rain storm would be identified by meteorologist and residents could be given notice days in advance. As a significant rain event nears, warnings and evacuation efforts would be increased and reiterated. This would allow time for evacuation of immobile residents and other people with special evacuation needs (hospitals, rest homes, jails, elderly individuals, schools) via the established routes.

Risk Analysis

A risk analysis was conducted for the GRR using data from the hydrologic and hydraulic modeling, geotechnical probabilistic analysis and an economic benefits analysis. This analysis conducted random sampling of the discharge-frequency, stage-discharge, stage-probability of failure, and damage-stage relationships and their respective uncertainty distributions. The primary outputs of the modeling are expected annual damage (EAD) and project performance statistics. Project performance statistics include the annual exceedence probability (AEP, or the expected annual probability of flooding in any given year), the long-term risk of flooding over a 10-, 25-, or 50-year period, and assurance values, which were previously known as the conditional non-exceedance probability (CNP) for specific events (the probability of passing specific flood events). A Hydrologic and Hydraulic (H&H) overtopping performance analysis was also conducted at a much larger Sacramento River scale to take into consideration the effects of the overall flood management system setting. Information derived from these analyses were considered and used in developing the inputs for the ARCF GRR study.

Flood Damages

Damageable property in the study area consists of commercial, industrial, residential, and public buildings. Many businesses would be forced to close, at least temporarily, during flooding and cleanup, resulting in lost revenues and wages. Physical damages caused by inundation losses or flood fighting preparation costs are the main types of flood damages within the flood plain. Physical damages include

damages to, or loss of, buildings and their contents, raw materials, goods in process, and finished products awaiting distribution. Other physical damages include damages to lot improvements such as damages to roads, utilities, bridges, and cleanup costs. Additional costs are incurred during flood emergencies for evacuation and reoccupation, flood fighting, and disaster relief. Loss of life or impairment of health and living conditions are intangible damages that cannot be evaluated in monetary terms and have not been included in this analysis.

Structure counts for the main categories are listed in Table 2-5 below, and represent only those structures falling within the 0.2% (500-year) ACE floodplain. The number of structures and value of damageable property were inventoried and displayed for the 0.2% ACE floodplain to capture a broad extent of potential damages within the study area.

Table 2-5: Number of Structures by Category and Basin Structures in 0.2% (500-yr) ACE Floodplain.

CATEGORY	STRUCTURE COUNT			
	ARS BASIN	ARN BASIN	NATOMAS BASIN	TOTAL
COMMERCIAL	3,210	754	292	**4,256**
INDUSTRIAL	1,064	224	149	**1,437**
PUBLIC	819	147	82	**1,048**
RESIDENTIAL	104,513	14,018	22,247	**140,778**
TOTAL	**109,627**	**15,143**	**22,770**	**147,540**

Table 2-6 shows the value of damageable property by basin for structures and contents.

Table 2-6: Value of Damageable Property by Category and Basin (in $1,000s): Structures and Contents, 0.2% (500-yr) ACE Floodplain October 2014 Price Level.

DAMAGE CATEGORY	VALUE OF DAMAGEABLE PROPERTY (in $1,000s) STRUCTURES AND CONTENTS			
	ARS BASIN	ARN BASIN	NATOMAS BASIN	Total
Commercial	8,853,821	3,234,176	945,982	13,033,979
Industrial	3,575,368	797,994	672,440	5,045,802
Public	7,019,380	835,101	771,535	8,626,016
Residential	27,293,188	3,972,078	6,393,909	37,659,175
TOTAL	**46,741,757**	**8,839,349**	**8,783,865**	**64,364,972**

ACE event damages are sometimes referred to as single-event damages. Single-event damages assume that a breach from a specific probability event occurs; it does not take into account the likelihood of this event actually happening. Single-event damages are useful in that they show the magnitude of consequences, within a particular consequence area, *should* a specific flood event occur in that area. Table 2-7 below shows the damages that may occur for a range of events within the three main basins.

These damage values include automobiles, structures, and contents, and represent damages based on flooding from one index point per basin.

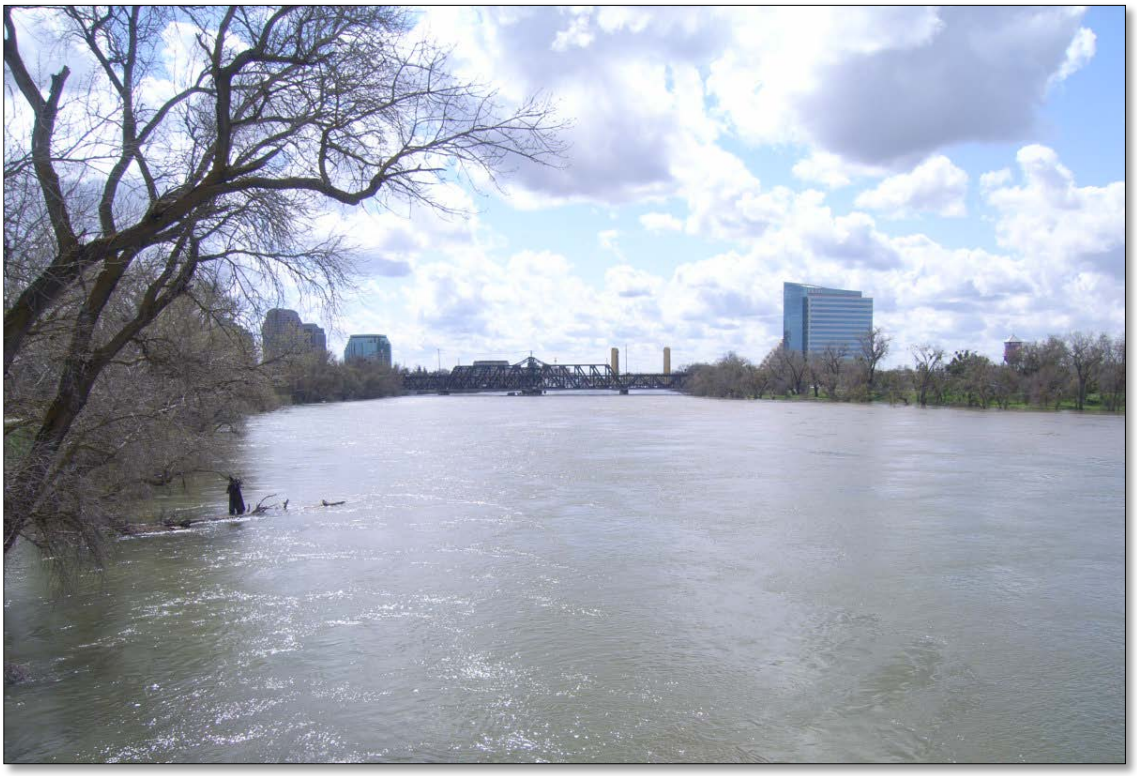

Figure 2-10: The Sacramento River Facing Downstream Toward the I Street Bridge.

Table 2-7: Annual Chance Exceedance (ACE) Event Damages, October 2014 Price Level (in $1,000s)

BASIN	ACE EVENT DAMAGES						
	50%	10%	4%	2%	1%	0.5%	0.2%
ARS	6,660,369	8,427,409	8,427,409	9,197,846	13,302,749	14,288,782	21,612,855
ARN	0	0	2,824,045	2,908,650	4,654,995	4,970,941	5,456,034
NATOMAS	4,404,922	5,579,812	5,784,706	6,109,155	6,271,056	6,403,807	6,896,591
TOTAL	**11,065,291**	**14,007,221**	**17,036,160**	**18,215,651**	**24,228,800**	**25,663,530**	**33,965,480**

EAD is the metric used to describe the consequences of flooding on an annual basis considering a full range of flood events – from high frequency/small events to low frequency/large events over a long time horizon (years). It is the main economic statistic used to describe the flooding problem in the study area; it is also used as the baseline to measure potential benefits from proposed alternatives. Table 2-8 displays the EAD results by basin.

Table 2-8: Without-Project Expected Annual Damages by Basin, October 2014 Price Level (in $1,000s)

BASIN	WITHOUT-PROJECT EXPECTED ANNUAL DAMAGES (EAD)						
	AUTOS	COMMERCIAL	FARM	INDUSTRIAL	PUBLIC	RESIDENTIAL	TOTAL
ARS	15,080	42,514	395	11,197	35,644	227,555	**332,383**
ARN	3,221	27,383	0	9,301	6,960	30,438	**77,303**
NATOMAS	863	3,294	36	2,328	2,774	19,300	**28,595**
TOTAL	**19,164**	**73,191**	**431**	**22,826**	**45,378**	**277,293**	**438,281**

Emergency Costs

Depreciated replacement values of structures are used to assess structure and content damages and to gage the cost of replacing damaged portions of structures and contents of similar use and condition. However, there are other costs/damages directly associated with structure and content damages that may result from a flood event but which are not captured in the estimate of structure and content damages. These additional damage categories were considered in the assessment of without-project damages and with-project benefits for the American River Common Features GRR, and include:

1. Clean-up costs
2. Temporary evacuation, relocation and housing assistance (TERHA)

Expected annual damages (EAD) under the without-project condition were computed using HEC-FDA. For the ARS Basin, damages were computed using the engineering data from Index Point ARS F (Sacramento River), since this location serves as both the starting point for measuring without-project damages and the ending point for measuring with-project residual damages in the incremental analysis presented in Chapter 4 of the Economic Appendix. For the ARN Basin, damages were computed using the engineering data from Index Points ARN A (American River) and ARN E (Arcade Creek). The Emergency Cost analysis was performed after the determination of the Final Array of Alternatives. Since none of the alternatives include the Natomas Basin, the emergency cost analysis did not include the Natomas Basin.

The Table Below displays the results of the HEC-FDA analysis. Expected annual damages associated with clean-up activities are estimated to be approximately $44 million; EAD associated with TERHA is estimated to be approximately $21.5 million. Total EAD for both emergency cost categories combined is estimated to be around $65 million. The assessment method used for this report follows the one used in the Sutter Basin Feasibility Study. The information is summarized in Table 2-9 below.

Table 2-9: Without-Project Expected Annual Damages (EAD) – Including Emergency Costs, ARS, ARN, and Natomas Basins, October 2014 Price Level Values in $1,000s.

BASIN	STRUCTURE, CONTENTS, & AUTO EAD[1] (IN $1,000S)	EMERGENCY COST LOSSES	TOTAL EAD (IN $1,000S)
ARS	332,383	54,792	387,175
ARN	77,303	10,459	87,762
NATOMAS	28,595	N/A	28,595
TOTAL	**438,281**	**65,251**	**503,532**

[1]Values taken from Table 2-8.
[2]Percentage extrapolated from ARS Index Point B analysis

Critical Infrastructure

A significant amount of critical infrastructure is located within the study area. Critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy. Most commonly associated with the term are facilities for:

- Electricity generation, transmission and distribution
- Gas production, transport and distribution
- Oil and oil products production, transport and distribution
- Telecommunication
- Water supply and wastewater
- Agriculture, food production and distribution
- Heating
- Public health (hospitals, ambulances)
- Transportation systems (fuel supply, railway network, airports, harbors, inland shipping)
- Financial services (banking, clearing)
- Security services (police, military)

Impacts to critical infrastructure from a flood event would have significant local, regional, and statewide impacts because Sacramento is the capitol of the State of California. The California State Capitol and many State office buildings are located in downtown Sacramento, which could be flooded by 5 to 10 feet several feet of water due to a flood event. If critical elements of the State government are disabled due to a flood event, the Central Valley region and the State of California could be severely impacted. State functions such as emergency response and other essential State services could be impacted. Impacts to State of California departments and agencies could become critical for the entire state if the duration of flooding extends beyond a few days. State agencies provide payroll, retirement benefits, medical benefits, vehicle registration, criminal justice, and other activities that affect people throughout California.

Business and government centers would be isolated from customers and employees. Significant numbers of people commute into downtown Sacramento to work at various Federal, State and local agencies and private businesses. The Sacramento District USACE offices are located in downtown Sacramento along with many other Federal and State facilities including the Secretary of State, Department of Transportation, Water Resources Board, Attorney General's Office, Department of Consumer Affairs, and the Legislative Office Building. Local government facilities include Police and Sheriffs' Offices, City Library, and City and County of Sacramento Administrative offices.

Flood recovery programs are run by State and local government agencies. Because these agencies could be located in areas impacted by flooding there could be significant impacts on the distribution of disaster assistance. Although funding may be available, limited material and labor availability could potentially slow implementation of needed repairs and recovery.

Another piece of critical infrastructure located in the Natomas Basin is the Sacramento International Airport, a major transportation hub for Sacramento and all of northern California. The airport can handle up to 29 flights per hour; in a typical month 800,000 passengers arrive or depart the airport. If a flood were to occur, passenger travel would be disrupted and those stranded at the airport would have to be evacuated to high ground. Mail and freight transit through the airport would also be interrupted. Flooding of transportation routes, utilities and public services will likely occur throughout the region and impacts could be felt in areas far beyond the actual flooding.

Transportation facilities that could potentially be affected by flooding in the study areas include:

- Light rail lines in east and south Sacramento and downtown
- Regional transit bus routes and facilities throughout the city of Sacramento
- Interstate 5
- Interstate 80
- US 99
- US 50

Critical infrastructure in the three basins has been characterized in two categories: At Risk Population Facilities and Essential Services Facilities. Overall data for these facilities can be found in Table 2-10. The identified impacted facilities are located within the 200-year floodplain.

Table 2-10: Critical Infrastructure Facilities at Risk within each Basin.

	Critical Infrastructure Facilities at Risk (n)			
	American River South	**American River North**	**Natomas**	**Total**
At Risk Population Facilities	162	44	22	228
Essential Services Facilities	142	26	11	179

2.4 PLANNING OPPORTUNITIES

There is an opportunity to increase public awareness of the flood risk and ongoing residual risk.

2.5 PLANNING OBJECTIVES

The water and related land resource problems and opportunities identified in this study are refined and stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without-project conditions. The planning objectives, which are applicable over a 50-year planning horizon, are specified as follows:

- Reduce the risk of flooding in the study area as measured by the reduction in EAD, the population at risk, life safety concerns and availability of evacuation routes.
- Reduce the impacts to critical infrastructure in the study area measured by the reduction in damages and availability of emergency facilities during flood events
- Encourage wise use of the flood plain measured by the strength of the Floodplain Management plan, and ability to direct flood flows away from urban areas and instead to floodways.
- Educate the public about ongoing residual risk measured by increased public awareness as a result of annual notifications of residual flood risk.

2.6 PLANNING CONSTRAINTS

Unlike planning objectives that represent desired positive changes, planning constraints limit plan formulation. The planning constraint identified in this study is as follows:

- Plans affecting the Natomas Basin must not violate the Federal Aviation Administration (FAA) restrictions regarding providing additional bird habitat in the area of the Sacramento International Airport.

2.7 LOCAL CONCERNS

Local concerns represent desired positive changes and/or restrictions that are important to various stakeholders, but have not been classified as either an objective or a constraint. These concerns have been considered during the plan formulation and analysis, and they can help compare plans that have similar outputs. These concerns are:

- Plans should be compatible with local land use plans to the extent practicable. Improvements should be compatible with the Natomas Basin Habitat Conservation Plan (NBHCP) that was

developed as a requirement of the Endangered Species Act (ESA), designed to support applications for Federal permits under Section 10(a)(1)(B) of the Act. The purpose of the Conservation Plan is to promote biological conservation in conjunction with economic and urban development in the Natomas Basin.

- If feasible, plans should achieve the minimal 200-year urban level of protection standard as defined by the State of California, to the extent that it is in the Federal interest. The State has established this standard for the Central Valley of California and it applies to cities with populations greater than 10,000. This standard requires levees to have a top elevation equal to the mean 200-year water surface profile, plus three feet of freeboard, plus an allowance for wave run-up, plus one foot to account for climate change. Portions of the Sacramento area levees do not meet this standard.
- Plans should strive for no or minimal loss of riparian vegetation. In some areas, the trees and shrubs on or near levees provide the only waterside habitat that remains for many sensitive wildlife species. According to some estimates, riparian forests in the Central Valley have declined by as much as 98 percent during the last 150 years. The remaining trees provide important environmental, recreational, and cultural benefits.
- Plans must be maintainable and should minimize costs for operation, maintenance, repair, rehabilitation, and replacement.
- Plans should be able to be implemented quickly, to reduce increased flood risk associated with the Folsom Dam improvements, which are scheduled to be completed between 2017 and 2019. Sacramento has an unacceptably high risk of flooding that poses a serious threat to life, health, and safety.

2.8 FUTURE WITHOUT-PROJECT CONDITION

The future without-project condition is the most likely condition expected to exist in the future in the absence of a proposed water resources project. Proper definition and forecast of the future without-project condition is critical to the success of the planning process. The future without-project condition constitutes the benchmark against which plans are evaluated. Other plans that have been adopted for the planning area and other current planning efforts with high potential for implementation or adoption shall be considered as part of the forecasted without-project condition.

The non-Federal sponsor will be seeking both permission to alter the Federal flood management project, pursuant to Section 14 of the River and Harbors Act (33 U.S.C. § 408, commonly referred to as “Section 408”) and credit consideration, pursuant to Section 221 of the Flood Control Act of 1970 (Section 221) for levee improvement work they intend on constructing prior to implementation of the recommended ARCF GRR project. This work will be located along the Sacramento River, the NEMDC and Arcade Creek. Section 221 of the Flood Control Act of 1970 as amended by Section 2003 of the WRDA of 2007 (42 U.S.C. § 1962d-5b) allows a non-Federal sponsor to seek credit for the study, design and construction of

Federally authorized water resources development projects that are carried out after the execution of an agreement with the ASA(CW). The sponsor has indicated that they intend to construct portions of the levee improvements recommended by the GRR that are considered the highest risk areas and seek credit for those improvements. These actions will not be considered part of the without project condition. However, neither the State nor SAFCA have sufficient funding to construct the recommended project in its entirety. As such, both the State and SAFCA wish to partner with USACE to construct the recommended project.

The following general assumptions have been made in regard to the future without-project condition for this study:

2.8.1 Common Features WRDA 1996 and WRDA 1999

The elements of the Common Features project as authorized by WRDA 1996 and WRDA 1999 are assumed to be in place. These features (Figure 2-11) addressed the seepage and stability concerns along the American River but do not address the erosion risk.

2.8.2 Natomas 2010 Post Authorization Change Report (PACR)

The levee modifications recommended in the 2010 Natomas PAC Report and authorized by WRRDA 2014 (Pub. L. No 113-121) are assumed to be in place, which improve the levees but do not include levee raises to address higher volume, low frequency flows. Even with the levee improvements recommended in the Natomas PACR, the Natomas Basin would still face significant flood risk. The recommendation included in the Natomas PACR reduced the expected annual damages from about $450 million to $19 million. The residual damage estimate for the Natomas Basin has been updated for this study to $28.6 million.. Even with a reduced probability of flooding with the recommendations of the Natomas PACR in place, due to the fact that there are 100,000 people in the Natomas Basin, the consequences, and therefore the residual risk, will remain high.

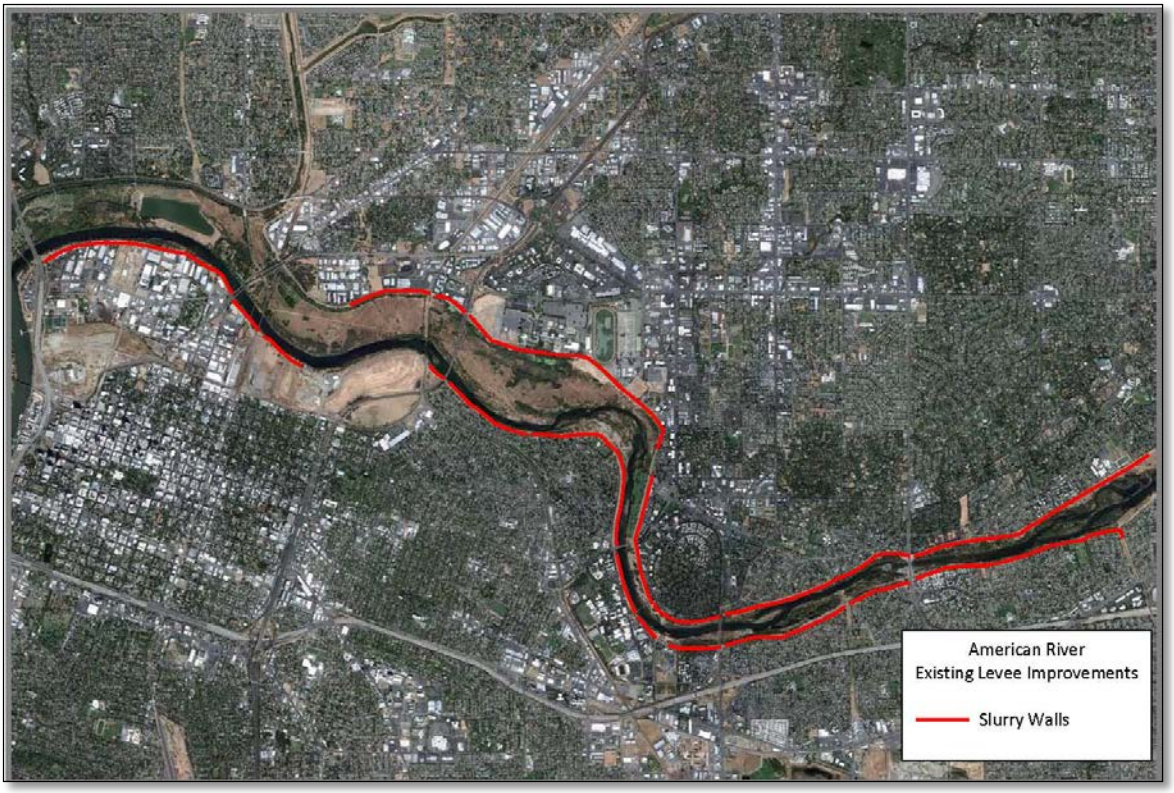

Figure 2-11: Existing Levee Improvements on the American River authorized by WRDA 96 and 99.

2.8.3 Folsom Joint Federal Project (JFP)

In 2017, the Folsom Joint Federal Project (JFP) auxiliary spillway at Folsom Dam (Figure 2-12) will be completed and a new water control manual will be adopted (Folsom Dam Modifications). This includes a 400,000 acre-feet to 600,000 acre-feet (400/600) variable flood space operation that takes incidental storage space in upstream reservoirs into consideration when determining flood storage requirements at Folsom Dam during the flood season. The JFP will allow dam operators to release larger quantities of water at lower reservoir stages and more efficiently utilize flood space in the reservoir. Operation of the JFP is to some degree dependent on the American River levees downstream of the dam being able to pass a release of up to 160,000cfs. At the time of the Folsom PAC report in 2007, assumptions were made based on the available information at the time, that the downstream improvements authorized by WRDA 1996 and 1999 would be in place and allow for the safe passage of the objective releases identified in the Folsom PAC report. However, as was noted in the Folsom PAC, an erosion study of the downstream channel was needed to provide more information on this subject. Results of this erosion study are included in the Engineering Appendix, which identifies the need for additional erosion protection. Therefore, erosion protection to these levees would enable more optimal operation of the JFP. In the absence of a Federal project to enable the levees to safely pass this objective release, downstream levees could fail leading to flooding in the Sacramento Metropolitan area.

Figure 2-12: Construction in Progress at Folsom Dam as part of the Folsom JFP.

2.8.4 Folsom Dam Raise

The 3.5-foot raise of the Folsom Dam will be completed between 2018 and 2020 and is assumed to be in place.

2.8.5 West Sacramento GRR

The West Sacramento GRR is evaluating recommendations for various improvements to the levees along the west side of the Sacramento River, directly across the river from the Common Features Study area. However, for evaluation purposes, these improvements are not included in the future without project condition assumptions. Plan formulation strategy with regards to the interrelation with West Sacramento is described in Chapter 4.

2.8.6 National Flood Insurance Program

At the present time, the American River North and American River South Basins are not mapped in the FEMA Regulatory (100-year) floodplain. Based on analysis conducted as part of this investigation as well

as other investigations by the State of California, the levee system for the greater Sacramento area has a high probability of failure in multiple locations. FEMA may remap these basins into the regulatory floodplain which would affect flood insurance rates and requirements. The Natomas Basin is currently mapped in the FEMA Regulatory floodplain and properties with federally insured mortgages are required to have flood insurance. In the absence of a Federal project to address flood risk in the greater Sacramento area, most of the city would remain exposed to a substantial long-term risk of flooding.

2.8.7 Future Development in Floodplain

The floodplains for the American River North and American River South Basins are largely built out. As such, the future conditions for these two basins are not considered significantly different from base year conditions for these two basins.

North Natomas is the largest new growth area of the City of Sacramento comprised of approximately 7,200 acres located in both the city and county. From the late 1990s to mid-2000's the Natomas Basin experienced extensive residential development, office park, and retail construction. At the time, this development was outside the 100-year floodplain. However, in 2008 the area was remapped and placed within the 100-year floodplain, which has since precluded most new construction. A North Natomas Community Plan has been developed to guide future development in the Natomas Basin after the floodplain designation is removed. This plan includes a mixture of residential, commercial and civic uses interdependent on quality transit service and a radial network of connections linking activity centers with streets, transit routes, and linear parkways with pedestrian/bike trails.

Using USACE Risk and Uncertainty methodology (EC 1110-2-6067), with the 2010 Natomas PAC and SAFCA Natomas Levee Improvement Program (NLIP) improvements in place, the Natomas basin would not meet the criteria of having 90% assurance of containing the 100-year event and therefore the levees surrounding the Natomas Basin would not be certified and the development restrictions would not be lifted. Using traditional FEMA methodology (Title 44 CFR Section 65.10), reflecting the same improvements, the Natomas basin may be eligible for certification. There are several locations within the levee system that have slightly less than 3 feet of freeboard for the 100-year event. There are provisions in the FEMA certification methodology that allow for less than 3 feet of freeboard in these conditions. Therefore, local interests may be able to demonstrate the case to certify the Natomas basin with completion of NPAC and NLIP work.

As a result of the recognition of the extent of levee problems in the Natomas Basin, SAFCA, in cooperation with the California Department of Water Resources and the Central Valley Flood Protection Board, has constructed urgently needed improvements to address seepage problems in the Natomas Basin levees as part of the Natomas Levee Improvement Program (NLIP). Specifically, these include levee improvements for the south levee on the Natomas Cross Canal and the east levee of the Sacramento River from the Natomas Cross Canal to near Powerline Road. These improvements were authorized as part of the WRDA 96/99 and WRRDA 2014 authorizations for the Common Features project. NLIP achieves the targeted flood risk reduction objectives in a manner that is consistent with current Federal

engineering and environmental standards. The Corps has provided extensive technical support for this effort. These levee improvements were permitted under Section 408 (33 USC 408) permits and are eligible for credit under provisions of Section 104 (WRRDA 1986). The features constructed by SAFCA and the State under NLIP were incorporated into the Natomas PACR. These levee improvements constructed as part of the NLIP program, along with the authorized improvements in the Natomas PACR have allowed the City of Sacramento, Sacramento County and Sutter County to jointly apply for a Physical Map Revision (PMR) to replace the Zone AE (BFE of 36 feet NAVD 88 datum) with the A99 Zone designation. The SAFCA Natomas Basin Flood Protection System A99 Eligibility Summary Report (dated June 20, 2012 and revised March 26, 2014) is the basis for the application to revise the zone. FEMA has determined that adequate progress has been made on the flood protection system project to warrant a change in zone designation to Zone A99 as defined by Paragraphs 61.12(b) of the National Flood Insurance Program (NFIP) regulations. Areas designated as Zone A99 still fall within the 1-percent annual chance flood floodplain however enough progress has been made on construction of a federally authorized flood protection system to consider it complete for insurance rating purposes. The revised Flood Insurance Rate Map (FIRM) panels are anticipated in 2015.

2.8.8 Vegetation

As part of the CVFPP, the State of California has developed a Levee Vegetation Management Strategy, which focuses on a long term vegetation life cycle management plan allowing existing trees and other vegetation to live out their normal life cycles but results in the gradual elimination of trees from the levee and adjacent areas, with the exception of the lower waterside slope of the levee. This study assumes that the Levee Vegetation Management Strategy presented in the CVFPP will be a part of the future without-project condition, forming the basis for the formulation of modifications to the Federal project that may be required to address the new requirements of the USACE Levee Safety Policy. The Levee Maintaining Agencieshave submitted a “Letter of Intent” (LOI), the first step in the development of a “Systemwide Improvement Framework” (SWIF) which would provide a formal agreement between the Corps of Engineers and the Levee Maintaining Agencies for addressing Levee Safety Policy issues specific for the study area. For the purposes of formulating a project, the Levee Safety policy will be taken into consideration, and its requirements factored into any alternatives.

The Levee Vegetation Management Strategy established in the CVFPP is summarized below:

- The State proposes adherence to USACE guidance for new levee construction, such as a setback levees, bypasses, or ring levees located away from the river channel.
- Vegetation present on the system, except for the lower waterside slope, will be trimmed to provide for visibility and access, as originally defined in the Framework.
- Vegetation present on the system will be evaluated, based on accepted engineering practice, and as part of the routine O&M responsibilities, trees and other woody vegetation will be monitored to identify changed conditions that could pose an unacceptable threat.

- DWR will implement and will advise local maintainers in their implementation of an adaptive vegetation management strategy that will include a long term vegetation life cycle management plan. This will allow existing trees and other vegetation to live out their normal life cycles but will result in the gradual elimination of trees from the vegetation management area zone through removal. Throughout their lives and after their deaths the trees will be periodically evaluated and if found to pose an unacceptable threat to levee integrity will be removed in coordination with the resource agencies. This strategy will gradually, over a period of several decades, result in levees that are clear of woody vegetation, consistent with the Corps ETL, except for vegetation on the lower waterside slope.

2.8.9 Potentially Developable Floodplains (Wise Use of Floodplains)

Current measures in place to restrict or mitigate development in areas subject to flooding in Sacramento and Sutter Counties are listed below.

- The Sacramento County General Plan and Floodplain Management Ordinance contain restrictive development policies for floodplains.
- Local policies, combined with recent state legislation and Federal regulations, are expected to limit land development.
- Conservation easements and Williamson Act contracts are in place, and the potential exists to expand use of these conservation tools.
- The State of California provides annual flood risk notifications to landowners.

3 - ALTERNATIVES

This chapter describes the formulation of alternative plans to address the planning objectives identified in Section 2.6 (in brief):

- Reduce the risk of flooding in the study area
- Reduce the impacts to critical infrastructure in the study area
- Encourage wise use of the flood plain
- Educate the public about ongoing residual risk

In this chapter, management measures (individual actions that can be taken) to address these planning objectives are described and screened for efficiency, effectiveness, and acceptability. Alternative plans are then formulated based on combinations of retained measures.

3.1 PLAN FORMULATION RATIONALE

A wide variety of management measures were developed to address the planning objectives. These measures were evaluated and screened based on efficiency, effectiveness, and acceptability. Formulation strategies were then developed to combine these measures into alternative plans that address various combinations of the planning objectives while avoiding the identified planning constraint. Based upon these strategies, which are discussed in Section 3.12, various combinations of the measures were assembled to form an array of preliminary plans. The preliminary plans were then evaluated, screened and reformulated, resulting in a final array of alternatives. From the final array of alternatives, a recommended plan is identified.

3.2 MANAGEMENT MEASURES

A management measure is a feature or activity at a site, which addresses one or more of the planning objectives. A wide variety of measures was considered and they are discussed in the following paragraphs. The measures are listed in Table 3-3 along with the objective each addresses.

3.3 MEASURES TO REDUCE FLOOD STAGES

Upstream Storage on the American River

This measure includes construction of a dam on the North Fork of the American River near the town of Auburn. This measure is assumed to be similar in scope to the proposed Auburn Flood Detention Dam project presented in the Supplemental Information Report (SIR) (USACE 1996) which was designed to be about 650 feet high and impound a reservoir of about 2.3 million acre feet. When operated with Folsom Dam downstream, it would provide greater than a 200-year level of flood protection to the Sacramento Metropolitan area. This measure would have adverse impacts on environmental resources through the loss of about 500 to over 2,000 acres of oak woodland, chaparral and coniferous forests.

Transitory Storage on the Sacramento River

Transitory storage on the Sacramento River provides reduction in stage primarily in the Natomas Basin. Three alternative locations were investigated as potential sites for transitory storage (or off-stream storage). These locations are shown in Figure 3-1 below.

Robbins Basin (RD1500)

Floodwaters would be diverted into the basin via an un-gated or gated weir at RM 69.50 on the Sutter Bypass that would be 5,280 feet long. To successfully perform, the basin would be empty at the start of weir flow. To assure this, all levees surrounding the basin would be improved. The target stage for diverting water into the basin would be the minimum elevation of the surrounding existing condition levees, 42.8 feet (NAVD88) for a storage space of approximately 988,000 acre-feet. Exit gates and/or a weir would also be needed to drain the water from the basin after the flood peak. They would be located at the lowest spot in the basin, in the left bank levee of the Sacramento River at about RM 85, about one mile upstream of the Fremont Weir. The total cost for implementing transitory storage in the Robbins Basin would be about $1 Billion. These costs include: construction of intake and outtake structures for water to enter and leave the detention basin, costs to improve the perimeter levees around the detention basin to current standards, cost to build a ring levee around Robbins, and costs to acquire real estate easements for water storage and to purchase and/or relocate existing properties in the basins. For various less probable flood events (more extreme than a 50-year event), the stage in the Sacramento River at RM 70 (about halfway between the Natomas Cross Canal and American River confluences) would be reduced by up to 2.3 feet.

Nicolaus Basin (RD1001)

Floodwaters would be diverted into Nicolaus Basin via a gated weir approximately 500 feet long at RM 8.5 on the Feather River. To assure that the basin is empty at the start of weir flow, all levees surrounding the basin would be improved. The target stage for diverting water into the basin would be equal to the minimum elevation of the surrounding existing levees, 44.4 feet (NAVD88) for a storage space of 25,000 acre-feet. Exit gates and/or weir would also be needed to drain the water out of the basin after the flood peak. They would be located at the lowest spot in the basin, along the left levee of the Sacramento River. The total cost for implementing transitory storage in the Nicolaus Basin would be $500 Million. For various less probable flood events (more extreme than a 50-year event), the stage in the Sacramento River at RM 70 would be reduced by 1.8 feet.

Elkhorn Basin (RD 537, 827, 785, 1600)

Floodwaters would be diverted into the basin via an ungated 10,560-foot long weir at RM 69 on the Sacramento River. For this alternative to perform successfully, it is necessary to assure that the basin would be empty at the start of weir flow. Therefore, all levees surrounding the basin would be improved. The target stage for diverting water would be the minimum elevation of the surrounding existing condition levees, 32.4 feet (NAVD88), for a storage space of 225,000 acre-feet. Exit gates and/or a weir would also be needed to drain the water from Elkhorn Basin after the flood peak. The total cost for implementing transitory storage in the Elkhorn Basin would be about $400 million. For various less probable flood events (more extreme than a 50-year event), the stage in the Sacramento River at RM 70 would be reduced by up to 0.9 feet.

Table 3-1: Comparison of Costs for Transitory Storage on the Sacramento River ($ millions).

Alternative	Construction Cost
Robbins Basin	$1,066
Nicolaus Basin	$545
Elkhorn Basin	$401

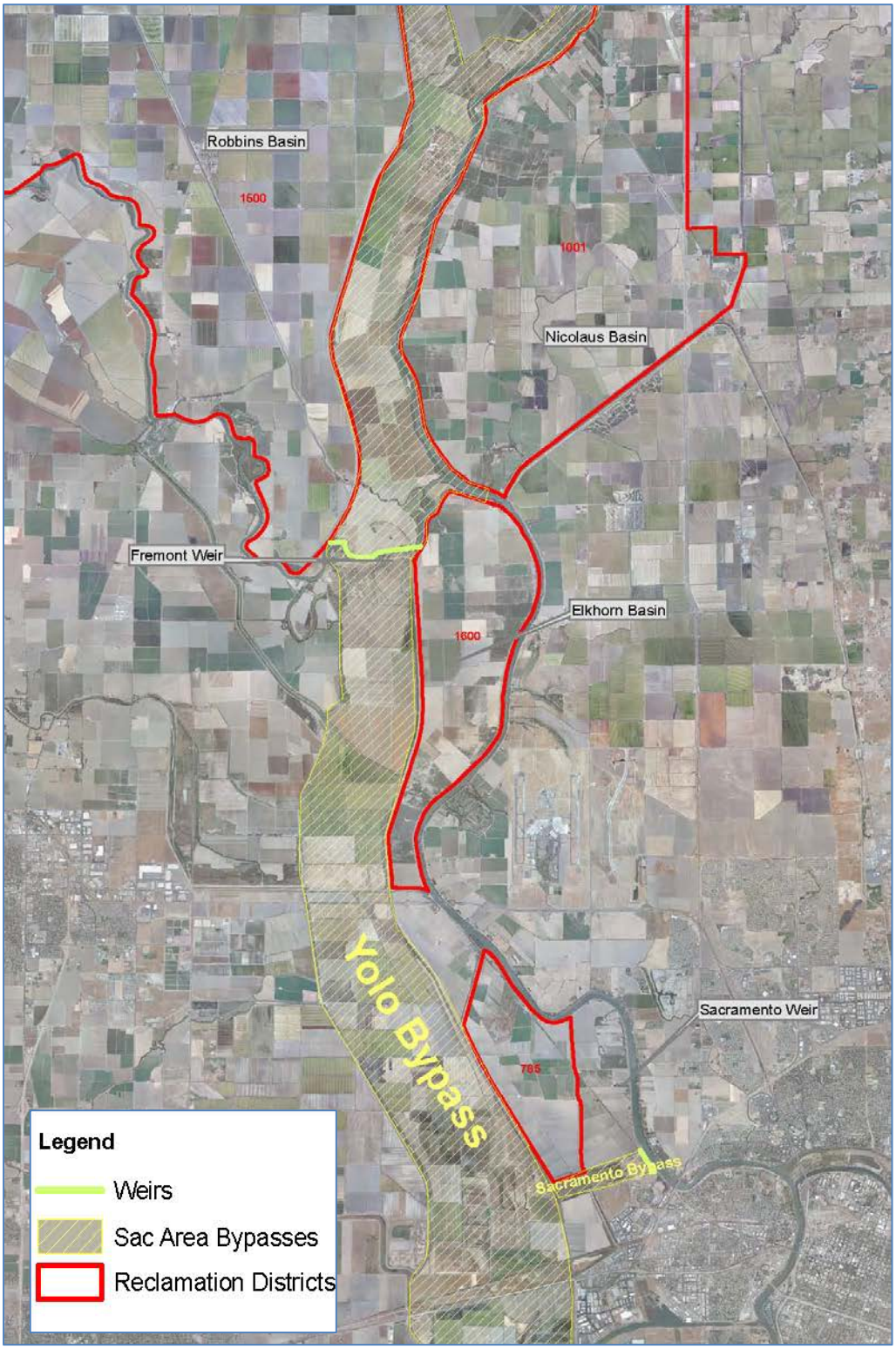

Figure 3-1: Transitory Storage Areas.

Reoperation of Upstream Reservoirs

Reoperation of SRFCP reservoirs upstream of the study area in the Sacramento River basin was considered. Reoperation of Folsom Dam was not considered under this GRR because the Folsom Water Control Manual Update, a segment of the overall American River Watershed Investigation, is currently studying reoperation of Folsom Dam. This study takes into account the potential changes to the watershed from all associated American River Watershed projects, including the Folsom JFP, the Folsom Dam Raise, and the ARCF GRR alternatives.

Major reservoirs upstream of the study area include Shasta Lake, Lake Oroville, Folsom Lake, and New Bullards Bar Reservoir. These reservoirs control approximately 11,000 square miles of the 27,000 square mile Sacramento River basin. This is about 40% of the drainage area. The flood storage is a small component of these dams' storage, since they are also water supply reservoirs. These dams were completed prior to the largest floods in Sacramento (1986 and 1997); therefore, their designs are based on hydrology that does not take these largest floods into account. Additionally, these dams are located far from the study area. Between where these reservoirs release their flow into the river system and the study area, numerous unregulated tributaries also flow in. These unregulated tributaries coupled with the attenuation of the Butte Basin, Sutter Bypass, and Yolo Bypass greatly reduce the benefits of reoperation of these reservoirs on the study area.

Sacramento Weir and Bypass Improvements

The Sacramento Weir and Bypass would be expanded by 1,500' to allow additional floodwaters to flow out into the Bypass and reduce the water surface elevation of the Sacramento River as it flows past the Sacramento Metropolitan area. The existing northern levee of the Sacramento Bypass would be degraded and a new levee constructed approximately 1,500 feet to the north. A new weir would be extended north of the existing Sacramento Weir without impacting the existing structure. The new north levee of the Sacramento Bypass will be constructed per the standard levee section for new construction and would include a 300 foot wide drained landside seepage berm to address the underseepage related issues in this area.

I Street Diversion Structure

This measure would include the construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River. This diversion structure would restrict flows going down the Sacramento River past the cities of Sacramento and West Sacramento, and would cause a portion of the flows from the Sacramento and American Rivers to be backed upstream through the Sacramento Bypass out to the Yolo Bypass. The Sacramento Bypass and Weir would be widened to accommodate the increased flows to the bypass system. The effect of this diversion structure would be to reduce the water surface elevation of the Sacramento River downstream of the structure to the point at which seepage, stability, height, and erosion improvements would not be needed.

Yolo Bypass Improvements

This measure is described in the report, Lower Sacramento River Regional Project Conceptual Design and Cost which was developed for the Sacramento/San Joaquin River Comprehensive Study. It would consist of lengthening the Fremont Weir, and widening the Yolo and Sacramento Bypasses to increase the amount of flood water conveyed through these facilities and reduce the amount of flood water conveyed through the Sacramento River channel downstream of the Bypass. This measure would consist of the following features:

- Redesign and reconstruction of the Fremont Weir.
- Construction of a new setback levee along the eastern edge of the Yolo Bypass extending from the Fremont Weir to the north levee of the Sacramento Bypass.
- Construction of a weir and closure structure in the Sacramento Deep Water Ship Channel south of I-80.
- Removal of existing Sacramento River Flood Control Project levees in the lower reach of the Yolo Bypass.

Offstream Storage on Deer Creek

This measure would involve the transfer of water from one basin to another to meet flood risk management goals. Deer Creek is a tributary of the Cosumnes River that comes within 10 miles of Folsom Reservoir. Water can be conveyed to Deer Creek via gravity flow. This measure would provide additional storage by diverting floodwaters from the American River watershed to the adjacent Cosumnes/Mokelumne Rivers system. Flood flows would be temporarily stored in a detention basin on Deer Creek and released into the Delta via the Cosumnes and Mokelumne Rivers after flood peaks had passed on those rivers. The measure would consist of several features:

- A six-bay radial gate overflow section outlet works adjacent to the west side of Folsom Reservoir's Mormon Island Dam.
- A connecting channel extending from the Folsom Reservoir Outlet Works to the detention basin approximately 8 miles to the south.
- A 600,000 acre-foot detention basin to store diverted flood flows from the American River, created by a 141-foot high random fill embankment dam.
- Channel modifications and revetment protection along Deer Creek, Cosumnes River, and the Delta to accommodate extended flood releases.

This measure could have substantial vegetation and associated wildlife impacts. This would require a long-term commitment to mitigation, maintenance, and monitoring of mitigation efforts. Detention basin releases would significantly extend flooding along the Cosumnes River and in the Franklin Pond

area. Additional flood easements would be acquired along the Cosumnes River to mitigate for these extended flood releases. The detention basin is located in the vicinity of several hazardous waste sites. Flood storage in the basin could affect groundwater flows under these sites or receive contaminated flows from the site. A plan to monitor shallow groundwater would need to be implemented, and groundwater entering or leaving the area would be checked for contamination. Additional information on this measure is located in the Supplemental Information Report, American River Watershed Project, California (1996).

3.4 MEASURES TO REDUCE LEVEE SEEPAGE AND UNDERSEEPAGE

Levee underseepage and levee through-seepage problems have been identified at many locations in the Sacramento River levee system. When the seepage velocity is great enough, piping of soil particles can occur because the frictional drag exerted on the particles is strong enough to mobilize the particles in the water flow. Seeping water thus removes soil, starting from the exit point of the seepage, and piping advances further into the levee up gradient. This piping of the soil, can lead to failure of the structure and to sinkhole formation. Vertically upwards seepage is a source of danger on the downstream side of sheet piling and beneath the toe of a dam or levee.

Underseepage problems can be corrected through the use of slurry cutoff walls, sheet pile cutoff walls, seepage berms, and relief wells. Through-seepage can be corrected by constructing cutoff walls or stability berms. Using cutoff walls in locations where through-seepage is a concern addresses both through-seepage and underseepage if constructed deep enough. Therefore, the following discussion focuses exclusively on underseepage remediation.

3.4.1 Seepage Berms

Seepage berms are wide embankments placed outward from the levee landside toe to lengthen the underseepage path and thereby lower the exit gradient of seepage through permeable layers under the levees to acceptable levels. Berms typically extend from 80 feet (a minimum berm width) to 300 feet from the landside toe of the levee. The thickness of the berm depends on the severity of the seepage flow but generally begins at 5 feet near the landside levee toe for a 100-foot berm or 7.5 feet for a 300-foot berm and tapers to a thickness of 3 feet at the end of the berm.

3.4.2 Relief Wells

Relief wells provide protection against excessive levee underseepage by providing a lower resistance pathway for underseepage to exit to the ground surface at the landside toe of the levee without creating sand boils or piping levee foundation materials. Relief wells are an option for addressing underseepage only in reaches where continuous sand and gravel layers have been identified by geotechnical explorations and analyses.

Relief wells are constructed near the landside toe of the levee to provide pressure relief beneath surface fine-grained soils (clay or silt "blanket"). The wells are constructed using drilling equipment to bore a hole vertically through the fine-grained blanket layer and into the coarse-grained aquifer layer beneath. Pipe casings and filters are installed to allow the pressurized water to flow to the ground surface, thereby relieving the pressures beneath the clay blanket. A collection pipe or ditch is used to carry seepage water to a surface drain.

Relief wells generally are spaced at 50- to 100-foot intervals. They can be used to avoid obstructions on the land side of the levee toe (such as buildings or trees) that otherwise would have to be removed for the construction of seepage berms. Although during elevated river stages relief wells conduct water to the surface without pumping (artesian flow), pumping costs are incurred to convey the collected water back into the river. Additional maintenance costs associated with the wells include annual inspections, periodic video surveying, well performance testing, cleaning, and miscellaneous repairs. Monitoring wells (piezometers) are installed between relief wells to allow monitoring of the relief wells to ensure that hydraulic pressure is being relieved. Relief wells have high operation and maintenance costs, which, if not conducted on a routine basis, will cause this feature to lose performance over time.

3.4.3 Seepage Cutoff Walls

Cutoff walls reduce through and underseepage by providing a barrier of low-permeability material through the levee and levee foundation where sandy or gravelly soils of higher permeability can transmit seepage during high water stages. Cutoff walls are generally installed to depths that will tie in with existing impervious or lower permeability soil layers in the foundation beneath the levee.

Cutoff walls can be constructed by a number of methods to suit site conditions and schedule requirements. The most common methods include the installation of cutoff walls consisting of a soil-cement-bentonite mix, cement-bentonite mix, or a soil-bentonite mix using conventional trench methods, deep soil mixing or trench remixing deep. The soil-cement-bentonite mix is used where the cutoff wall is constructed through the centerline of a levee that has been constructed with potentially unstable soil materials. In that case, if the encapsulating material begins to slough, the soil-cement-bentonite wall can provide some structural stability. Soil bentonite walls can be installed through the centerline of an adjacent levee where the mass of the joint structure significantly reduces the potential for instability.

Cutoff walls are typically constructed using an excavator with a long-stick boom capable of digging a trench to a maximum depth of approximately 80 feet. However, use of clam shell excavators can extend this distance to reach depths as great as 110 feet. Bentonite slurry is pumped into the trench during trench excavation to prevent caving. The soil and bentonite or soil, cement, and bentonite are mixed to achieve the required cutoff wall strength and permeability, and the mixture is backfilled into the trench. Construction of a conventional slurry cutoff wall through the center of the levee typically requires that the existing levee be degraded as much as one-half of the levee height to prevent hydraulic fracturing and to provide a working platform for the construction equipment. Select fill is used to rebuild the levee.

Deep soil mixing cutoff walls can reach depths of 200 feet. They are constructed by parallel augers drilling vertically through the levee and foundation. Cement and bentonite are pumped into the interconnected holes as the augers are inserted and withdrawn. The levee is normally degraded as necessary to create a 30-foot flat top width on which the equipment operates.

Trench remixing deep cutoff walls can be constructed to depths similar to those of deep soil mixing walls. The trench remixing method uses a cutter chain on a wide shaft (similar to a large chain saw) set vertically into the foundation soil. Cement and bentonite are pumped into the shaft at various depths as the cutters move along the wall alignment. Again, the levee is normally degraded as necessary to create a 30-foot flat top width on which the equipment operates.

3.4.4 Sheet Pile Walls

Sheet pile walls consist of a row of interlocking vertical pile segments driven to form an essentially straight wall. Sheet piles can consist of hot- or cold-rolled steel, aluminum, or vinyl. Hot-rolled steel sheet piles have tighter interlocks than do cold-rolled sheet piles and, therefore, do a better job of controlling seepage. Additionally, interlocks can be treated to help seal the interlocks.

3.4.5 Removal of Ditches Adjacent to Levees

There is a ditch located adjacent to the landside toe along a portion of the Arcade Creek right bank levee. This ditch poses problems for the levee in that seepage from flood waters has a shorter path to the landside of the levee. This shorter path results in exit gradients that can cause material to be removed from the foundation of the levee by piping. A measure that could manage the seepage and the resulting soil loss is to replace the ditch with a culvert.

3.5 MEASURES TO ADDRESS LEVEE STABILITY

Many of the measures designed to address seepage problems will also address stability problems, if seepage pressures are seen to be the cause of those stability problems. These measures would include seepage cutoff walls or sheet pile walls. Measures that specifically address stability issues include widening and flattening levee slopes, construction of stability berms, and full levee degrade and reconstruction.

3.5.1 Widen and Flatten Levee Slopes

Some levees within the study area have landside slopes that are considered too steep to remain stable when subjected to prolonged high water conditions. This condition can be addressed by flattening the affected levee slopes to achieve at least a 3H:1V waterside or 2H:1V landside slope geometry.

3.5.2 Stability Berms

A stability berm adds weight to the landside toe of the slope. This method is used when land is available on the landside of the levee. Stability berms are constructed of fill material to capture seepage through the levee.

3.5.3 Full Levee Degrade and Reconstruction

In areas where the available construction footprint is limited due to existing infrastructure and development, a full levee degrade may be used to reduce stability issues. The levee would then be reconstructed using geotextile material placed in alternating layers with soil in three foot intervals.

3.5.4 Reconstruct with Geotextile Materials

In areas where the steepness of the levee slope has created a slope stability problem, the levee could be partially degraded and reconstructed with a geotextile material buried within the soil to reinforce the levee slope. Geotextile material is synthetic and used primarily for soil reinforcement within an embankment.

3.6 MEASURES TO ADDRESS LEVEE OVERTOPPING

Throughout most of the Sacramento Valley including within the study area, the levees were not designed to convey a particular flood event and instead were sized to convey the flows that had previously been experienced (1907, 1909, and 1927); some subsequent flood events were larger than those for which the flood control system was sized (1955, 1964, 1986, and 1997). Measures to address levee height fall in two general categories: levee raises and floodwalls. These methods of levee raising can also be combined with various seepage and stability measures, depending on what problems exist in specific locations.

3.6.1 Raise Levees in Place

Levee raises can be accomplished by adding more embankment material to the top of the levee (providing that the width of the levee is adequate) or by widening the existing levee to gain the required height and width.

3.6.2 Raise Levees with Adjacent Levees

This measure involves construction of a new levee adjacent to and adjoining the existing levee.

3.6.3 Add Floodwalls to Existing Levees

Floodwalls can be added to the top of an existing levee.

3.6.4 Construct Natomas Cross Levee

This measure involves construction of a cross levee running east to west across the Natomas Basin to protect existing developed areas in the City of Sacramento. This measure would make it unnecessary to implement levee raises in the Northern Natomas portion of the basin.

3.6.5 Remove Levees and Construct Floodwalls

This measure consists of removal of the levee, construction of a cutoff wall, and placement of a floodwall along the same alignment. The advantage of this measure is that no additional real estate would be needed. The disadvantages are the relatively high cost of floodwall construction and the significant environmental impacts associated with the removal of the levee.

3.6.6 Construct Partial Floodwalls

This measure would add a floodwall to the top of the existing levee but the floodwall would be constructed more toward the riverside slope of the levee. This would move the levee prism riverward, which would allow the removal of landside levee embankment to provide landside access to the levee toe.

3.6.7 Construct New Levees

In areas where no levees exist, new levees could be constructed to reduce flood risk.

3.7 MEASURES TO ADDRESS EROSION

Waterside armoring of the levees to prevent erosion and subsequent damage to the levee can be accomplished using riprap and vegetation.

3.7.1 Waterside Armoring of Levee Slopes

One measure consists of placing riprap on the bank in a manner similar to that used for the Sacramento River Bank Protection Project. This measure is generally cost effective and depending on vegetation conditions, can be the least environmentally damaging option.

3.7.2 Launchable Rock Trench

Another measure includes a launchable trench filled with rock, designed to deploy once erosion has removed the bank material beneath it.

3.7.3 Bioengineered Armoring of Slopes

Another measure being considered is bioengineering, which uses plant material along with rock to stabilize the eroded slope and prevent further loss of material.

3.7.4 Grade Control Structures in the River

In addition to bank erosion concerns, there are concerns with channel degradation along the American River. Degradation of the channel could lead to bank destabilization and ultimately to levee failure. Currently, locations of hardpan are preventing further down-cutting. However, if erosion degrades through the hardpan, the potential exists for rapid erosion of the softer layers underneath the more erosion-resistant layer. To combat this, rock would be placed in the channel at appropriate locations to enhance erosion resistance.

3.8 NON-STRUCTURAL MEASURES

Risk reduction and risk education are objectives that can be partially addressed through the implementation of non-structural measures. These measures are included in the basic approaches to non-structural flood risk management discussed below. These measures would be largely implemented by the non-Federal sponsor or other local agencies with land use jurisdictions.

Zoning

Avoidance of using the floodplain for activities other than those compatible with periodic flooding is a risk reduction measure. Floodplain development requirements can be instituted, such as land-use controls that minimize new unsafe development in high-risk areas. Non-Federal sponsors for USACE FRM projects are required to publicize floodplain information and provide this information to zoning and other regulatory agencies.

Building Codes

Building codes can promote construction techniques that reduce damages to future construction due to flooding. These techniques include the raising of structures and flood proofing.

Outreach

A wide array of measures that address the objectives of risk education and community cohesion can be employed. These can include conducting training for hospitals and schools, media dissemination of information before, during, and after construction, development of a school curriculum on flooding, community workshops on flooding, and the establishment of websites that educate the public of flood risk, and flood warning and evacuation plans.

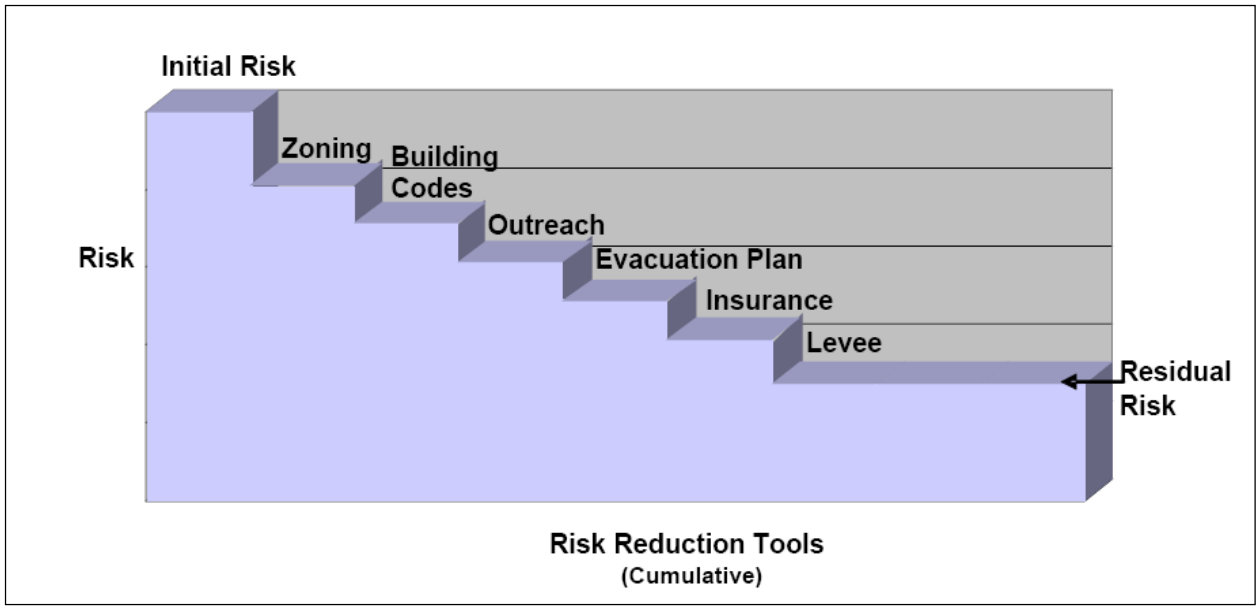

Figure 3-2: Implementation of Flood Risk Management Measures.

Evacuation Plan

Robust and effective evacuation plans and warning systems are essential in order to get people out of harm's way, should the need arise. Authorized features include three telemeter stream flow gauges upstream from the Folsom Reservoir and modifications to the flood warning system along the Lower American River. These measures have been constructed and are currently operational.

Insurance

Insurance is a way to mitigate losses to those who are subject to flooding by providing indemnification through forms of public and private insurance.

Removing Structures from the Floodplain

Another non-structural measure is to remove the structures from the floodplain. There are three ways to do this. The first is permanent relocation of all residents and businesses affected by flooding. The second is raising affected structures above flood elevations. The third is flood proofing of structures. These measures are generally most effective when the number of structures affected by flooding is small. The urbanization in Sacramento is very concentrated. Most of the urban area is within the 1/200-year ACE floodplain. There are over 85,000 structures in the 1/100 year ACE floodplain, 122,000 structures in the 1/200-year ACE floodplain and over 147,000 in the 1/500-year ACE floodplain.

Permanent relocation, raising in place, and floodproofing of existing structures are non-structural measures that would face significant obstacles to implementation given the concentrated urbanization of the Sacramento Metropolitan area: to relocate everyone out of the floodplain would involve the nearly-impossible task of moving 500,000 residents. Raising or floodproofing every structure in the Sacramento metropolitan area would completely change the character of the city, and would face opposition from residents. A significant number of historic structures would have to be altered. The first line of defense against flood risk should be to avoid or minimize damages through land-use controls and regulations for safe floodplain development. Figure 3-2 shows the order in which solutions for flood risk management would ideally be implemented.

Table 3-2 summarizes the non-structural measures. The measures identified in the Authorized Project column are those from previous American River Common Features authorizations. The measures identified under State Programs, are those included in the State of California's Public Law 84-99 Eligibility Retention and Flood System Improvement Framework or the FloodSAFE California program. Based on this, a determination was made as to whether these measures would be considered a part of the No Action plan or could be non-structural measures included as a part of a plan for reauthorization. Other measures, including floodplain management, providing information to regulatory agencies, local building codes, annual publication of residual risk and participation in Federal flood insurance programs, are all existing measures that are currently in place but will also be agreed to by the sponsor as part of implementation of the Recommended Plan.

Table 3-2: Non-Structural Measures.

Measure	Authorized Project	State Programs	Without Project	Non-Structural Alternative
Permanent Relocation				X
Raising Structures in Place				X
Flood Proofing Existing Structures				X
Zoning				
Floodplain Management	*	X	X	
Provide Floodplain Information to Regulatory Agencies	*	X	X	
Building Codes				
Local Building Codes		X	X	
Outreach				
Annual Publication of Residual Risks	*	X	X	
Evacuation Plan				
Telemeter Stream Flow Gages	X			
Modifications to Flood Warning System	X			
Insurance				
Federal Flood Insurance Program	*		X	

* Required items of local cooperation

3.9 SCREENING OF MEASURES

An initial evaluation of the measures was performed to assess their response to the measures screening criteria. These criteria include Effectiveness and Efficiency and are described below. In the formulation of preliminary plans, measures are selected from this list that best meet the planning objectives plus when combined best meet the Federal planning criteria of Effectiveness, Efficiency, and Acceptability.

Table 3-3: Measures and Objectives.

	Objective Addressed			
	Reduce the Risk of Flooding within the Study Area	**Reduce Risk to Critical Infrastructure within the study area**	**Encourage Wise Use of the Floodplain**	**Educate the public about ongoing risk**
Measures to Reduce Flood Stages				
Upstream Storage on the American River	X	X		
Transitory Storage on the Sacramento River	X	X		
Reoperation of Upstream Reservoirs	X	X		
Sacramento Weir and Bypass Improvements	X	X		
I Street Diversion Structure on Sacramento River	X	X		
Yolo Bypass Improvements	X	X		
Offstream Storage on Deer Creek	X	X		
Measures to Reduce Levee Seepage and Underseepage				
Seepage Berms	X	X		
Relief Wells	X	X		
Slurry Walls	X	X		
Sheet Pile Walls	X	X		
Removal of Ditches Adjacent to Levees	X	X		
Measures to Address Levee Stability				
Widen/Flatten Levee Slopes	X	X		
Stability Berms	X	X		
Full Levee Degrade and Reconstruction	X	X		
Reconstruction with Geotextile Material	X	X		
Measures to Address Levee Overtopping				

	Objective Addressed			
	Reduce the Risk of Flooding within the Study Area	**Reduce Risk to Critical Infrastructure within the study area**	**Encourage Wise Use of the Floodplain**	**Educate the public about ongoing risk**
Raise Levees in Place	X	X		
Raise levees with Adjacent Levees	X	X		
Add Floodwalls to Existing Levees	X	X		
Construct Cross-Natomas Levee	X	X	X	
Remove Levees and Construct Floodwalls	X	X		
Construct Partial Floodwalls	X	X		
Construct New Levees	X	X		
Measures to Address Erosion				
Waterside Armoring of Levee Slopes (Sac Bank-type Repair)	X	X		
Launchable Rock Trench	X	X		
BioEngineering Armoring of Slopes	X	X		
Grade Control Structures in River	X	X		
Non-Structural Measures				
Permanent Relocation	X	X	X	
Raising Structures in Place	X	X	X	
Flood Proofing of Existing Structures	X	X	X	
Revise Floodplain Management and Emergency Plans				X

A preliminary screening of the measures identified was done before combining them into alternatives. Screening level cost estimates were developed for the measures described. These estimates included construction costs, environmental costs, and real estate costs. The estimates were developed by applying each measure over the entire length of the area under consideration. The goal was to screen out measures that would not be cost-effective. A measure may be ruled out for general use in this preliminary screening, but if circumstances in a particular area warrant special treatment, that measure may be employed if it satisfies the need.

An estimate of environmental mitigation costs was also made. The purpose of developing these costs was to indicate a relative level of environmental impact for each measure. It is important to realize that appropriate environmental mitigation may not be possible for a particular measure. Some impacts could have the result of a jeopardy opinion from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

Table 3-4 displays the screening criteria and metrics used to evaluate and screen the measures. Table 3-5 displays the summary of the management measures retained for further analysis or dropped from further consideration.

Table 3-4: Measures Screening Criteria and Metrics.

	Measure Screening Criteria	Metric
1	Effectiveness	Does the measure respond to one or more of the planning objectives?
2	Efficiency	Ability of measure to address the problem for the least cost for a given output.

Table 3-5: Summary of Management Measures Retained or Dropped.

Measures	Retained	Dropped	Rationale
Measures to Reduce Flood Stages			
Upstream Storage on the American River	x		Effective method of reducing the flood risk to the downstream communities.
Transitory storage on the Sacramento River		x	Implementation of this measure is not efficient, because it does not reduce stages enough to preclude levee improvements anywhere within the study area.
Reoperation of Sacramento River Watershed reservoirs upstream of study area		x	Implementation of this measure is not efficient, because it does not reduce stages enough to preclude levee improvements anywhere within the study area.
Reoperation of American River Watershed reservoirs upstream of study area		x	Folsom Dam Modification Water Control Manual update is considering modifications to the flood control space. Additional reoperation of reservoirs upstream of Folsom Dam would most likely yield minimal downstream flood risk reduction benefits because these reservoirs only slightly regulate a small portion of the overall watershed tributary to Folsom Dam. Therefore, this measure is not effective.
Sacramento Weir and Bypass Improvements	x		Provides regional benefits in the form of reduced water surface elevations in the Sacramento River in the study area and to communities downstream of the study area. High reliability of moving flood flows away from urban area to rural bypass area
Improvements to the Yolo Bypass		x	Implementation of this measure is not efficient, because it does not reduce stages enough to preclude levee improvements in the study area.

Measures	Retained	Dropped	Rationale
Offstream Storage on Deer Creek		x	This measure is not efficient, because substantial development has taken place in the area where this alternative would be located. High costs would be incurred in relocating these communities. Further information on why this alternative is screened out can be found in the 1996 Supplemental Information Report (USACE 1996).
Construct Diversion Structure on Sacramento River near I Street Bridge	x		Reduces water surface elevation in the Sacramento River downstream to the extent that seepage, stability and erosion issues are addressed and levee improvements not needed.
Measures to Address Seepage and Underseepage			
Seepage Berms	x		Existing residential and commercial development immediately adjacent to the levee toe makes this measure more costly than other seepage reduction measures in most areas. May be retained for use in areas with land available on the landside of the levee.
Relief Wells	x		Effective method of addressing residual seepage without jeopardizing levee integrity.
Slurry Walls	x		Effective method of reducing levee seepage and underseepage.
Sheet Pile Walls		x	Not an effective construction technique for deep cutoff of seepage. Screened based on cost and constructability.
Removal of Ditches Adjacent to levees	x		Effective at lengthening seepage path to meet seepage criteria.
Measures to Address Levee Stability			
Stability Berms		x	This measure is not efficient, because existing residential and commercial development immediately adjacent to the levee toe make this measure much more costly than other stability improvement measures.
Sheet Pile Walls		x	Not an effective construction technique to address stability. Screened based on efficiency.
Widen/Flatten Levee Slopes	x		Effective method of improving levee stability.
Full Levee Degrade	x		Effective method of improving levee stability.
Reconstruction with Geotextile Material	x		Effective method of improving levee stability.
Measures to Address Levee Overtopping			
Raise Levees in Place	x		Effective method of increasing levee performance.
Raise levees with Adjacent Levees		x	This measure is not effective, because residential and commercial development exists immediately adjacent to existing levee toe. Real estate requirements make this measure much more costly than other measures that achieve similar results.
Add Floodwalls to Existing Levees	x		Effective method of increasing levee performance.
Construct Cross-Natomas Levee		x	This measure is not efficient, because it is much more costly than improving existing levees. Very high real estate costs.
Remove Levees and Construct Floodwalls		x	This measure is not efficient, because other measures that achieved the same result were more cost effective. High environmental effects. May be used in localized areas.

Measures	Retained	Dropped	Rationale
Construct Partial Floodwalls		x	This measure is not efficient, because other measures that achieved the same result were more cost effective. May be used in localized areas.
Construct New Levees		x	This measure is not efficient, because improving existing levees is more cost effective due to construction and real estate costs.
Measures to Address Erosion			
Waterside Armoring of Levee Slopes (Sac Bank-type repair)	x		Effective method of reducing erosion potential on the levee.
Launchable Rock Trench	x		Effective method of reducing erosion potential on the levee.
Biotechnical Armoring of Slopes	x		Used in areas with a wide natural bank. Would not be used on levee slopes. Effective method to reduce erosion.
Grade Control Structures in River		x	Analysis confirmed that erosion of the river bed is not a significant concern during the period of analysis.
Non-Structural Measures			
Permanent Relocation		x	This measure is not efficient, because it is too costly to relocate the City of Sacramento out of the floodplain, however, relocation of individual structures at specific locations may prove to be justified and help reduce flood risk.
Raising in Place		x	This measure is not efficient, because it is more costly than improving levees and would alter the character of the community, however, raising of individual structures at specific locations may prove to be justified and help reduce flood risk.
Flood Proofing of Existing Structures		x	This measure is not efficient, because it is more costly than improving levees and would alter the character of the community, however, flood proofing of individual structures, and specifically critical infrastructure features, at specific locations may prove to be justified and help reduce flood risk.
Revise Floodplain Management and Emergency Plans	X		Information developed as part of the study would be used to update Floodplain Management and Emergency Plans.

3.10 PLAN FORMULATION STRATEGIES

Plan formulation is the process of putting together plans that meet the planning objectives and avoid the planning constraints. Often, the plan formulation process emphasizes structural details, costs, project outputs, safety, reliability, and other matters that are quantifiable. However, formulation must be balanced by also considering environmental, social, institutional, and other qualitative information. To overlook such information runs the risk of developing plans that cannot be implemented. In an effort to balance the technical evaluations with those that are less so, the formulation process begins with the development of strategies. A plan formulation strategy is a systematic way of combining measures into plans based on selected criteria. The inspiration for a strategy may be institutional, as in laws, policies,

regional plans, or other institutional realities. It may be technical, as in formulation of the least cost plan. Or it may be inspired by issues important to stakeholders or local objectives and constraints. A strategy becomes the recipe for formulating a plan. And during iterations of the planning process, strategies can become more precise. The development of strategies usually begins with screened management measures. The combinability, dependency and mutual exclusivity of the measures are evaluated, and then a strategy is applied to combine measures into candidate plans.

The plan formulation strategy applied for this study consisted of a few steps. Overall, alternatives were developed to comprehensively reduce flood risk. However, this was done by starting with an understanding of addressing the greatest risk drivers. As described in the problems section, the greatest flood risk driver to the Sacramento Area is the risk of a geotechnical levee failure along the Sacramento River from a relatively high frequency event. The next risk driver is a levee failure from erosion from a relatively high frequency flow along the American and Sacramento Rivers. The third order risk driver is from lower frequency, high volume flows exceeding the flood carrying capacity of the Sacramento, American and Natomas levee systems. Lastly, there is some risk from encroachments and from vegetation, although there are isolated instances of significant risk from encroachments and vegetation. Encroachments may obstruct flood monitoring or flood fighting activities in areas of distress occurring on a levee during high flow; depending on the circumstances of a specific encroachment, some encroachments might pose a significant risk. Vegetation has the effect of shortening seepage paths, leading to piping of material. Vegetation might also fall during a flood event greatly reducing the geometry of the levee and therefore the stability, possibly to the point of levee failure.

There are some reaches of levees where the seepage and stability issues are worse than other reaches. However, improving those reaches just moves the point(s) of greatest concern to the next location. It would not be efficient to improve only a few reaches at a time when the extent of the problem applies to the Sacramento River levee from the confluence with the American River to the south. Traditionally, erosion has been addressed from a reactionary standpoint once erosion is active or imminent. This has been done via the Sacramento River Bank Protection Project. (The Sacramento River Bank Protection Project is an authority to preserve the integrity of the Sacramento River Flood Control Project, which includes the Sacramento and American River levees.) However, evaluating the history and nature of erosion as part of this GRR indicates strong evidence that active and imminent erosion is present and constitutes a relatively high risk. There is also a high degree of likelihood that extensive erosion will occur without preventative measures put in place to prevent erosion of the existing and proposed flood risk reduction features.

Additional plan formulation strategies include the following:

- Combine measures that improve levee performance
    - *Improve conveyance*
    - *Improve levees in place by various methods*

- Combine measures that reduce flood stages
  - *Improve upstream storage*
  - *Reduce flow which reaches study area*
- Develop minimum and maximum plans which bracket possible solutions.
- Combine measures which improve levee performance and reduce flood stages
  - *Identify measures which together provide optimal storage and conveyance opportunities*

3.11 INITIAL ARRAY OF ALTERNATIVES

Using the formulation strategies outlined, retained measures were assembled into initial alternatives. These initial alternatives were then screened using the Federal planning criteria along with risk management tools, and coordination with the non-Federal sponsor, stakeholders and the vertical team. The Corps is required to consider "No Action" as one of the alternatives for selection in order to comply with Corps planning policies and the requirements of the National Environmental Policy Act (NEPA). The No Action Plan here assumes that neither the Federal Government nor local interests would implement the recommendations in this GRR. Consequently, the No Action Alternative would not improve the current condition of the levees in the project area and the likelihood of failure of those levees would not change. The potential loss of life, loss of property, and loss of critical infrastructure would not be reduced under this scenario. Because the No Action Plan is required to be included among the candidate plans in the final array of alternatives, the resulting effects of a levee failure are described in the Summary System of Accounts Comparison of the Final Array of Alternative Plans, later in this chapter. The No Action plan and the future without-project condition are assumed to be the same for this study.

3.12 SCREENING OF INITIAL ARRAY OF ALTERNATIVES

Federal planning criteria were used for the first level screening of the initial array of alternatives. Planning criteria are used to formulate, screen, evaluate and compare alternative plans. Four specific criteria are required in USACE water resource studies: completeness, effectiveness, efficiency and acceptability. These criteria are useful in narrowing down the array of possible alternatives plans.

Completeness

The definition of "completeness" from ER 1101-2-100, the Planning Guidance Notebook, is "the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities."

Effectiveness

Within identified constraints of the study, each alternative in the focused array addresses the planning objectives regarding flood risk management and life safety to varying degrees. No further evaluation and screening was necessary for this criterion.

Efficiency

This criterion is defined in terms of cost efficiency and compares economic benefits to economic costs from a national perspective. As part of the analysis for cost efficiency, the NED Plan is identified as the alternative that reasonably maximizes annual net benefits. The focused array of alternatives will be screened for cost efficiency using economic criteria.

Acceptability

Alternatives are acceptable when they are compatible with existing laws, regulations, and public policies.

Table 3-6 displays the extent to which the initial alternatives meet the planning criteria and the results from this screening. Because all of the alternatives in the Initial Array met at least three of the four criteria, they were all carried forward for additional consideration. This was considered beneficial in order to evaluate the alternatives using more study specific metrics.

Table 3-6: Screening of the Initial Array of Alternatives.

Preliminary Alternative	Completeness	Efficiency	Effectiveness	Acceptability	Carried Forward?
Improve Levees within Existing Geometry (Minimum Plan)	Yes	Yes	Yes	Yes	Yes
Improve Levees	Yes	Yes	Yes	Yes	Yes
Improve Levees & Widen Sacramento Weir and Bypass	Yes	Yes, benefits exceed costs	Yes	Yes	Yes
Improve Levees and Construct I-Street Diversion Structure	Yes	No	Yes	Yes	Yes
Upstream Storage on American River	Yes- if combined with downstream levee improvements	No	Yes – if combined with downstream levee improvements	No, Congressional support and public support lacking	Yes
Maximum Plan	Yes	No	Yes	No	Yes
Non-Structural	Yes	No	Yes	Yes	Yes

From this screening, the initial alternatives were refined to form a focused array of alternatives that were carried forward for further evaluation. A description of each of the focused array of alternatives follows.

3.13 DESCRIPTION OF THE FOCUSED ARRAY OF ALTERNATIVES

A focused array of alternatives was identified from the screening process described in the previous section. Verification of the geotechnical levee issues and hydraulic modeling scenarios focused these alternatives on the need to improve the levee performance or drastically reduce the water surface elevation.

Focused Alternative 0.5: Improve Levees within Existing Geometry (Minimum Plan)

This alternative would incorporate levee improvements for seepage, stability and erosion but not include any levee raises or other conveyance improvements. This is considered to be the minimum amount of levee improvements needed to substantially reduce the flood risk and would perform at about the 1/100 ACE event. Events larger than this would cause levee overtopping. Screening level costs for this plan were developed in 2013 at the time of the evaluation of the focused array of alternatives. Table 3-7 identifies the measures recommended for this alternative for each waterway.

Table 3-7: Focused Alternative 0.5: Improve Levees within Existing Geometry – Proposed Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, geotextile and slope flattening	Bank Protection, Launchable Rock Trench	---
NEMDC	Cutoff Wall	Cutoff Wall	---	---
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	---
Dry/Robla Creeks	---	---	---	---
Magpie Creek	---	---	---	---
Natomas	---	---	---	---

Focused Alternative 1: Improve Levees

Focused Alternative 1 adds levee raising to the previous alternative which increased the performance to approximately a 1/200-year ACE. Screening level costs were developed for this alternative in 2013 which are displayed in Table 3-14. Focused Alternative 1 involves the construction of in-place levee improvement measures to address seepage, slope stability, erosion, and overtopping concerns identified for the American and Sacramento River levees, NEMDC, Arcade, Dry/Robla, and Magpie Creeks. In addition, Alternative 1 would include levee raises for the Natomas Basin. Analyses of the Natomas Basin levee raises are included in this GRR; however, this measure was analyzed for NEPA and CEQA in the Natomas Levee Improvement Program, Phase 4b, Landside Improvement Project EIS/EIR in 2010. As a result, the EIS/EIR accompanying this GRR incorporates the analysis of the levee raise by reference to the earlier EIS/EIR.

Due to environmental, real estate, and hydraulic impact concerns within the American River North and South basins, Alternative 1 proposes to improve levees within their existing footprint to the extent possible. The purpose of this alternative would be to improve the flood management system to convey flows to a level that maximizes net benefits. Table 3-8 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 3-8: Focused Alternative 1 – Improve Levees – Proposed Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, geotextile and slope flattening	Bank Protection, Launchable Rock Trench	Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

Focused Alternative 2: Improve Levees and Widen the Sacramento Weir and Bypass

Focused Alternative 2 consists of levee improvements similar to what is proposed in Focused Alternative 1, and also includes widening the Sacramento Weir and Bypass, which negates the need to include most of the levee raising measures contained in Focused Alternative 1. Levee raises are unnecessary because flow that would have gone down the Sacramento River is rerouted to the widened Sacramento Weir and Bypass. Screening level costs developed for this alternative in 2013 are displayed in Table 3-14. The levees along the American River, NEMDC, Arcade Creek, Dry Creek, Robla Creek, and Magpie Creek would be improved to address identified seepage, stability, erosion, and height concerns through the methods described under Alternative 1. The levees along the Sacramento River would be improved to address identified seepage, stability, erosion, and overtopping concerns through the measures described under Alternative 1. Due to environmental, real estate, and hydraulic capacity constraints within the American River North and South basins, the majority of the levees would be improved within the existing levee footprint to the extent possible.

This alternative would include widening the Sacramento Bypass by approximately 1,500 feet to increase the amount of flow it conveys into the Yolo Bypass. This alternative includes construction of a new weir adjacent to the existing Sacramento Weir, demolition of the existing north Sacramento Bypass levee, and construction of a new levee approximately 1,500 feet to the north. Expanding the Sacramento Weir and Bypass would greatly reduce the amount of levee raises needed along the Sacramento River. Table 3-9 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 3-9: Focused Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass – Proposed Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, geotextile and slope flattening	Bank Protection, Launchable Rock Trench	Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

Focused Alternative 3: I-Street Diversion Structure

Focused Alternative 3 would include the construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River. This diversion structure would restrict flows going down the Sacramento River past the cities of Sacramento and West Sacramento, and would cause a large portion of the flows from the Sacramento and American Rivers to be forced upstream through the Sacramento Bypass out to the Yolo Bypass. The Sacramento Bypass and Weir would be widened to accommodate the increased flows to the bypass system. The effect of this diversion structure would be to reduce the water surface elevation of the Sacramento River downstream of the structure to the point at which seepage, stability, height, and erosion improvements would not be needed. Diverting this much flow from the Sacramento River into the Sacramento Weir/Bypass and into the Yolo Bypass required the addition of features to mitigate the effect of the additional flow. The cost for this alternative includes the cost of Alternative 2 with much of the work along the Sacramento River removed, the cost of the I-Street Diversion structure itself at $122 million plus the cost of Yolo Bypass mitigation features, roughly estimated at $1.13 billion. Table 3-10 summarizes the levee problems discussed above and the proposed measure for each waterway.

The I Street Diversion Structure would consist of a two hundred (200) foot wide, non-gated u-frame structure and four (4) sixty-two (62) foot wide Tainter gates. Tie-in-T-Walls are provided on either side of the major structures to tie in to the existing levees along the Sacramento River. The structures consist of conventionally reinforced concrete, supported on pipe pile foundations. Upper sand layers within the Sacramento River will be densified with ground improvement technology to prevent liquefaction during a seismic event. The structures would be constructed in three phases utilizing internally braced temporary retaining structures (TRS) for cast-in-place construction.

Table 3-10: Focused Alternative 3 – I Street Diversion Structure – Proposed Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	I Street Diversion Structure	I Street Diversion Structure	I Street Diversion Structure	Sacramento Bypass and Weir Widening and I St. Diversion Structure
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

Focused Alternative 4: Upstream Storage on the American River

This alternative involves construction of a flood control dam near the town of Auburn on the north fork American River for the purpose of attenuating flows continuing downstream into Folsom Reservoir and the lower American River. The basis for this alternative is the 1996 American River Watershed Investigation Supplemental Information Report updated to current price levels and understanding of downstream levee work. The location of the dam is driven by the shape of the canyon; costs for seismic considerations are not a driver. Additionally, levee improvements to address seepage, stability, erosion, and overtopping concerns are included where they exist in various stretches of levee protecting the City of Sacramento.

Table 3-11 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 3-11: Focused Alternative 4 – Upstream Storage on the American River – Proposed Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	Upstream Storage (reduce flanking)
Sacramento River	Cutoff Wall	Cutoff Wall, geotextile and slope flattening	Bank Protection, Launchable Rock Trench	Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

Focused Alternative 5: Maximum Plan

The Maximum Plan to reduce flood risk for the City of Sacramento and the surrounding area would include most of the measures previously discussed. It basically includes all building block steps including levee improvements from Alternative 1, the Sacramento Weir and Bypass widening of Alternative 2, the I Street Diversion Structure from Alternative 3, and the Auburn Dam from Alternative 4. The costs were developed by taking the cost of all of these features and adding them together. Due to the fact that the City of Sacramento is the Capital of the State of California, has several hundred thousand residents residing and working in the floodplain, critical infrastructure of State and National value, and is one of the most at risk urban areas in the country for flooding, the focus of this Maximum Plan would be to identify all means possible to reduce the risk of flooding and not constrain the plan by net benefits or performance. Therefore, the Maximum Plan would include levee improvements along the Sacramento and American Rivers as well as the NEMDC, Arcade, Dry/Robla and Magpie Creek tributaries and the Natomas levee raises. This alternative would also include construction of a dam upstream on the American River near the town of Auburn which would further reduce the risk of flooding from a 200 year to about a 400 year event. Additional levee raises along the Sacramento River would also be included to increase the performance of these levees to a level comparable to that of the American River flood management system with an upstream dam in place. The Maximum Plan was developed to establish an outer boundary for costs and benefits. Table 3-12 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 3-12: Focused Alternative 5 (Maximum Plan) – Proposed Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	Upstream Storage (reduce flanking)
Sacramento River	I Street Diversion Structure and Cutoff Wall	I Street Diversion Structure and Cutoff Wall	I Street Diversion Structure and Bank Protection, Launchable Rock Trench	I Street Diversion Structure and Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

Focused Alternative 6: Non-Structural Alternative

The non-structural alternative would consist of measures such as raising or relocating structures where economically and practically feasible. And flood proofing critical infrastructure features and individual structures on the floodplain fringe where inundation depths are lower.

Several non-structural flood risk management elements could be added to any of the structural alternative plans in the final array to further reduce flood risk. Whereas structural project features, such as levees and channel improvements, can reduce the probability of flooding, non-structural features can reduce the consequences of flooding. The combination of both structural and non-structural elements should ideally be used to reduce the flood risk to an area.

Table 3-13 below lists the measures included in each of the Focused Array of alternatives.

Table 3-13: Measures Included in the Focused Array of Alternatives.

Retained Measures	Focused Array of Alternatives						
	0.5 Minimum Plan	1 Improve Levees	2 Sac Bypass	3 I Street Diversion	4 Auburn Dam	5 Maximum Plan	6 Non Structural
Upstream Storage on the American					x	x	
Sacramento Weir and Bypass			x	x		x	
I St. Diversion Structure				x		x	
Relief Wells	x	x	x	x	x	x	
Slurry Walls	x	x	x	x	x	x	
Remove Ditches Adjacent to Levees	x	x	x	x	x	x	
Widen & Flatten Levee Slopes	x	x	x	x	x	x	
Raise Levees in Place		x	x		x	x	
Add Floodwalls to Existing Levees		x	x	x	x	x	
Waterside Armoring of Levee Slopes	x	x	x	x	x	x	
Launchable Rock Trench	x	x	x	x	x	x	
Revise Floodplain Management and Emergency Plans	x	x	x	x	x	x	x

Evaluation and Comparison of the Focused Array of Alternatives

After alternative plans have been screened using the planning criteria, they are evaluated and compared against more specific evaluation criteria. Evaluation criteria can include costs, outputs, or effects and reflect the planning objectives or constraints. Some or all of the evaluation criteria may be used at various stages in the plan formulation process to compare alternative plans. Effective evaluation criteria must be measurable and reveal differences or trade-offs between alternative plans.

An evaluation of the Focused Array of Alternatives was conducted using criteria established by Executive Order 11988. Based on the findings, all alternatives were compliant for the ARN and ARS basins. However, additional levee improvements for the Natomas Basin were determined to not be compliant with E.O. 11988. Additional discussion regarding the Natomas Basin is included in the evaluation and comparison of the Final Array of Alternatives below.

Comparison of the Focused Array of Alternatives focuses on the economic benefits and costs of each alternative. The economic benefits are derived from the computation of without project annual damages and the associated reduction in those damages as a result of implementation of the various alternatives. The costs displayed here are screening level costs developed early in the study phase and these have not been updated since they were initially established.

Without-project expected annual damages were computed at eight representative index points throughout the study area. These index points, which are located on the main flood sources, were chosen in order to be able to reasonably characterize the flood risk associated with each of the three main basins by accounting for the multiple sources of flooding in each basin.

Similarly, with-project damages reduced (benefits) associated with various project alternatives were also computed at each representative index point for each basin. If the flood risk in a basin (or any other consequence area) could be attributed to one and only one flood source, then the total benefits computed at an index point along a particular flood source would represent the benefits of building a project on that flood source. This is not the case, however, for the ARCF study area as flood risk in each basin/consequence area can be attributed to multiple flood sources. Under this scenario, benefits were computed first at each index point (source), and then estimated for the whole basin using the appropriate calculation method as determined by assessments of the hydrologic/hydraulic correlation between the flood sources within a basin. (For more detail, see the Economic Appendix to the ARCF GRR).

Table 3-14 compares the preliminary first costs, annual costs, annual benefits, and net benefits for the focused array of alternatives. Additional information on the development of the costs for the focused array of alternatives is located in Appendix A.

Table 3-14: Comparison of Costs (in $1,000s) and Benefits of the Focused Array of Alternatives[1,2].

	Alt 0.5 (minimum)	Alt 1 (Improve Levees)	Alt 2 (Widen Sac Weir and Bypass)	Alt 3 (I Street Diversion Structure)	Alt 4 (Upstream Storage)	Alt 5 (Maximum Plan)	Alt 6 (Non-Structural)
First Costs	1,262,915	1,426,055	1,567,746	2,122,000	3,226,055	4,681,746	N/A
Average Annual Costs[3]	71,213	80,412	88,401	119,654	181,885	263,992	N/A
Average Annual Benefits	384,047	433,581	430,798	428,000	451,600	451,600	N/A
Net benefits	312,834	353,169	342,397	308,346	269,715	187,608	N/A
B/C	5.4	5.4	4.9	3.6	2.5	1.7	N/A

Notes:
[1] Based on October 2013 price levels, 3.5% discount rate, and a 50-year period of analysis.
[2]Preliminary costs were based on a combination of estimates developed for the GRR, previous USACE studies and costs developed by private consultants.
[3]Average Annual Costs include preliminary Interest During Construction (IDC) calculations.

Net benefits were derived for each of the alternatives in the focused array and the net benefits curve is shown in Figure 3-3 below.

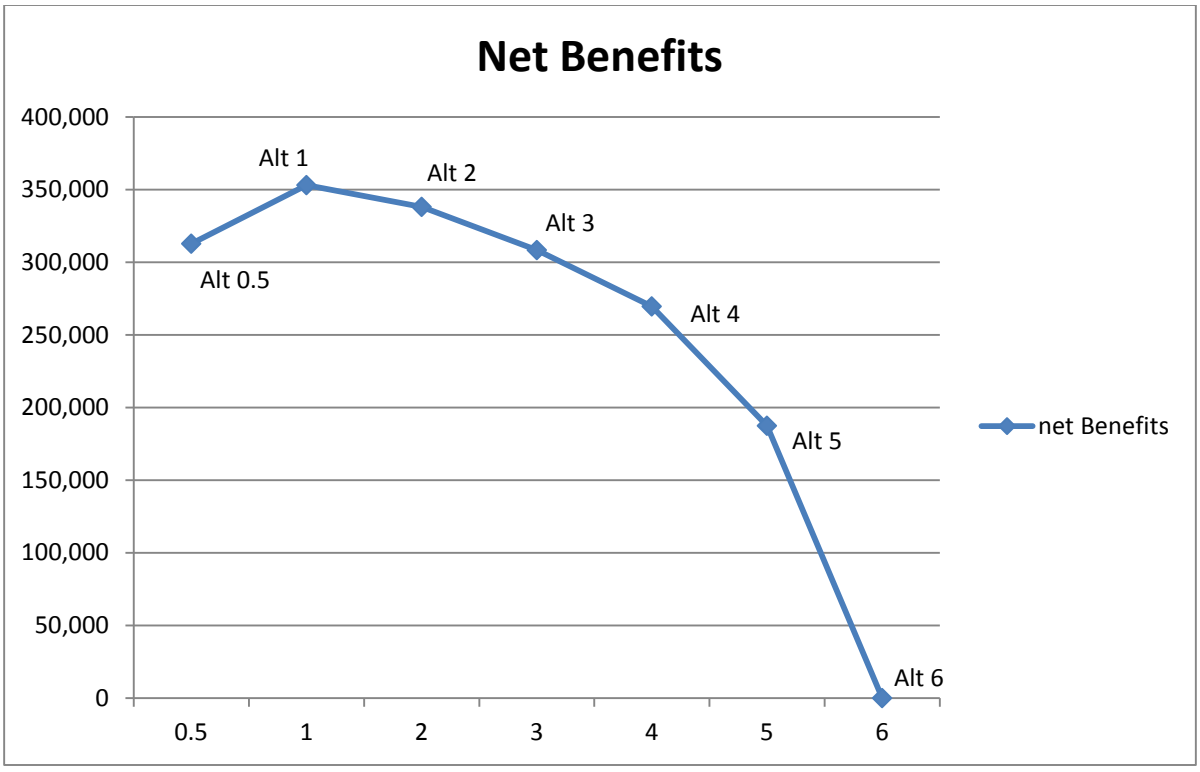

Figure 3-3: Net Benefits of Focused Array of Alternatives.

A summary of the evaluations of the Focused Array of Alternatives are presented in Table 3-15 below.

Table 3-15: Summary Evaluation of Focused Array of Alternative Plans.

Focused Alternative	Evaluation Summary	Carried Forward?
0.5. Improve Levees within Existing Geometry (Minimum Plan)	This alternative does not maximize net benefits and is on the rising portion of the net benefits curve. It was therefore dropped from further consideration.	No
1. Improve Levees	Improving the existing levees to address seepage, stability, erosion and height issues is the first increment to reducing flood risk for the Sacramento area. Because this alternative increases system performance and appears to have the highest net benefits, it was carried forward for further consideration.	Yes
2. Improve Levees & Widen Sacramento Weir and Bypass	This alternative reduces the flood risk to the urbanized area and has high net benefits and is therefore carried forward for further evaluation. This is the sponsor supported plan.	Yes
3. I-Street Diversion Structure	This alternative is not efficient. Does not meet worst-first implementation strategy. The implementation sequencing would leave the densely populated areas of Sacramento at risk of flooding until the end of the construction timeframe. The Yolo and Sacramento Bypass levee work would be constructed first in order to accept the higher flows associated with this alternative. Once this was completed, then work on the diversion structure itself would begin. Since no levee work is recommended on the Sacramento river levees as part of this alternative, this high risk area would remain exposed throughout implementation of the project.	No
4. Upstream Storage on American River	Construction of an upstream storage facility does not address the high frequency flood risk associated with the poor performance of levees in the study area. It also does not reduce the risk for the highest risk area along the Sacramento River since this is dominated by Sacramento River flows. All downstream levee improvements contained in Alternatives 1 and 2 would need to be included to effectively reduce the high frequency flood risk for the study area. Other alternatives offer more efficient methods to reduce the flood risk. The Dam would perform at approximately a 1/400-year ACE. The cost of Auburn Dam, inflated from 1996 to 2014 is approximately $1.8 billion. It does provide additional benefits beyond Alternative 1, however not enough to keep it on the rising limb of the net benefits curve.	No
5. Maximum Plan	Other plans offer more efficient ways to reduce risk.	No
6. Non-Structural	These measures reduce the consequences of flooding, but do not reduce the probability of flooding and therefore do not significantly reduce the overall risk of flooding. Other plans offer more efficient ways to reduce risk.	No

Based on the evaluation, two alternatives were retained for the final array of alternatives.

Identification of Tentative NED Plan

The comparison of the costs and benefits of the Focused Array of Alternatives identifies Alternative 1 as the tentative NED plan; the plan which reasonably maximizes net benefits, pending more detailed evaluation. Due to the fact that the costs and benefits for both Alternative 1 and Alternative 2 were very close, both alternatives were carried forward to the final array of alternatives for further evaluation and comparison. Alternative 1 is the tentative NED Plan.

3.14 FINAL ARRAY OF ALTERNATIVES

Based on the results of the evaluation of the focused array of alternatives, Alternatives 1 and 2, along with the No Action plan, were carried forward to the final array of alternatives for further evaluation and comparison. This section contains more detailed descriptions of each of these alternatives.

Final Alternative 1: Improve Levees

Alternative 1 would include the construction of levee improvement measures to address seepage, stability, erosion, and height measures identified for the Sacramento River, Natomas East Main Drainage Canal (NEMDC), Arcade Creek, and Magpie Creek. Alternative 1 would also include erosion measures for specific locations along the American River. This alternative combines construction of levee improvement measures while maintaining the present levee alignment in its existing location (fix in place). Due to the urban nature and proximity of existing development within the American River North and South basins, Alternative 1 proposes to improve the levees within their existing footprint, with minimal additional real estate requirements. The purpose of this alternative would be to improve the flood risk management system to safely convey flows to a level that maximizes net benefits.

No additional recommendations for levee improvements in the Natomas Basin are included in the final alternatives. Seepage, stability, and erosion problems in the Natomas Basin were addressed in the Natomas PACR. Levee raises were evaluated as part of this GRR but were not carried forward for recommendation as a result of evaluation of the final array of alternatives. It was determined that proposed actions by the State of California and local authorities could render the levee raises unnecessary. The widening of the Sacramento Weir and Bypass, as proposed by this study, along with a proposal by the State of California to expand the Fremont Weir and the Yolo Bypass, would lower the water surface elevation in the Sacramento River adjacent to the Natomas Basin by allowing additional flows to leave the river and enter the bypass system. Widening of the Sacramento Bypass also lowers the backwater effect in the American River and the NEMDC adjacent to the Natomas Basin.

The following sections contain more detailed information on the specific features and reaches included in this alternative.

Sacramento River Levees

Levees along the Sacramento River would be improved to address seepage, stability, erosion and height issues. Some real estate acquisition will be required for levee construction, inspection, maintenance, monitoring, and flood-fighting access.

A slurry wall would be constructed through the levee crown to address seepage concerns. Degradation of the levee crown is necessary to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. Depending on the depth of the slurry wall needed to address the seepage issue the slurry wall would be installed by one of two methods. The conventional slot trench method, utilizing a long boom excavator can install a slurry wall to a depth of approximately 80 feet. For slurry walls of greater depth the Deep Soil Mixing (DSM) method would be utilized. The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of approximately 140 feet. For both methods, once the slurry has hardened it is capped and the levee embankment reconstructed with impervious or semi-impervious soil.

The proposed levee section consists of 20-foot wide levee crown with 2:1 to 3:1 side slopes. Where the existing levee does not meet the levee design requirements, slope flattening, crown widening, and or levee raise is required. This improvement measure addresses problems with slope stability, geometry, and levee crest access and maintenance.

To begin levee embankment grading, the area is cleared, grubbed, stripped, and where necessary portions of the existing embankment are removed to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) must be stockpiled at staging areas. Haul trucks and front end loaders bring borrow materials to the site and graders spread material evenly according to levee design plans. Sheepsfoot rollers compact the material. In the lower reach of the Sacramento River, near the town of Freeport, the steepness of the levee slope has created a slope stability problem. To address this problem, the levee would be partially degraded and reconstructed with a geotextile material to reinforce the levee slope. Landside access will likely be required to construct this feature from the levee toe upwards.

Erosion concerns would be addressed by either rock protection on the bank or the launchable rock trench method described in the American River section. There are about 10 miles of erosion protection required.

American River Levees

The erosion protection measures for the American River levees consist of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. One measure consists of placing rock protection on the bank to prevent erosion; this, in general, is the approach of the Sacramento River Bank Protection Project. This measure entails filling the eroded portion of the bank and installing

revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. Another measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. The trench would be excavated at the toe of the existing levee. The bottom of the trench will be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required. After rock placement the trench would be covered with a minimum of 3 feet of soil. The levee slope would be reshaped and armored with riprap and covered with 2 feet of soil. All disturbed areas would be reseeded with native grasses and small shrubs, where appropriate. Another feature that would be used in lower velocity reaches is a bioengineering method, which uses plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of material. Figure 3-4 identifies the sites where either bank protection or launchable rock would be required. There are about 4 miles of erosion protection required for the right bank and about 7 miles required for the left bank.

Tributaries

- **Natomas East Main Drain Canal (NEMDC).** Along the east levee of the NEMDC, there are seepage and stability problems at the locations where historic creeks had intersected the current levee alignment. A conventional slurry wall would be constructed at these locations to address the seepage and stability problems.
- **Arcade Creek.** The problems on Arcade Creek are seepage and, to a lesser degree, stability as well as some levee height issues when the event exceeds the design. A cutoff wall would be constructed for seepage management. There is a ditch adjacent to the north levee at the landside toe which provides a shortened path for deep seepage, and could affect the stability of the levee. The ditch would be replaced with a pipe or culvert and then backfilled. This would lengthen the seepage path and improve the stability of the levee. The levee stability would also be reinforced through the use of geotextile materials. An on-bank floodwall would address height issues on both sides of Arcade Creek along with a raise and bolster method where there is already existing on-bank floodwall.
- **Magpie Creek.** The existing left bank levee of the Magpie Creek Diversion Canal would be raised and the overall levee length would be extended by about 1,000 feet to prevent flanking. A new culvert will be constructed under an embankment which will connect with Robla Creek. The alternative also includes the purchase and preservation of about 80 acres of the floodplain in perpetuity for attenuation of flood flows.

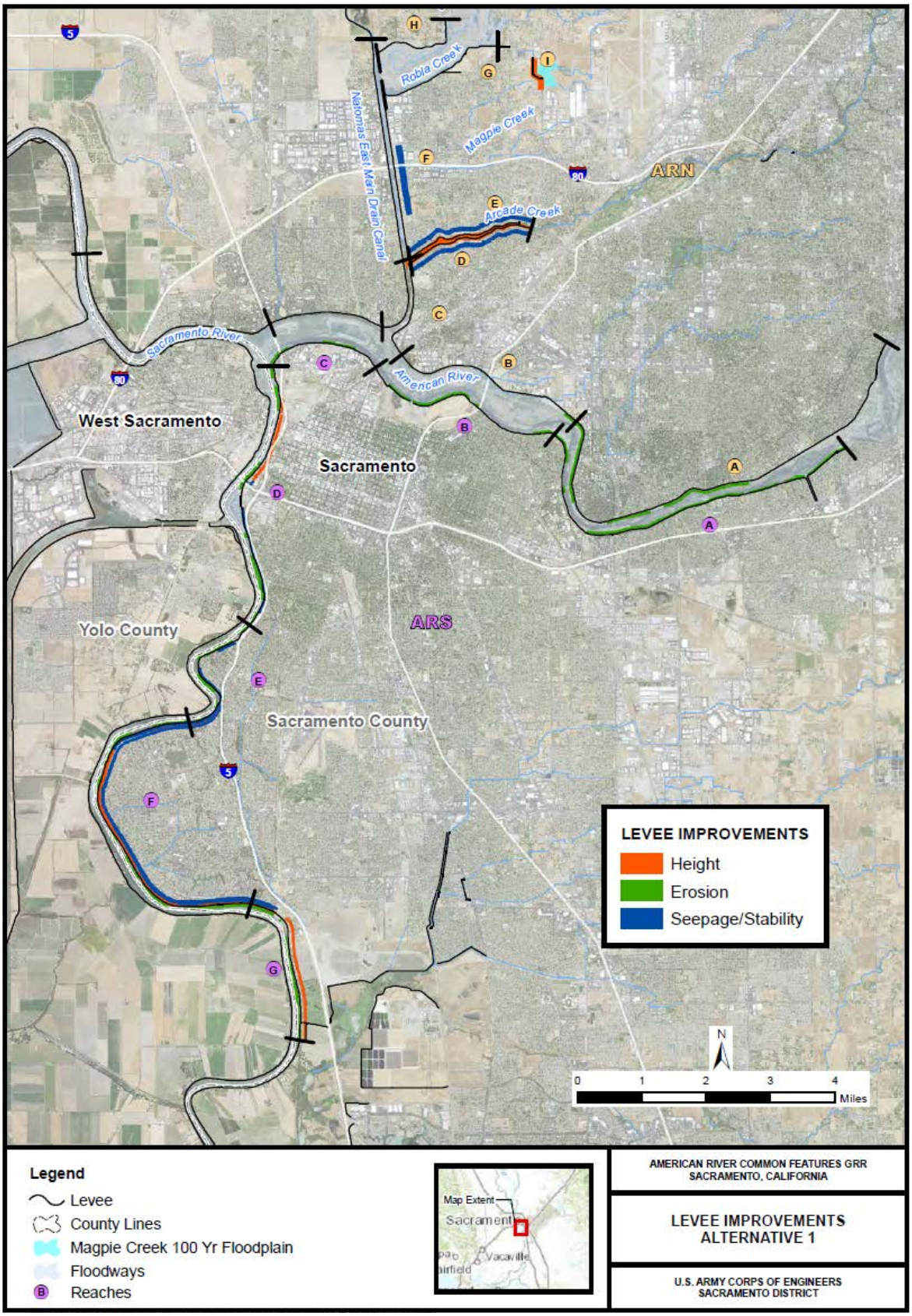

Figure 3-4: Final Alternative 1 – Improve Levees.

Vegetation and Access

ETL 1110-2-571, updated as ETL 1110-2-583 on April 30, 2014, requires that a vegetation free zone be established. The vegetation free zone is a three-dimensional corridor surrounding all levees, floodwalls, embankment dams, and critical appurtenant structures in all flood risk management systems. The vegetation free zone applies to all vegetation except perennial, non-irrigated grass. Grass species are permitted, but only perennial grasses whose primary function is to reliably protect against erosion. The Sacramento District, USACE, *Geotechnical Levee Practice, SOP 003*, requires a minimum 20-foot wide landside easement for maintenance, inspection, and flood fight access.

As per ETL 1110-2-583, the primary purpose of a vegetation free zone is to provide a reliable corridor of access to, or along, levees, floodwalls, embankment dams, and appurtenant structures. This corridor must be free of obstructions to assure adequate access by personnel and equipment for surveillance, inspection, maintenance, monitoring, and flood-fighting. In the case of flood fighting, this access corridor must also provide the unobstructed space needed for the construction of temporary flood fighting features. Access is typically by four-wheel-drive vehicle, but for some purposes, such as maintenance and flood-fighting, access is required for larger equipment, such as tractors, bulldozers, dump trucks and helicopters. Accessibility is essential to the reliability of flood risk management systems. The minimum width of the corridor shall be the width of the levee, floodwall, or embankment dam, including all critical appurtenant structures, plus up to 15 feet on each side, measured from the outer edge of the outermost critical structure. The minimum height of the corridor shall be 8 feet from any point on the ground.

The Common Features GRR addresses vegetation requirements by recommending removal of vegetation on the waterside upper half of the levee slope, the levee crest, and the upper half of the landside levee slope as part of construction related activities required to install the seepage cutoff wall. The remainder of the lower portion of the landside levee slope would be covered by a SWIF or other sort of formal agreement with the sponsor to address remaining levee safety issues. Levee safety policy compliance for areas outside of the construction footprint would be a sponsor action and not part of this project. These actions are considered part of the future without project condition and would affect future operation and maintenance (O&M) requirements of the sponsor and its local cooperating agencies. For levee reaches where levee slopes would be flattened or the levee would be raised, vegetation would be removed on the entire landside levee slope as part of construction activities and construction access would be provided at the landside levee toe. A vegetation variance, as per the *Policy Guidance Letter (PGL) – Process for Requesting a Variance from Vegetation Standards for Levees and Floodwalls,* will be sought for the lower half of the waterside levee slope and up to 15 feet waterward of the waterside levee toe. Figures 3-5, 3-6, and 3-7 below describe the construction footprint, the areas covered by a vegetation variance, and the areas covered by a SWIF or other formal agreement with the sponsors.

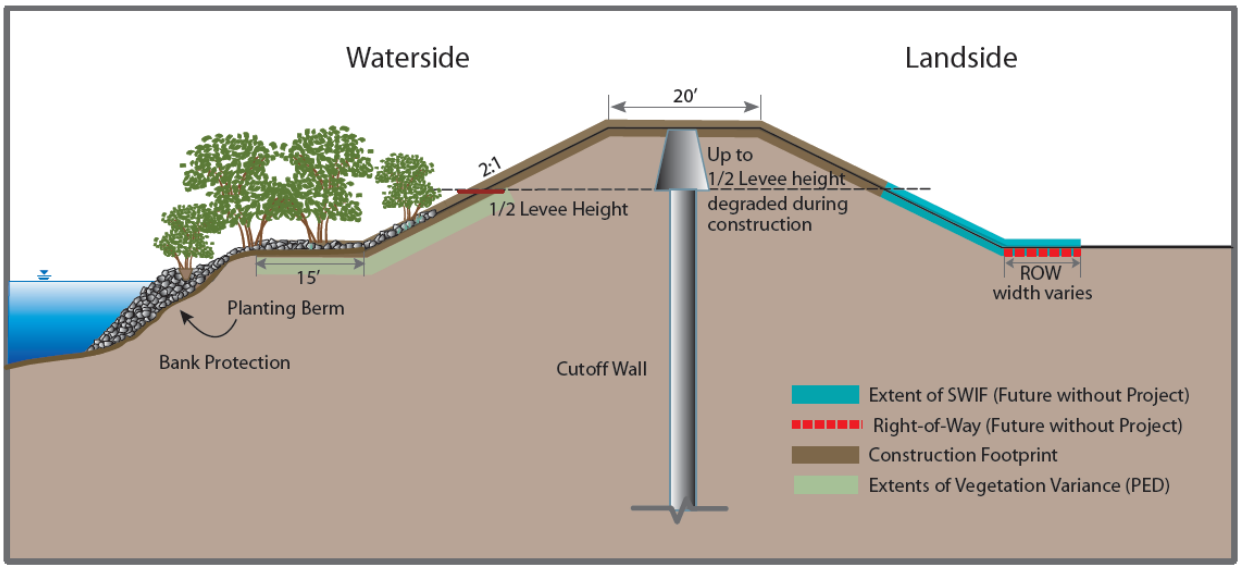

Figure 3-5: Levee Safety Compliance for Segments with No Recommended Levee Raise.

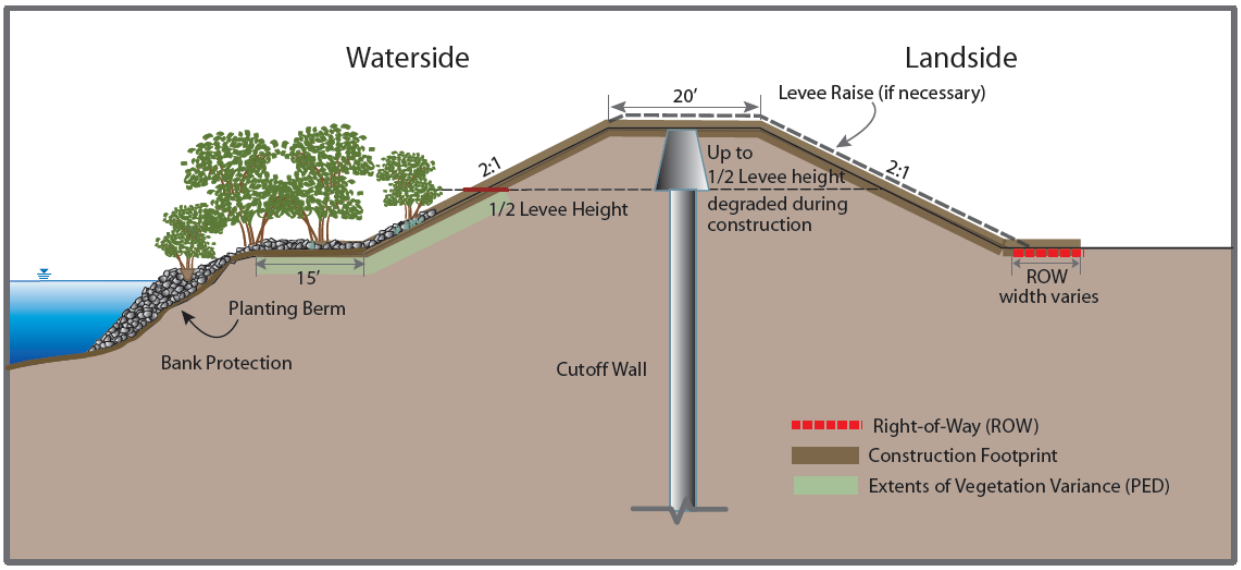

Figure 3-6: Levee Safety Compliance for Segments with Recommended Levee Raise.

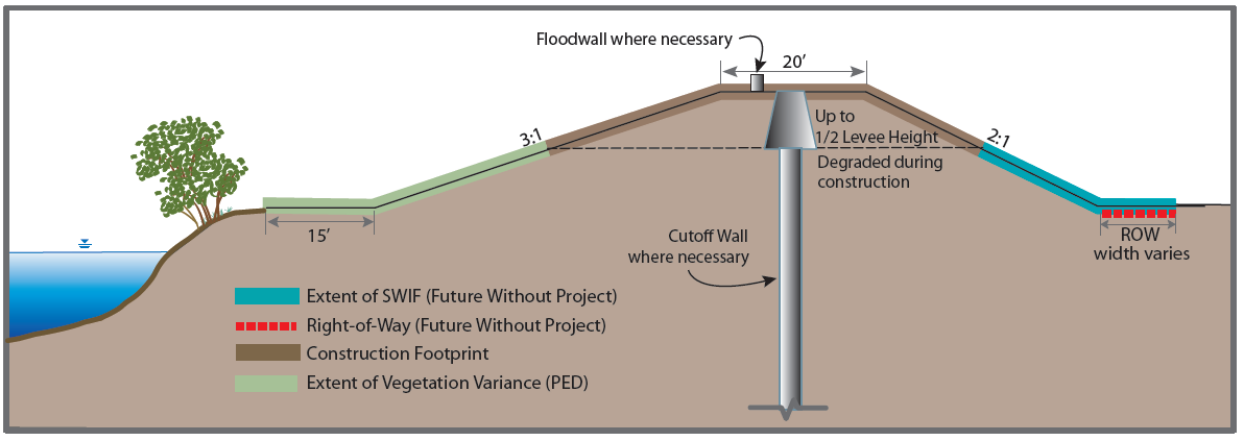

Figure 3-7: Levee Safety Compliance for Segments with Floodwall Raise.

Table 3-16 below describes the first costs, the interest during construction (IDC), the average annual cost, the operations and maintenance costs and the total annual cost for Alternative 1.

Table 3-16: Final Alternative 1 – Costs.

Basin	Final Alternative 1: Improve Levees (in $1,000s, October 2015 Price Level, 50-Year Period of Analysis, 3.125% Discount Rate)						
	Risk Source	First Costs[1]	IDC[2]	Total Costs	Average Annual	O&M[3]	Total Aac
ARS	American	260,439	68,565	329,004	13,092		13,092
	Sacramento	677,122	127,289	804,411	32,010		32,010
	Sac Raises	61,088	13,948	75,036	2,986		2,986
	Total Basin	**998,649**	**209,803**	**1,208,452**	**48,088**	168	**48,256**
ARN	American	139,076	22,540	161,616	6,431		6,431
	Tributaries[4]	198,080	22,379	220,409	8,771		8,771
	Total Basin	**337,106**	**44,919**	**382,025**	**15,202**	118	**15,320**
GRAND TOTAL	**All Basins**	**1,335,755**	**254,722**	**1,590,477**	**63,290**	**286**	**63,576**

[1]First costs include mitigation for environmental effects within the construction footprint.

[2]Interest During Construction

[3]Operation and Maintenance Costs are further described in Section 4.5.3.

[4]Includes Arcade, Dry, and Robla Creeks and the Natomas East Main Drainage Canal (NEMDC)

Final Alternative 2: Improve Levees and Widen the Sacramento Weir and Bypass

Alternative 2 would include the levee improvements discussed in Alternative 1, except for the extent of levee raises along the Sacramento River. While Alternative 1 would include about 7 miles of levee raising along the Sacramento River, Alternative 2 would only require about 1 mile of levee raising. The Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. This would reduce the amount of raising required on the Sacramento River levees to meet the State's criteria of the 200 year water surface elevation (WSEL) plus 3 feet. The levees along the ARN Basin Tributaries, including the NEMDC, Arcade Creek, and Magpie Creek, would be improved to address identified seepage, stability, erosion, and height concerns through the methods described under Alternative 1. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns though the measures described under Alternative 1. Rock erosion protection would be placed on the American River levees to reduce the risk of erosion. Due to environmental, real estate, and hydraulic constraints within the American River North and South basins, the majority of the levees would be improved within the existing levee footprint with minimal additional real estate requirements.

No additional recommendations for levee improvements in the Natomas Basin are included in the final alternatives. Seepage, stability, and erosion problems in the Natomas Basin were addressed in the Natomas PACR. Levee raises were evaluated as part of this GRR but were not carried forward for recommendation as a result of evaluation of the final array of alternatives. It was determined that proposed actions by the State of California and local authorities could render the levee raises unnecessary.

The following sections contain more detailed information on the specific features and reaches included in this alternative.

Sacramento River Levees

All of the levee improvements for the Sacramento River proposed in Alternative 1 would also be included in Alternative 2 with the exception of the 7 miles of levee raising. The inclusion of the Sacramento Weir and Bypass widening in Alternative 2 allows for a reduction in water surface elevation between 1 to 1.5 feet in the Sacramento River between the American River confluence and the Freeport Bridge to the point where only 1 mile of levee raising would be required in the project area. The location of these proposed levees improvements is shown in Figure 3-9.

Erosion concerns would be addressed by either the Sacramento Bank Protection Project method or launchable trench method described in the American River section above. There are about 9.5 miles of bank protection and about 1 mile of launchable trench identified.

American River Levees

The erosion protection measures identified in Alternatives 1 would also be included in Alternative 2. These measures consist of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. One measure consists of placing rock protection on the bank to prevent erosion. Another measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. Another measure being considered in lower velocity reaches is a bioengineering method, which uses plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of material. Figure 3-9 identifies the sites where either bank protection or launchable rock would be required. There are about 4 miles of erosion protection required for the right bank and about 7 miles required for the left bank.

Tributaries

The measures described for the Tributaries in Alternative 1 would also be constructed as part of Alternative 2.

Sacramento Weir and Bypass

The existing Sacramento Weir and Bypass, which allow high flows in the Sacramento River to be diverted into the Yolo Bypass, would be expanded to roughly twice their current width to accommodate increased bypass flows (Figure 3-9). The increased flow in to the bypass will reduce the flow in the Sacramento River, thus eliminating the need for most of the levee raises downstream. The existing north levee of the Sacramento Bypass would be degraded and a new levee would be constructed approximately 1,500' to the north. The existing Sacramento Weir would be expanded to match the wider bypass. A new weir segment would be built with operable gates. The new north levee of the bypass would include a 300' wide seepage berm on the landside with a system of relief wells. An HTRW site near the existing north levee would be remediated by the non-Federal sponsor prior to construction. Seepage and stability improvements were made to the existing south levee of the Sacramento Bypass as part of the Early Implementation Program (EIP) conducted by the State of California and the West Sacramento Area Flood Control Agency (WSAFCA).

The widening of the Sacramento Bypass and Weir was analyzed by expanding the width in increments from 500 feet to 3,000 feet to the north. Each width variation included adding gates (identical to the ones already in place) to the new portion of the weir and widening the bypass to the north. Widening the bypass/weir by 1,500 feet was found to be optimal in terms of the amount of water surface elevation reduction in the river.

Figure 3-8: Sacramento Weir and Bypass.

Vegetation, Encroachments and Access

Alternative 2 recommends about 1 mile of levee raise compared to the 7 miles of levee raises recommended in Alternative 1. With the exception of this one mile, Alternative 2 will rely on a SWIF to address landside vegetation, encroachment and access issues outside of the construction footprint. Again, outside of the construction footprint, levee safety policy compliance would be a sponsor action and not part of this project. These actions are considered part of the future without project condition and would affect future O&M requirements of the sponsor and its local cooperating agencies. Where the mile of levee raise is required, the construction footprint will extend to the landside levee toe and ten feet beyond to provide construction access. Similar to Alternative 1, a vegetation variance will be sought under Alternative 2 to allow vegetation to remain on the lower waterside levee slope. Figures 3-5, 3-6 and 3-7 display the construction footprints, the areas covered by a vegetation variance and the areas covered by a SWIF or other formal agreement with the sponsors.

Table 3-17: Project Costs – Final Alternative 2 (in $1,000s, October 2015 Price Level, 50-Year Period of Analysis, 3.125% Discount Rate).

Basin	Risk Source	First Costs[1]	IDC[2]	Total Costs	Average Annual Costs (AAC)	O&M[3]	Total AAC
ARS	American	262,447	69,096	331,543	13,193		13,193
	Sacramento	677,122	127,289	804,411	32,010		32,010
	Sac Bypass	278,527	67,601	346,128	13,773		13,773
	Total Basin	**1,218,096**	**263,986**	**1,482,082**	**58,976**	376	**59,352**
ARN	American	140,151	22,714	162,865	6,481		6,481
	Tributaries[4]	199,266	22,530	221,796	8,826		8,826
	Total Basin	**339,417**	**45,244**	**384,661**	**15,307**	118	**15,425**
GRAND TOTAL	**All Basins**	**1,557,513**	**309,230**	**1,866,743**	**74,283**	**494**	**74,777**

[1]First costs include mitigation for environmental effects within the construction footprint.

[2]Interest During Construction

[3]Operation and Maintenance Costs are further described in Section 4.5.3

[4]Includes Arcade, Dry, and Robla Creeks and the Natomas East Main Drainage Canal (NEMDC)

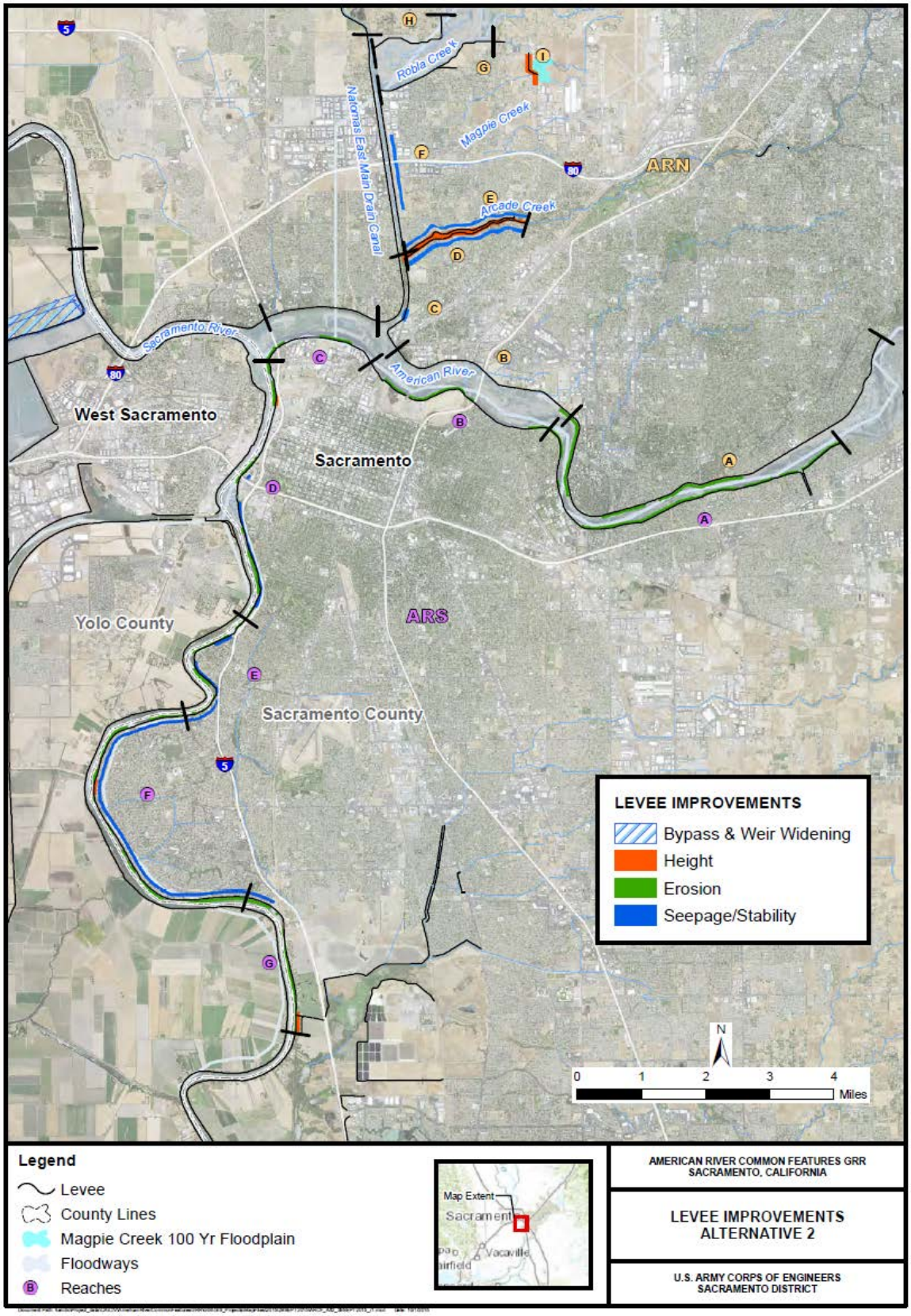

Figure 3-9: Final Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass.

3.15 EVALUATION OF FINAL ARRAY OF ALTERNATIVE PLANS

The final alternatives have been evaluated based on refined costs, refined benefits, contributions to the Federal objectives and planning objectives (Tables 3-18 and 3-19), environmental considerations and planning criteria. The results of these analyses indicate that Alternative 1 is the NED plan. These results are displayed in the comparison section below. The evaluation of the final array of alternatives also included consideration of the hydraulic effects of each alternative, consideration of the inclusion of further recommendations for the Natomas Basin, and management of vegetation, access and encroachment issues.

Table 3-18: Evaluation Metric Criteria and Study Objectives.

Study Objectives	Evaluation Metric
(1) Reduce the risk of flooding within the study area	Reduction in Expected Annual Damages (EAD)
(2) Reduce the risk of damage to critical infrastructure due to flooding	Identify number of critical infrastructure features within the residual floodplain within each basin and availability of emergency facilities during flood events
(3) Encourage the wise use of the floodplain	Conduct E.O. 11988 analysis
(4) Educate the public about ongoing residual risk in the Greater Sacramento Area.	Support ongoing Sponsor activities (Yes/No)

Table 3-19: Evaluation of Final Array of Alternatives.

Objective	Metric		Alternative		
			No Action	Alt 1	Alt 2
Reduce the risk of flooding within the study area	Annual Exceedence Probability[1] (AEP)	ARS F	1 in 32	1 in 135	1 in 147
		ARS A	1 in 93	1 in 185	1 in 192
		ARN E	1 in 61	1 in 200	1 in 256
		ARN A	1 in 96	1 in 182	1 in 172
	Residual Expected Annual Damages (EAD)	ARS	$332,383,000	$68,037,000	$66,078,000
		ARN	$77,303,000	$45,928,000	$46,360,000
Reduce the risk of damage to critical infrastructure due to flooding	Critical infrastructure features within 1/100 ACE floodplain		523	0	0
Encourage the wise use of the floodplain	Conduct E.O. 11988 analysis		N/A	Compliant except for Natomas Basin	Compliant except for Natomas Basin
Educate public about residual risk.	Support ongoing Sponsor activities		N/A	Yes	Yes

Notes:

[1]Chance of flooding in any given year

[2] Table 3-26 later in this chapter displays the Assurance values for the without project and with project conditions.

Natomas Basin

As noted in the description of the problems, the vast majority of the study area is located in the natural floodplain of the Sacramento and American Rivers. There are approximately 500,000 people living and working within this floodplain, which is divided into the three separate and distinct basins that make up the study area. Two of these basins, the American River North and American River South have essentially been built out. The remaining area, the Natomas Basin, had largely been an agricultural area until recent times. After having been given assurances that the levees provided adequate flood protection, residential and commercial development increased in this area in the late 1990s and mid-2000s. Subsequent investigations and signs of levee distress during high flows have shown that the area is still at significant risk of flooding. Further flood risk reduction is needed, not only to meet the FEMA regulatory requirements, but also to meet the State of California requirement for 200-year level of protection for urban areas. The Natomas 2010 PAC report includes recommendations for Federal involvement in flood risk reduction through levee improvements which would provide a 1:67 annual exceedence probability (a 1 in 67 chance of being exceeded in any given year). These recommendations were authorized by WRRDA 2014. State and local agencies implemented improvements to more than a third of the perimeter levee system in advance of the Federal authorization. Some of those improvements were previously approved for consideration for credit under Section 104 (WRDA 1986). This draft GRR considered further flood risk reduction features for the Natomas Basin.

Up to this point in the planning process, both of the final alternatives included additional flood risk reduction for the Natomas Basin. Specifically, the final alternatives included measures that would attain FEMA level accreditation as well as meet the State of California's requirement for 200 year level of protection for urban areas. The Administration has concerns with USACE projects enabling growth in floodplains. This additional growth would increase the consequences of flooding within the Basin and therefore increase the future flood risk. Discussions with the project partners determined that, in light of ongoing locally-driven regional planning efforts that are investigating regional-scale flood risk reduction measures to deal with large flood events, this ARCF GRR would not make further recommendations for the Natomas Basin. This is because the other local regional planning efforts could recommend implementation of other measures that would render levee raises around the Natomas Basin unnecessary.

Raising levees around the Natomas Basin is a separate element common to both of the action alternatives in the final array. As such, removal of those features from both alternatives does not change the identification of the NED Plan. Therefore, as a final step following plan comparison, the final array of alternatives was reformulated to remove the Natomas levee raise features.

Vegetation, Encroachment and Access Management

Vegetation and encroachment management, including the establishment of continuous obstruction free landside levee toe access, as defined in Engineer Technical Letter (ETL) 1110-2-583, is an extremely sensitive issue in California's Central Valley. Finding an acceptable balance between flood risk reduction

actions, private property interests, and impacts to ecosystems important to threatened and endangered species is critical to identifying a project that can be successfully implemented.

This issue is particularly acute for the American River Common Features GRR study area where the levees in many places do not meet modern engineering or operations and maintenance standards. However, the engineering analysis conducted to date indicates that levee performance is highly sensitive to the correction of geotechnical deficiencies and erosion and significantly less sensitive to the correction of most vegetation and maintenance issues.

The results of this analysis indicated that the likely time and cost necessary to bring the levees into complete compliance with the ETL though implementation of the Recommended Plan would likely negatively impact the overall project implementation schedule therefore delaying the ability to implement levee improvements for the higher risk geotechnical and erosion deficiencies. Additionally, public opposition to complete compliance with the ETL though implementation of the Recommended Plan could also potentially negatively impact the overall project implementation schedule.

As a result, USACE has been in discussions with the non-Federal partners concerning the use of a SWIF to address all vegetation, encroachment, and access issues outside of the anticipated construction footprint necessary to correct the identified geotechnical and erosion deficiencies. This approach eliminates the direct schedule and cost connection between these lower risk and high risk deficiencies; however, it still provides a means to ensure steady modernization of the maintenance conditions over time.

Alternative 2 would avoid most of the vegetation, encroachment and access effects that would be part of the Alternative 1 project since Alternative 2 has far fewer miles of levee raise than Alternative 1 and this equates to a reduced construction footprint. However, the SWIF associated with Alternative 2 would have more substantial future effects than the SWIF associated with Alternative 1 because of the larger area where vegetation, encroachment and access issues would be dealt with at a later date rather than as part of the construction of the project. The SWIF process would be implemented in accordance with the life cycle management policy of the State's Central Valley Flood Protection Plan which specifies that encroachments would be removed and landside levee access and visibility would be provided in accordance with the State's Urban Levee Design Criteria. The extent of the affected vegetation has been surveyed by USACE (2011). The extent and character of landside access and visibility activities would be determined over time and could involve a combination of acquiring land, establishing visibility corridors, or other measures designed to ensure that levee maintenance agencies can appropriately monitor and respond to signs of levee distress along the landside toe of affected levees.

3.16 COMPARISON OF FINAL ARRAY OF ALTERNATIVE PLANS

Table 3-20 displays the recommended features in each alternative, and the associated problem each feature would address.

Table 3-20: Final Alternatives 1 and 2 – Proposed Improvement Measures by Waterway.

	Final Alternative 1			Final Alternative 2		
	American River	**Tribs[1]**	**Sacramento River**	**American River**	**Tribs[1]**	**Sacramento River**
Seepage Measures	*WRDA 96/99*	Cutoff Wall	Cutoff Wall	*WRDA 96/99*	Cutoff Wall	Cutoff Wall
Stability Measures	*WRDA 96/99*	Cutoff Wall	Cutoff Wall, geotextile and flatten slope	*WRDA 96/99*	Cutoff Wall	Cutoff Wall, geotextile and flatten slope
Erosion Protection Measures	Bank Protection, Launchable Rock Trench	---	Bank Protection, Launchable Rock Trench	Bank Protection, Launchable Rock Trench	---	Bank Protection, Launchable Rock Trench
Overtopping Measures	*WRDA 96/99*	Floodwall/ Levee Raise	Floodwall/ Levee Raise	*WRDA 96/99*	Floodwall/ Levee Raise	Floodwall/ Levee Raise & Sac Weir and Bypass Widening

Notes: 1 – Tribs = Tributaries include NEMDC, Arcade Creek, Dry/Robla Creeks, and Magpie Creek

Table 3-21 compares the final alternatives and how they meet the planning criteria.

Table 3-21: Comparison of Final Array of Alternatives in meeting the Planning Criteria.

Preliminary Alternative	Completeness (Stand-alone)	Efficiency (Cost Effective)	Effectiveness (meets objectives)	Acceptability (Implementability)
1. Improve Levees	Yes	100%	Chance of flooding 4 times lower	Yes
2. Improve Levees & Widen Sacramento Weir and Bypass	Yes	96%	Chance of flooding 4 times lower	Yes

Table 3-22 compares the without project damages, the with project residual damages, the average annual benefits, the benefits prior to the base year and the total average annual benefits for the final alternatives[1].

[1] Information on the development of these categories is located in Appendix E: Economics.

Table 3-22: Average Annual Benefits for Final Alternatives 1 and 2 (in $1,000s at October 2015 Price Level, 50-Year Period of Analysis).

	Final Alternative 1			Final Alternative 2		
	America n River North	American River South	Total	American River North	American River South	Total
Without Project Damages	87,761	387,176	**474,937**	87,761	387,176	**474,937**
With Project Residual Damages	51,963	78,676	**130,639**	52,452	77,790	**130,242**
Average Annual Benefits	35,398	**308,500**	**344,298**	**35,309**	**309,386**	**344,386**

Preliminary, screening-level cost estimates were used for economic analysis and are summarized in Table 3-23 below. In addition to project first costs, interest during construction (IDC), which is an economic cost, was also factored into the net benefit/BCR analyses (Table 3-23). Information regarding the construction period (number of years) and the construction schedule for each alternative was used to compute IDC on an annual basis.

Table 3-23: Estimated Costs ($1,000s) for Final Alternatives 1 and 2.[1]

	Final Alternative 1			Final Alternative 2		
	American River North	American River South[2]	Total	American River North	American River South[3]	Total
First Costs[4]	**337,106**	**998,649**	**1,335,755**	**339,417**	**1,218,096**	**1,557,513**
IDC	**44,919**	**209,803**	**254,722**	**45,244**	**263,986**	**309,230**
Total	**382,025**	**1,208,452**	**1,590,477**	**384,661**	**1,482,082**	**1,866,743**
Average Annual Costs	**15,202**	**48,088**	**63,290**	**15,307**	**58,976**	**74,283**
OMRR&R[5]	118	168	286	118	376	494
Total Average Annual Costs	**15,320**	**48,256**	**63,576**	**15,425**	**59,352**	**74,777**

Notes:

1. Based on October 2015 price levels, 3.125 percent discount rate, and a 50-year period of analysis.
2. Includes costs of levee raises along the Sacramento River.
3. Includes the cost of the Sacramento Weir and Bypass widening.
4 Does not include Cultural Resources Data Recovery
5. Operation, Maintenance, Repair, Replacement and Rehabilitation costs are further discussed in Section 4.5.3.

Investment costs, annual costs, and annual benefits are displayed in Table 3-24 below.

Table 3-24: Comparison of Total Annual Benefits and Costs ($1,000s) for Final Alternatives 1 and 2.[1,2]

Item	Final Alternative 1	Final Alternative 2
Investment Costs:		
Flood Risk Management First Costs[3]	$1,335,755	$1,557,513
Interest During Construction	$254,722	$309,230
Total	**$1,590,477**	**$1,866,743**
Annual Cost		
Interest and Amortization	$63,290	$74,283
OMRR&R[4]	$286	$494
Total	**$63,576**	**$74,777**
Annual Benefits	$344,298	$344,695
Net Annual Flood Risk Management Benefits	**$280,722**	**$269,918**
Benefit to Cost Ratio	5.4	4.6

Notes:
[1] Based on October 2015 price levels, 3.125 percent discount rate, and a 50-year period of analysis.
[2] Some numbers have been rounded and may be slightly different than those displayed in the appendices.
[3]Does not include Cultural Resources Data Recovery
[4] Operation, Maintenance, Repair, Replacement and Rehabilitation.

Based on the above comparison, Alternative 1 is confirmed as the plan which maximizes net benefits and is therefore identified as the NED plan. Alternative 2 has been identified by the non-Federal sponsor as the Locally Preferred Plan (LPP). The sponsor supports the LPP based on its ability to reduce the water surface elevation in the river adjacent to two urban areas, increase the regional flexibility of the flood management system, provide benefits to downstream communities in the form of reduced water surface elevations in the Sacramento River, and improve natural floodplain values by increasing the areas exposed to overbank flooding.

3.17 EXECUTIVE ORDER (EO) 11988

The objective of the study is to reduce flood risk within the study area. EO 11988 has an objective of "avoidance, to the extent possible, of long- and short-term adverse impacts associated with the occupancy and modification of the base flood plain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative". The study is responsive to the EO 11988 objective because the proposed features focus on reducing the threat of flooding to the existing urban area. These features would reduce the hazard and risk associated with floods thereby minimizing the effects of floods on life safety, health, and welfare, and would preserve the natural and beneficial values of the base floodplain. Additional discussion of the EO is located in Chapter 4.

3.18 SYSTEM OF ACCOUNT ANALYSIS AND COMPARISON

The system of accounts is a set of categories which provide a comprehensive framework to demonstrate both the positive and negative effects of each plan. The intent is to provide decision makers with plan rankings based on advantages and disadvantages of each alternative. In addition, the accounts provide a visual display and assessment of the effects as required by NEPA.

National Economic Development (NED)

The NED account includes the estimates of project benefits and costs used to calculate net economic benefits. A full display of the analysis for the NED account is located in the Economic Appendix. This analysis establishes the economic feasibility of each plan and is used to identify Federal interest. The NED analysis dates back to the Flood Control Act of 1936 in which Congress determined that the Federal Government should participate in flood management and determine the benefits and costs of those activities. The analysis has been documented and refined over the years in various publications, including the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)*. It is in the P&G that the following additional accounts of environmental quality (EQ), regional economic development (RED) and other social effects (OSE) are identified.

Environmental Quality (EQ)

The EQ account displays the effects on the ecological, cultural, aesthetic, and other attributes of natural and cultural resources. The environmental effects of the various alternatives are classified as direct and indirect. Direct effects result immediately from constructing and operating the project. Indirect effects are effects caused by the action that are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air, water, and other natural systems, including ecosystems. Additional information on the EQ analysis is captured in the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) accompanying this report.

Regional Economic Development (RED)

The RED analysis measures changes in the distribution of regional economic activity that result from alternative plans. Changes in economic activity and employment that occur locally or regionally when a project is implemented are excluded from the NED Account to the extent that they are offset through transfers of this economic activity and employment to other regions of the Nation. The effects on the regional economy, including income effects, income transfers, and employment effects not addressed in the NED account are evaluated in the RED. Two measures of the effects of the plan on regional economies are used in the account: regional income and regional employment. Additional information on the RED analysis performed for this study can be found in Attachment C of the Economic Appendix.

Other Social Effects (OSE)

OSE relates to the quality of life, health, and safety in the community. Destruction or disruption of the built environment, esthetic values, community cohesion, and availability of public facilities and services has also been analyzed. These include displacement effects to people and businesses, the general population (including minorities and special interest groups), and public health and safety. Assessments of beneficial and adverse effects are based on comparisons of the with project alternative to the without project alternative conditions expected to prevail in the future in the absence of the project. The social effects of the alternatives have both direct effects and indirect effects. Direct effects result immediately from constructing the project. Indirect effects result from the effects of the project on existing patterns, including ecosystem patterns, in the study area. Additional information on the OSE analysis performed for this study can be found in the Economic Appendix.

Table 3-25: Summary System of Accounts Comparison of Final Array of Alternative Plans.

	NO ACTION	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 2
1. PLAN DESCRIPTION			
	The No Action provides no physical project constructed by the Federal Government or local interests.	The NED plan reduces the risk of flooding within the study area by improving levees.	The LPP plan reduces the risk of flooding to the study area by improving levees and widening the Sacramento Weir and Bypass.
2. IMPACT ASSESSEMENT			
A. National Economic Development (NED)			
1. Project Cost	$0	$1,590,477,000	$1,866,743,000
2. Annual Cost	$0	$63,290,000	$74,283,000
3. Total Annual Benefit	$0	$344,298,000	$344,695,000
4. Annual Net Benefits	$0	$280,722,000	$269,918,000
5. Benefit - Cost Ratio	N/A	5.4	4.6
B. Environmental Quality (EQ)			
1. Air/Noise	No construction activities present; Normal noise levels created by traffic, business, and industrial activities.	Temporary increased noise levels and air quality effects during estimated 10 year construction period.	Temporary increased noise levels during estimated 10 year construction period. Slightly higher air quality effects than NED due to additional construction associated with Sacramento Bypass expansion.
2. Water Quality	Significant impacts if a flood event were to occur as urban runoff would contaminate rivers, streams, and eventually damage Delta estuary.	Temporary decreased water quality due to increased turbidity during in-water construction of erosion protection measures.	Same as NED.

	NO ACTION	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 2
3. Biological Resources	Long term erosion would cause the loss of habitat along the waterways.	Loss of riparian habitat due to construction – replacement habitat will take many years to provide similar value of those removed.	Similar to NED with a reduced quantity of habitat loss due to the reduced length of levee raises. Potential to create habitat within the expanded Sacramento Bypass.
4. Threatened & Endangered Species	Potential loss of habitat as erosion of berms and levees will result in vegetation loss in flooded areas.	Temporary impact to endangered fish species, valley elderberry longhorn beetle, and giant garter snake. Possible impact to vernal pools near Magpie Creek. Also impacts to avian species nesting and foraging habitat.	Similar to NED with additional loss of habitat along the Sacramento River associated with expansion of the Weir, but less impact from levee raises downstream. There is potential to create habitat within the expanded bypass for fish species and GGS.
5. Cumulative Effects	No increased effects.	Potential cumulative impacts to noise and recreation could be adverse if the NED is constructing in close proximity to other local projects, such as across the river from West Sacramento GRR construction sites. Cumulative impact contributing to air quality and GHG emissions in the Sacramento region.	Same as described for NED.
6. Cultural Resources & Historic Properties	Long term erosion, inundation, and/or scouring could cause adverse effects to existing cultural resources.	Potential adverse effects to existing cultural resources are significant and unavoidable under CEQA. Execution of a Programmatic Agreement and Historic Property Treatment Plan(s) reduces effects to less than significant under NEPA, and resolves these effects under Section 106 of the NHPA.	Same as described for the NED, with one additional known historic property potentially adversely affected, the Sacramento Weir.
7. Recreation	Loss of recreation facility in American River Parkway with continued erosion of berm.	Short term impacts during construction.	Same as described for NED.
8. Land Use	Loss of Parkway land with continued erosion of Parkway berm.	Conversion of private property to flood risk management features (this will be a taking of homes).	Similar to NED plus the possible conversion of 300+ acres of farm land to floodway.
9. Socio-economics	Continue high risk of levee failure and flooding of the Sacramento Metropolitan area and the State Capitol.	Temporary disruption to the community during construction.	Same as described for NED.

	NO ACTION	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 2
C. Regional Economic Development (RED)			
1. Construction Activities	Future flooding would destroy part of infrastructure resulting in a loss in the region's ability to produce goods and services. Little to no RED benefits.	Value added: temporary jobs added within the region and jobs added within the State. Adds to the gross regional product for the State and Nation.	Slightly higher value added due to additional construction work: temporary jobs added within the region and jobs added within the State. Adds to the gross regional product for the State and Nation.
2. Future Residential Development	New development must be built above the 1% flood elevation, which is not economical to accomplish. Effectively creates a building moratorium in Natomas. ARN and ARS basins already built out.	Levee construction would decrease the risk of flooding to the established urban areas.	Levee construction would decrease the risk of flooding to the established urban areas.
3. General Economic Gains	Emergency response and recovery activities and reconstructions and repairs. The economic stimulus generated would only be temporary and minor compared to overall losses.	The with-project regional economic impacts would emerge from more gradual spending over an extended timeframe. Levee construction is expected to take place over a 10-year period.	The with-project regional economic impacts would emerge from more gradual spending over an extended timeframe Levee construction is expected to take place over a 10-year period. Benefits to small communities downstream of the project area along the Sacramento River in terms of reducing the water surface elevation.
D. Other Social Effects (OSE)			
1. Life, Health, and Safety	Continued flood risk in the City of Sacramento and surrounding areas.	The plan significantly reduces risk to life, health and safety.	The plan significantly reduces risk to life, health and safety.
2. Community Cohesion (displacement of people & businesses)	Future flooding would displace selected businesses and subject the community to potential catastrophic flood risk.	Reduced risk to homes and businesses within the City of Sacramento.	Reduced risk to homes and businesses within the City of Sacramento and surrounding areas.
3. Residual Risk	Residual risk remains high throughout the study area	Residual Risk reduced in the City of Sacramento. However increased water surface elevation against urban levees.	Residual Risk reduced. Directs floodflows away from urban centers of Sacramento and West Sac to rural bypass areas.

3.19 PERFORMANCE OF THE FINAL ARRAY OF ALTERNATIVES

The estimated reduction in the probability of flooding provided by each plan, based on the Corps' risk analysis methods, is measured in two different ways. The first measure is the Annual Exceedence Probability (AEP), which describes the potential that a given location will experience flooding from the studied water sources (typically excluding interior flooding/storm sewer system performance) on an annual basis. The second measure is the assurance (i.e. non-exceedence probability) that a given flow will NOT result in flooding at a given location. The AEP combines the probabilities of all flow events that could possibly cause flooding into a single aggregate value, whereas assurance values relate to (i.e. are "conditional" to) flows with specific likelihoods of occurring (e.g. the 1/100 or 1% annual chance exceedence event, aka the 100-yr return interval flow or "100-yr flood"). In other words, assurance values provide a measure of how "assuredly" a location is protected from a specific flood.

Table 3-26 presents the performance statistics under both without-project and with-project conditions for each index point, basin and alternative. The Annual Exceedence Probability (AEP) values under with-project conditions indicate that each alternative provides significant risk reduction in terms of the chance of flooding in any given year.

Table 3-26: Assurance – Without-Project and With-Project Conditions for Final Alternatives 1 and 2.

Index Point	Assurance by Annual Chance Exceedence Event											
	Without				ALT. 1 (WITH SAC RAISES)				ALT. 2 Sac Bypass Widening			
	4% 25yr	1% 100yr	0.5%[1] 200yr	0.2% 500yr	4% 25yr	1% 100yr	0.5%[1] 200yr	0.2% 500yr	4% 25yr	1% 100yr	0.5%[1] 200yr	0.2% 500yr
ARS A (American River)	93%	77%	45%	18%	98%	91%	64%	31%	98%	91%	60%	32%
ARS F (Pocket)	75%	69%	55%	24%	95%	95%	93%	89%	95%	95%	94%	81%
ARN A (American River)	92%	75%	47%	22%	99%	90%	59%	24%	98%	89%	57%%	22%
ARN E (Arcade Creek)	90%	68%	29%	7%	99%	94%	69%	23%	99%	95%	80%	28%

Notes: [1] – the value for the 0.5% (200 year) has been interpolated.
[2] Long Term Risk is displayed in Chapter 4 of the Economic Appendix.
[3] Table 3-19 displays the Annual Exceedence Probability (AEP) for the without project and with project conditions.

The State has established a standard for urban flood protection in California which applies to cities with populations greater than 10,000 inhabitants. This standard requires levees to withstand flows with a top elevation equal to the mean 200-year water surface profile, plus three feet of freeboard, plus an allowance for wave run-up, plus one foot to account for climate change. USACE does not identify a target level of risk reduction but rather identifies the plan which reasonably maximizes net benefits. The analysis to identify the plan which maximizes net benefits was done with an awareness of the State's

goal for urban flood protection for the purpose of informing the State of where the individual plans fall with regards to the State's standards. Neither of the final alternatives is currently able to contain a 1/200 ACE event with 90% assurance. The levee improvements along the Sacramento River will increase the assurance to a level close to 90% but the assurance for the levees along the American River will remain around 60% for the 1/200 ACE. It will be upon the local community to prove to the State that the aggregate flood risk management projects meet the State's standard.

3.20 THE NED PLAN

The NED plan has been optimized to ensure that it is the plan which reasonably maximizes net benefits. This optimization has occurred both for the incremental addition of features to the plan and the level of performance for these features. Specific refinements corresponding to different annual chance exceedence (ACE) water surface elevations were conducted to identify the optimized combination of levee improvements to address the identified levee problems related to seepage, stability, erosion and overtopping. These refinements used a building block approach to add improvements to each other, starting with the seepage and stability work which represents the largest risk factor. The next optimization added erosion protection to the seepage and stability work (but no levee raises). The next increment adds the levee raising to address overtopping which is the plan identified as the NED Plan. Finally, various scenarios larger than the NED were analyzed. Details of the NED optimization are described below.

NED Plan 0.25 – Levee failure as a result of seepage and stability issues pose the greatest risk of flooding in the study area. For this scenario, only seepage and stability improvements were implemented. No erosion protection was implemented on the American River and the Sacramento River. This scenario is shown on the Net Benefit curve below as NED Plan 0.25. The cost of the alternative was greatly reduced compared to the identified NED, however the benefits were more significantly reduced, which comprehensively, greatly reduced the net benefits.

NED Plan 0.5 - This plan includes seepage, stability, and erosion improvements, but does not include levee raising or any other measure to address overtopping. This plan only provides approximately 1/100 ACE performance because it does not address levee overtopping. Therefore, the costs and benefits are less as compared to the identified NED and there is less net benefit as well. The seepage, stability, and erosion improvements included in this alternative correct legacy problems with the levees attributable to the construction methodology of utilizing dredged material from the adjacent river to construct the levees (which left inherent seepage, stability, and erosion problems). Therefore, the improvements for seepage, stability, and erosion are the same for flood events more frequent than the 1/100 ACE.

NED Plan 1.0 – This is the identified NED.

Plans larger than NED 1.0 - (Improvements beyond the 1/200 ACE water surface elevation) Improvements to Folsom Dam are intended to control approximately a 1/200 ACE flood event with a peak release of 160,000 cfs. Beyond this 1/200 ACE flood event, releases from Folsom increase quickly to the point where the downstream capacity is exceeded. Methods to convey more flow down the American River would take much more substantial improvements, such as vast levee setbacks, levee raises and massive amounts of rock to accommodate the high velocities associated with flows above 160,000cfs. These methods are impractical because of the huge cost of such measures and the relatively small increase in benefits. An alternate measure to manage a flood event more significant than a 1/200 ACE would be construction of upstream storage above Folsom Dam. Adding upstream storage on the American River would still require the levee improvements included in NED Plan 1.0. The costs and benefits from the preliminary Alternative 4 (NED Plan 1.0 plus upstream storage) have been updated to 2014 price levels and the result is shown on the Net Benefits graph below. In order to achieve any measurable increase in project outputs, these scenarios would equate to a considerable cost jump from the currently identified NED Plan. The sponsor's goal is to achieve FEMA level accreditation and State of California SB 5 criteria for 200 year level of protection. The identified LPP meets that goal, so a larger plan was not pursued. Because the identified NED Plan is the most cost-effective, Federally-supportable plan that is no greater in scale (FRM outputs) than the LPP, the identified NED Plan is also the appropriate basis for determining the maximum Federal cost-share for the LPP.

Conclusion: Plans smaller than NED 1.0, have less cost and less benefit, and plans larger than NED 1.0 cost more and have slightly more benefits but fewer net benefits. Therefore, NED 1.0, designed for a 1/200 ACE water surface profile is optimized and is the NED.

The average annual benefits (AAB) of the LPP are essentially the same as the NED Plan. The NED plan has average annual benefits of $344,298 while the LPP has AAB of $344,695. The cost share would be based on the most cost effective plan that provides the same level of out puts as the LPP. The most cost effective plan is the NED Plan.

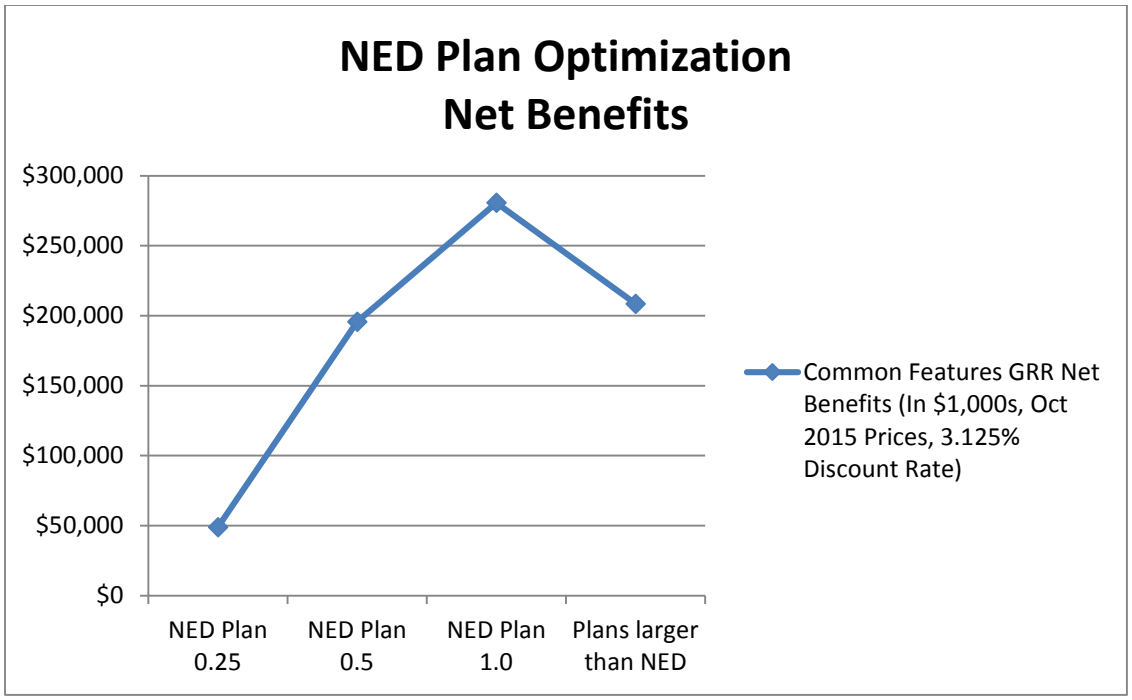

Figure 3-10: Net Benefits of the Optimized Plan.

3.21 THE RECOMMENDED PLAN

The recommendation of the District Engineer of the Sacramento District, U.S. Army Corps of Engineers is that the LPP plan be considered the Recommended Plan and authorized for implementation as a Federal project.

The non-Federal sponsor will agree to provide all lands, easements, rights-of-way, relocations, and suitable borrow and disposal areas. The non-Federal sponsor will also assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project. The non-Federal sponsor will publicize floodplain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to ensure compatibility between future development and protection levels provided by the project.
The Recommended Plan is not the NED plan. The Sacramento District has received permission for a deviation from the policy that requires recommendation of the NED plan.

4 - THE RECOMMENDED PLAN

This chapter provides details on the Recommended Plan and its implementation requirements. The chapter integrates the revaluated portions of the Common Features Project with the previously authorized and constructed portions of the project.

4.1 FEATURES AND DESCRIPTION OF THE RECOMMENDED PLAN

The features included in the 1996 and 1999 ARCF authorizations, as well as the Natomas features authorized by WRRDA 2014 are all part of the future without project condition. The Recommended Plan includes additional features to reduce flood risk in the ARCF study area. The principal features of this plan are:

1. Sacramento River: Construction of about 9 miles of slurry cutoff walls to address levee seepage and stability problems and about 10 miles of rock bank protection to address erosion problems along the Sacramento River east levee, as well as about 2.5 miles of geotextile stabilized slope and 2 miles of slope flattening to address levee stability and less than 1 mile of levee raise.
2. American River: Construction of rock bank protection and launchable rock trenches to address erosion problems along 4 miles of the right (north) bank and 7 miles of the left (south) bank of the American River.
3. Eastside Tributaries: Construction of about 4 miles of slurry cutoff walls to address levee seepage and stability problems along the NEMDC and Arcade Creek and 4 miles of levee raises to address potential overtopping of floodwaters along the Arcade Creek levees. The recommendation also includes about 1 mile of levee raise and extension along Magpie Creek along with 80 acres of floodplain preservation.
4. Sacramento Bypass: Widen the Sacramento Weir and Bypass by 1,500 feet to reduce the water surface elevation in the Sacramento River and allow more water to flow into the Bypass system. This would include the construction of a new 2 mile long setback levee. The existing Sacramento Weir and Bypass are shown in Figure 4-1 below.

Figure 4-1: Sacramento River overflowing in to the Sacramento Bypass.

Table 4-1 summarizes the recommended levee improvements by waterway. A more detailed discussion of the recommendations for each waterway is included in the subsequent sections below.

Table 4-1: Recommended Plan Proposed Improvement Measures by Waterway.

	Sacramento River	American River	East Side Tributaries[1]
Seepage Measures	Cutoff Wall	*WRDA 96/99*[2]	Cutoff Wall
Stability Measures	Cutoff Wall, Geotextile, and Slope Flattening	*WRDA 96/99*	Cutoff Wall and Geotextile
Erosion Protection Measures	Bank Protection, Launchable Rock Trench	Bank Protection, Launchable Rock Trench	---
Overtopping Measures	Levee Raise and Sacramento Weir and Bypass Widening	*WRDA 96/99*	Floodwall/Levee Raise

Notes: [1] East Side Tributaries include NEMDC, Arcade Creek, and Magpie Creek

[2]Seepage, Stability and Overtopping issues along the American River have been addressed by the work authorized in WRDA 1996 and WRDA 1999.

The features of the Recommended Plan are displayed in Figure 4-2.

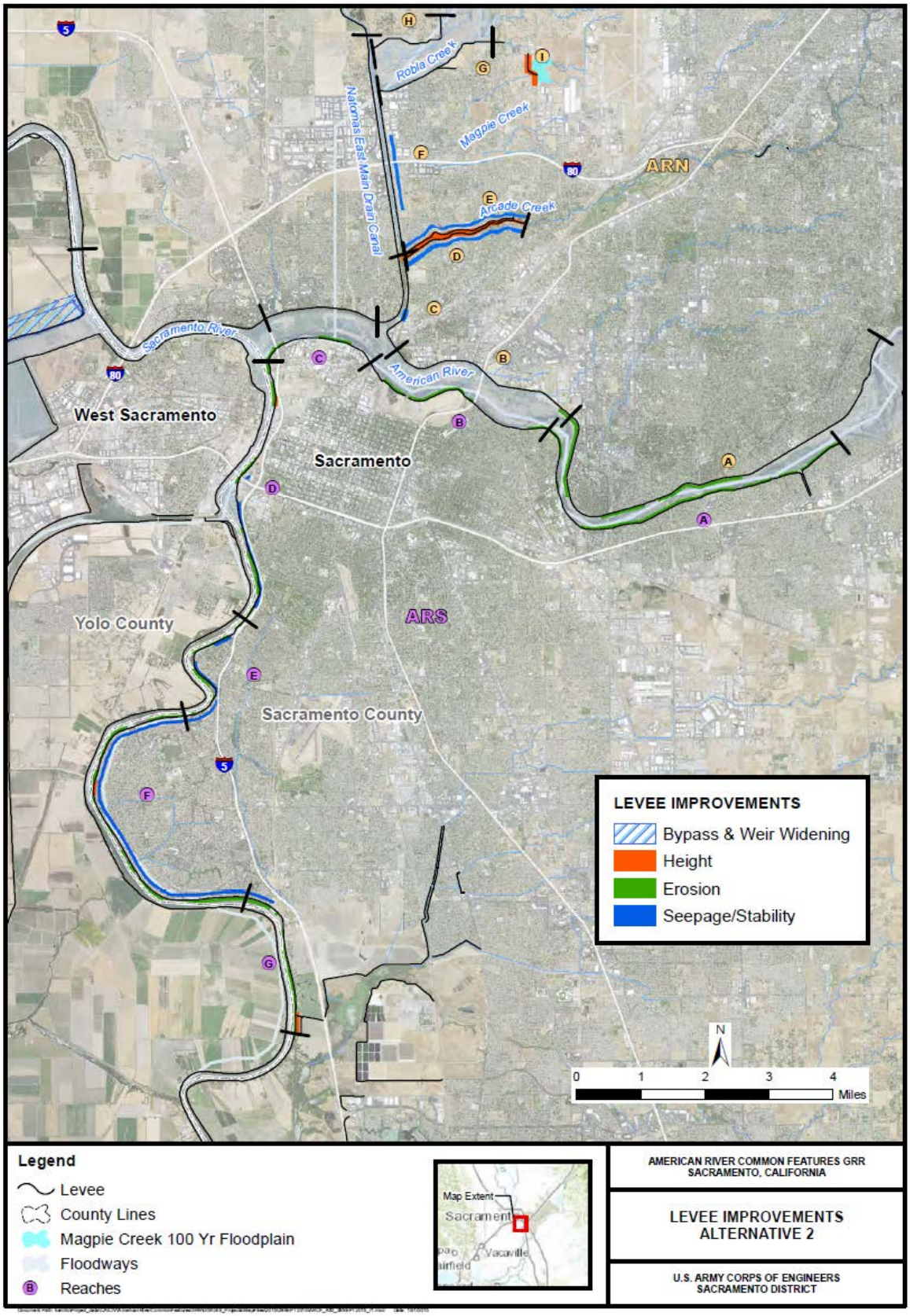

Figure 4-2: Recommended Plan Recommended Features.

4.1.1 Sacramento River

Levees along the Sacramento River require improvements to address seepage, slope stability, and erosion. In addition, a levee segment almost 1 mile long requires a raise. The features proposed for the Sacramento River levees include: (1) cutoff walls, (2) levee geometry measures, and (3) bank protection. These measures are described in detail in the subsections below.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 80 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Levee Geometry

Where the existing levee cross section does not meet the levee design requirements, (as discussed in Section 4.2) slope flattening, crown widening, and/or a levee raise is required. This improvement measure addresses problems with slope stability, geometry, and overtopping. The levee crown would be widened to 20 feet and 2:1 landside and waterside slopes would be established. The existing levee centerline would be shifted landward, where necessary in order to meet the Corps' standard levee footprint requirements. The levee crown patrol road would be re-established. It is estimated that about 2 miles of slope flattening would be required in scattered locations along the Sacramento River.
In the lower reach of the Sacramento River, near the town of Freeport, the steepness of the levee slope has created a slope stability problem. To address this problem, approximately 2.5 miles of levee would be partially degraded and reconstructed with a geosynthetic material, to reinforce the levee slope within the existing levee footprint where possible.

Bank Protection

Bank protection on the Sacramento River would be addressed via either conventional bank protection or the launchable rock trench method. The conventional bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, when necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. After the erosion protection work has been completed, a small planting berm would be constructed in the rock when feasible to allow for some revegetation of the site.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. Figure 4-9 shows a typical cross section of launchable rock trench. All launchable rock trenches would be constructed outside of the natural river channel. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Small trees could be permitted on the berm if planted outside the specified vegetation free zone required by ETL 1110-2-583.

Levee Safety Compliance on the Sacramento River

In an effort to modernize the levee system to meet current engineering standards, vegetation and encroachment issues (including landside levee access) in the study area will be resolved through a combination of construction actions associated with implementation of the recommended plan and formal agreements (such as a Systemwide Improvement Framework known as a SWIF) which allow specific vegetation and/or encroachments to remain in place permanently or defer their resolution to some future date. In the case of construction associated with the recommended plan, vegetation and encroachment removal would only occur within the construction footprint. Outside of the construction footprint, the non-Federal sponsors will apply for a SWIF separately from this project to ultimately bring levees into compliance with the ETL 1110-2-583.[1] In the case of a formal agreement, the integrated use of a SWIF and a variance from vegetation standards would both be required to ultimately assure compliance with the ETL.

A variance to ETL 1110-2-583 would be sought to allow vegetation to remain on the lower half of the waterside slope along the Sacramento River and NEMDC, Arcade Creek, and Magpie Creek. If granted, the variance would allow for vegetation to remain on the lower waterside slope and within the waterside 15 foot vegetation-free zone. The variance requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained. An evaluation of underseepage and waterside embankment slope stability was completed for this study.

This analysis was completed for the section/index point at levee mile (LM) 5.92, on the Sacramento River which was chosen for the variance analyses because it was considered to be representative of the most critical channel and levee geometry, underseepage and slope stability conditions, and vegetation conditions. The cross-section geometry of the index point incorporated tree fall and scour by using a maximum depth of scour for cottonwoods as approximately 11.0 feet; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets

[1] Section 3013 of WRRDA 2014 (Pub. L. No. 113-121) contains a requirement to conduct a review of current Federal policy relating to levee vegetation that may affect the guidelines presented in ETL 1110-2-583.

Corps seepage and slope stability criteria considering the seepage and stability improvement measures are in place ("with project" conditions). Therefore, it is a reasonable conclusion that with a Variance to allow vegetation to remain as stated above, the safety, structural integrity, and functionality of the Sacramento River levee and levees along the tributaries would be retained.

The SWIF Policy was released by the Corps in November 2011, providing with guidance to local maintaining agencies for obtaining a SWIF. The intent of the SWIF is to collaboratively work with resource agencies and levee sponsors to transition existing levees to Corps standards while maintaining PL 84-99 rehabilitation assistance and protecting sensitive environmental resources. The SWIF is a two-step process completed by the applicant that is composed of a Letter of Intent, which is followed by submission of a SWIF plan. The SWIF process allows eligible local sponsors to implement levee improvements in a prioritized "worst first" way to optimize the achievement of risk reduction. The Corps acknowledges that implementing system-wide improvements will need to be done within a collaborative intergovernmental framework and that it will take time to develop and implement improvements in complex situations. Challenges include ensuring that both environmental and levee safety imperatives are adequately served.

The construction footprint for the majority of the levee improvements along the Sacramento River will be confined to the top half of the levee and areas along the waterside bank where erosion protection is required. This is displayed in Figure 4-3 below. Vegetation and encroachments within this footprint will be removed during construction; however, the vegetation on the waterside of the levee would largely remain in place and the rock erosion protection would be placed around the existing vegetation. For levee segments along the Sacramento River where levee raises are required, the construction footprint would extend to the landside levee toe and a certain distance beyond that to allow for construction access. Vegetation and encroachments on the landside of the levee in these areas would be removed by the non-Federal sponsors as part of construction of the levee raise.

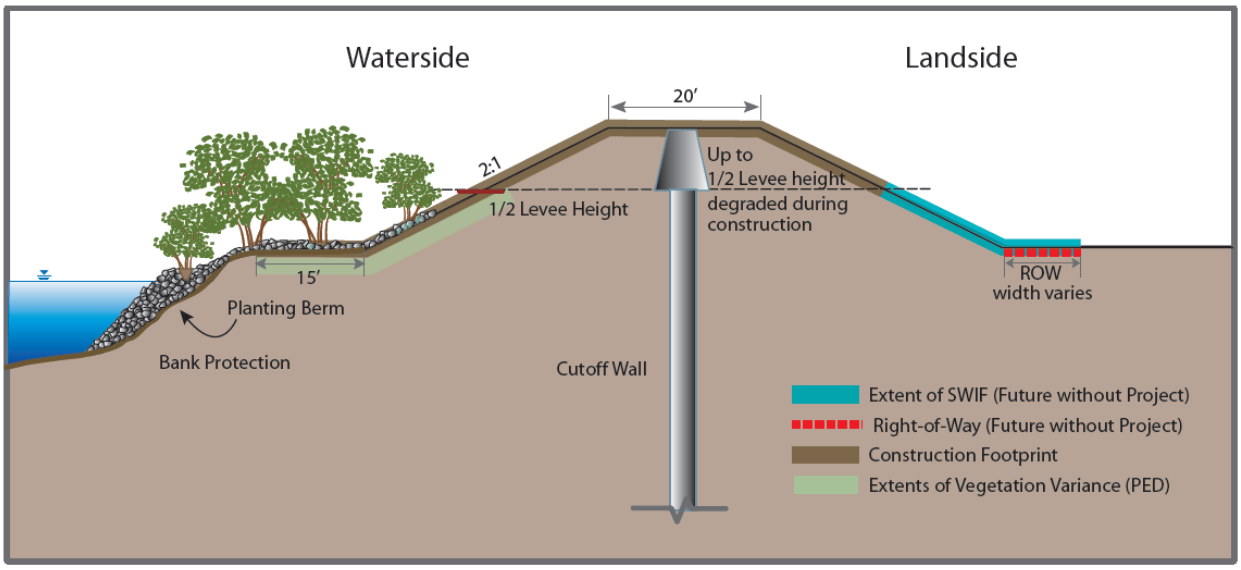

Figure 4-3: Recommended Plan Levee Safety Compliance for Segments with No Recommended Levee Raise.

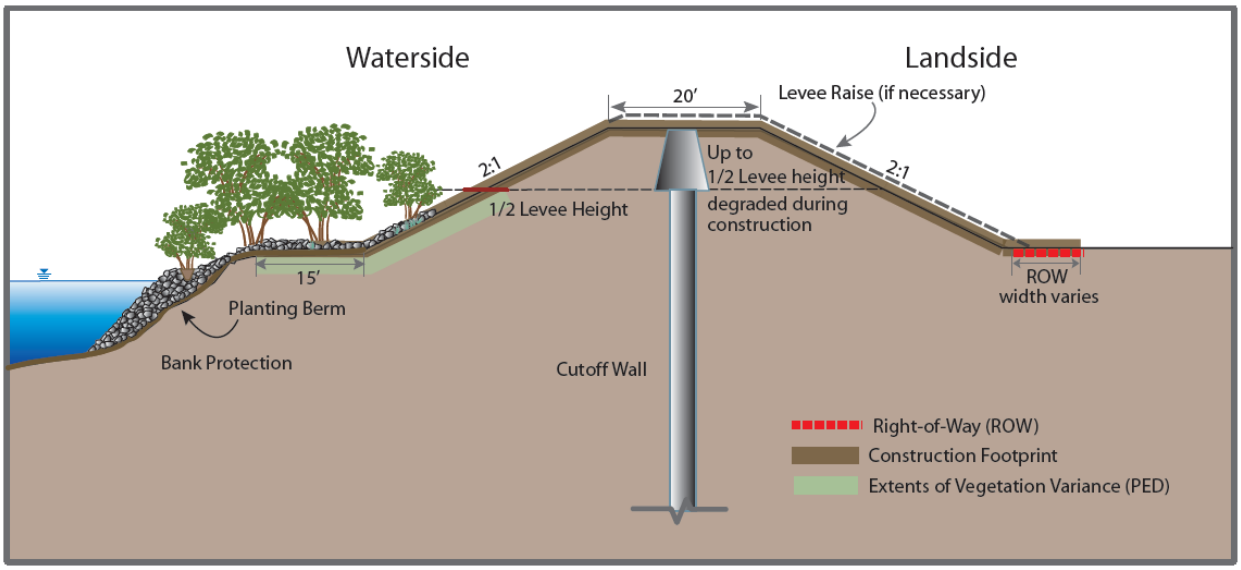

Figure 4-4: Recommended Plan Levee Safety Compliance for Segments with Recommended Levee Raise.

4.1.2 American River

Levees along the American River require improvements to address erosion. The rationale used to determine where erosion protection was required involved consideration of several factors. The most important factors included: 1) the velocity computed by the hydraulic modeling (Ayres 2004) for a discharge of 160,000 cfs, 2) the erodibility of the material near the levee prism, and 3) the past performance of the levee segment with respect to erosion. The proposed measures for these levees

consist of waterside armoring to prevent erosion of the river bank and levee, which could potentially undermine the levee foundation. Figure 4-5 identifies the reaches where erosion protection measures would be required. It also displays areas where levee erosion has been repaired with rock erosion protection measures. There are two measures proposed for the American River levees: (1) bank protection, and (2) launchable rock trench. Both of these measures are described in detail in the subsections below.

An initial assessment with regards to the method of bank stabilization has been made for this document. During detailed design, the Corps will coordinate closely with the county, state, and federal agencies responsible for managing the resources of the parkway in selecting which method of bank stabilization should be deployed. In carrying out this effort, the Corps will coordinate through the formal and informal processes that have been created to facilitate management of the parkway in application of the above criteria. Where erosion protection is needed to meet established flood risk reduction objectives, the selection of the method of protection will be based on a determination of which method would do the most to protect valuable parkway land, fish and wildlife resources, and recreational facilities considering both the short term impacts of construction and the long term effects of any mitigation measures included in the design of the project.

Where multiple erosion protection methods were possible, the cost estimates and environmental impacts used the more conservative erosion protection feature for evaluation (typically launchable rock trench). During detailed design, the type of erosion protection method will be further evaluated in terms of costs and environmental effects to determine which method is appropriate at a specific location.

Bank Protection

This measure consists of placing rock revetment on the river's bank, and in some locations on the levee slope, to prevent erosion. This measure entails installing revetment along the waterside levee slope and streambank based on site-specific analysis. Figures 4-6, 4-7, and 4-8 show a time lapse sequence of a site on the American River where bank protection has been constructed. Figure 4-8 shows a typical cross section of bank protection. In most cases large vegetation would be permitted to remain at these sites. After the erosion protection work has been completed, a small planting berm would be constructed in the rock where feasible to allow for revegetation of the site.

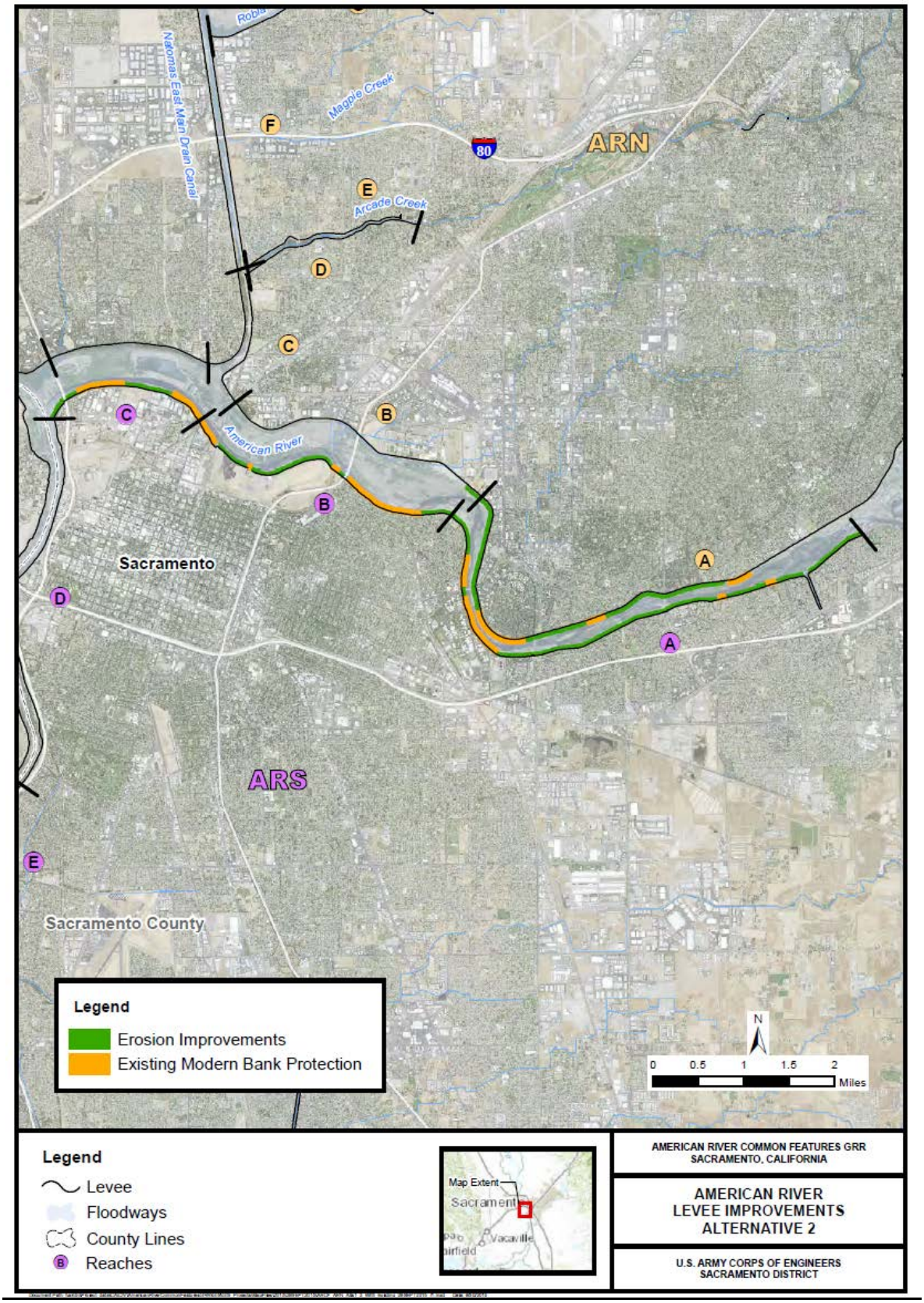

Figure 4-5: Recommended Plan Recommended Features along the American River.

Figure 4-6: American River Levee near California State University, Sacramento, 2001.

Figure 4-7: American River Levee near California State University, Sacramento, 2005.

Figure 4-8: American River Levee near California State University, Sacramento, 2010.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. Figure 4-9 shows a typical cross section of launchable rock trench. All launchable rock trenches would be constructed outside of the natural river channel. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Small trees could be permitted on the berm if planted outside the specified vegetation free zone as required by ETL 1110-2-583.

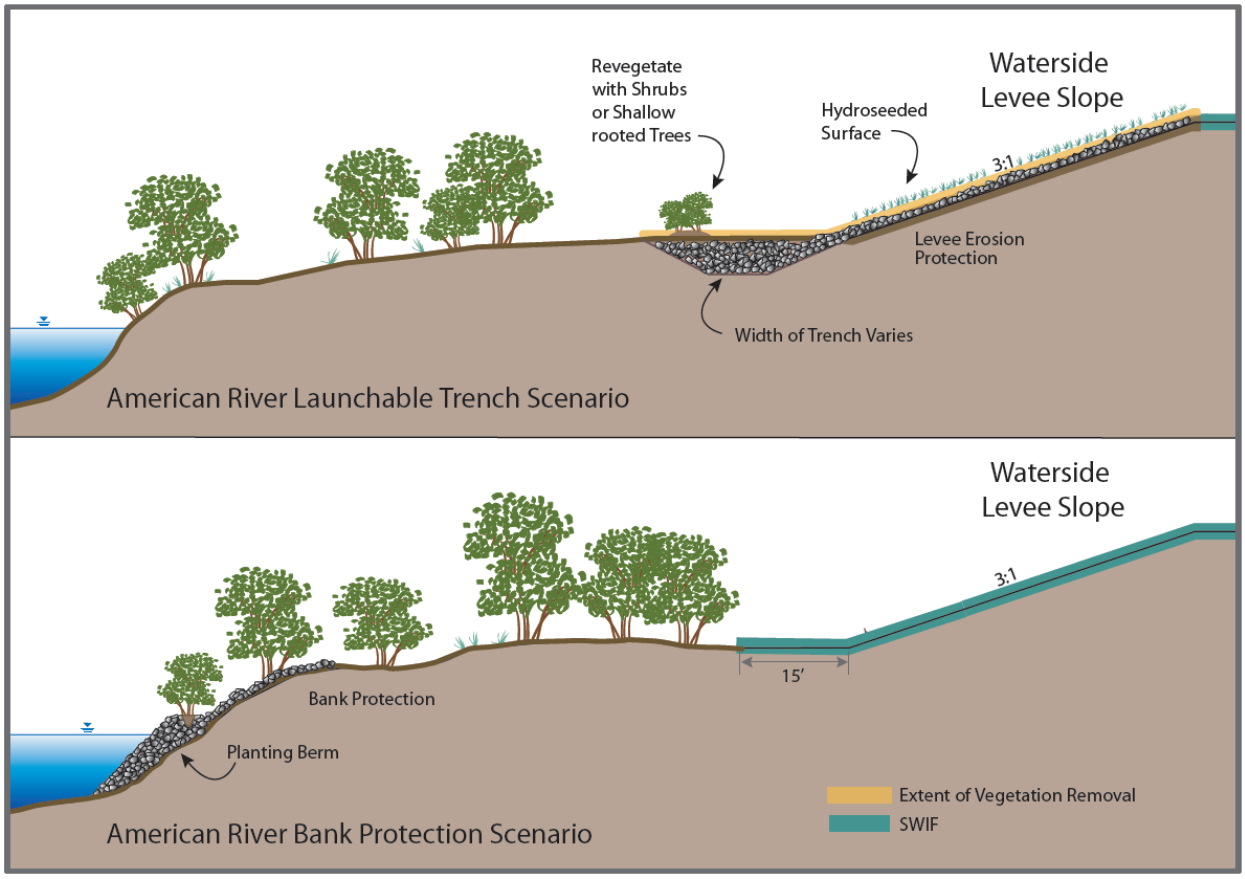

Figure 4-9: Bank Protection and Launchable Rock Trench Typical Design.

Levee Safety Compliance on the American River

Consistency with levee safety criteria for vegetation, access and encroachments will be limited, as with the other study reaches, to the construction footprint. The construction footprints of the erosion protection features on the American River are limited to the waterside levee slope or the actual river bank. As shown in Figure 4-9, all other vegetation, access and encroachments issues outside of the construction footprint would be brought into compliance with Levee Safety Policy through the use of a SWIF by the local maintaining agency, the American River Flood Control District (ARFCD).

4.1.3 East Side Tributaries

Natomas East Main Drain Canal (NEMDC)

The east levee of the NEMDC requires improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A conventional open trench cutoff wall would be constructed at these locations to address the seepage and stability problems. The total length of this cutoff wall would be about 1.5 miles. The cutoff walls would be constructed as described for the Sacramento River levee in Section 4.1.3.3 above.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A cutoff wall would be constructed to address seepage for about half of the total length of the creek equaling about 1.3 miles on both the north and south banks. There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path, and could affect the stability of the levee. The ditch would be replaced with a conduit or box culvert for about 0.5 mile and then backfilled. This would lengthen the seepage path and improve the stability of the levee. The Arcade Creek south levee has a slope stability problem in some areas due to the steepness of the levee slope. To address this problem, the levee would be partially degraded and reconstructed with a geosynthetic material to reinforce the levee slope.

The Arcade Creek levees upstream of Norwood Avenue have existing floodwalls, however there remains a height issue in this reach. A 1 to 4-foot floodwall and levee raise for about 2 miles on both the north and the south banks would allow the levees to pass flood events greater than the current design level. Constructing the floodwall raise would require doweling into the existing concrete floodwall and adding reinforced concrete to the floodwall section. Construction of the levee raise would be consistent with the description for the Sacramento River levee raises.

In addition to the measures discussed above, in areas where the current levee geometry does not meet current Corps standards, measures would be implemented to bring these levees into compliance. These measures include widening the crown to 12 feet, when necessary, and flattening slopes that are steeper than 2:1.

Magpie Creek Diversion Canal

The existing left bank levee of the Magpie Creek Diversion Canal would be raised for a distance of approximately 2,100 feet. A new levee would be constructed along the west side of Raley Boulevard south from the bridge down to Santa Ana Avenue for a distance of approximately 1,000 feet.

In addition, a culvert would be constructed under the Sacramento Northern Railway Bike Trail embankment. A new channel would be excavated upstream and downstream from the culvert, connecting the culvert with Robla Creek. The new channel would be slightly above the existing channel invert to allow low flows to continue through the existing bridge. Stone protection would be placed in the bed and sides of the new channel to minimize erosion. The culvert would meter the flow to reduce the chance of flood waters overtopping the levees downstream. This feature would increase the area of floodplain inundation upstream of the culvert. The project would include acquisition of flowage easements for this floodplain. A takings analysis has been conducted which determined acquisition of flowage easements is warranted.

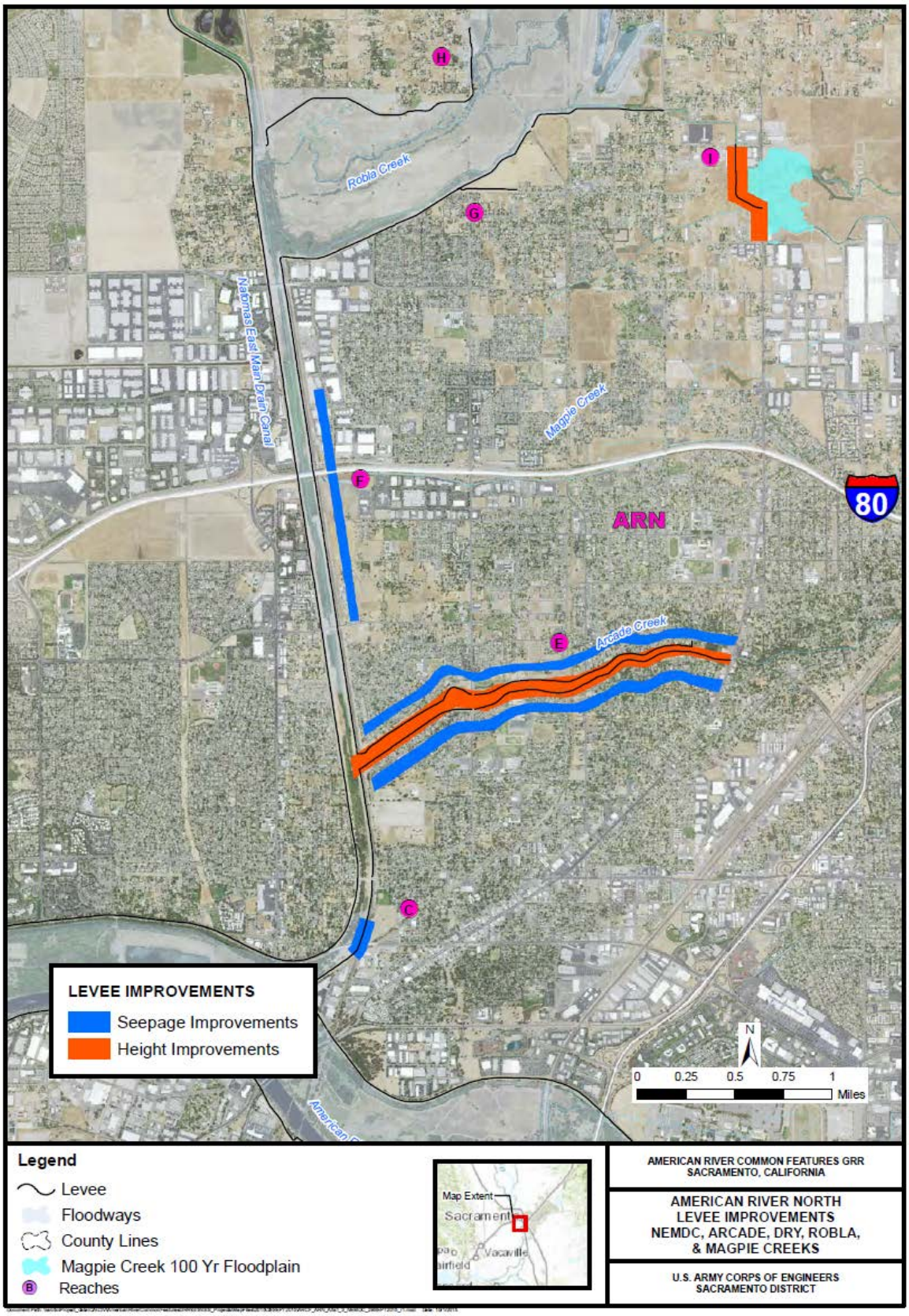

Figure 4-10: Recommended Plan Features for NEMDC, Arcade, and Magpie Creek Tributaries.

Levee Safety Compliance for the Tributaries

The construction footprint for the levee improvements along the Tributaries will be confined to the top half of the levee. This is displayed in Figure 4-11 below. Vegetation and encroachments within this footprint will be removed during construction. A vegetation variance is assumed to be in place for the lower half of the waterside levee slope.

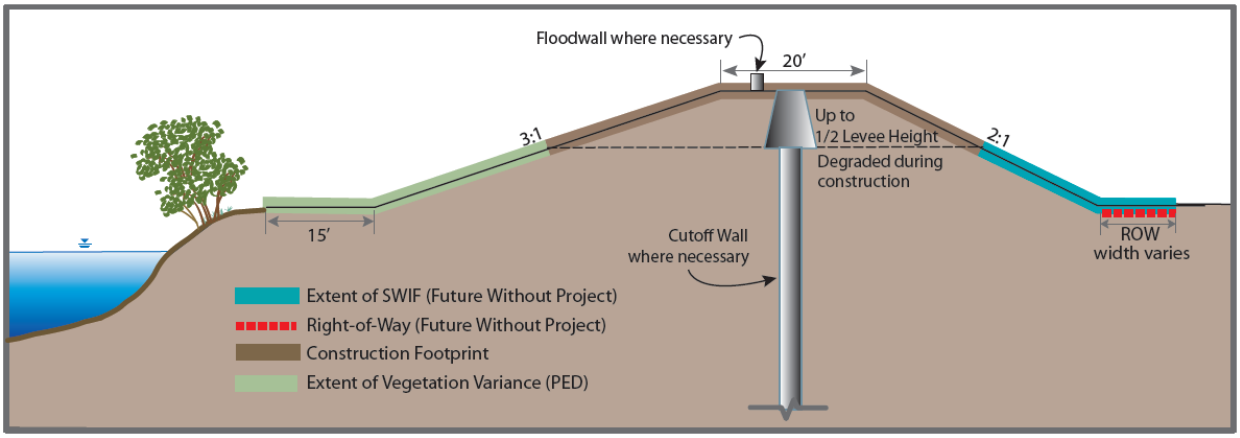

Figure 4-11: Levee Safety Compliance on the NEMDC, Arcade, and Dry/Robla Creeks.

4.1.4 Sacramento Weir and Bypass

The Sacramento Weir and Bypass would be expanded to roughly twice their current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass would be degraded and a new 2 mile long levee would be constructed approximately 1,500 feet to the north. Various widths were analyzed and 1,500 feet was found to be optimal in terms of the amount of water surface elevation reduction in the Sacramento River. The new north levee of the bypass would be designed to be consistent with the existing Sacramento Bypass north levee, however, the slopes would be flattened to 3:1 and it would also include a 300-foot-wide seepage berm on the landside with a system of relief wells. An abandoned landfill associated with farming activities is located at the western end of the landside of the existing north levee. The site is approximately 17 acres and is under continued investigation by the California Integrated Waste Management Board for clean up. This site would be remediated by the non-Federal sponsors prior to construction.

The existing Sacramento Weir would be expanded to match the wider bypass. At this time, it is not known whether the new segment of weir would be constructed consistent with the existing weir design, or whether it would be designed to be a gravity-type weir. The existing 1916 weir design concept was used for cost estimating purposes and was deemed acceptable for project feasibility phase purposes. The possibility of changes to the weir design was considered within the cost risk analysis and is therefore contained within the contingencies.

Figure 4-12: Proposed Sacramento Weir and Bypass Expansion.

4.2 DESIGN AND CONSTRUCTION CONSIDERATIONS

4.2.1 Design Consideration

The project development team (PDT), including the non-Federal sponsors, employed a design approach focused on developing recommendations for levee improvements that would comply with USACE design criteria while at the same time, identifying options supported by the non-Federal sponsors and stakeholders. These recommendations meet the State of California levee design criteria as well. The focus was on improving the existing legacy levee system and identifying methods to address the greatest risk factors. It is acknowledged that these design recommendations will be refined during PED.

The top half of the levee would be removed during construction to provide an adequate platform width for the machinery needed for installation of the anticipated cutoff wall. This method of degrading the levee by half its height prevents the fracturing of the levee embankment during construction and also improves public and worker safety. Degrading the top half of the levee will also allow for this material to be replaced with better material for levee construction compared to the existing levee material. This new material will be applied and compacted according to modern engineering specifications.

Utility encroachments and penetrations within the construction footprint will be brought into compliance with applicable Corps policy or removed depending on the type and location. Utility replacements would occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices. Private encroachments within the construction footprint shall be removed by the non-Federal sponsors or property owner prior to construction.

During construction of levee improvements, the cross section geometry would be modified to meet Corps and State standards[2] within the construction footprint. The standard levee footprint consists of:

- A 20 foot crown width for the Sacramento and American Rivers, or
- A 12-foot crown width for NEMDC, Arcade, and Magpie Creeks, and
- Either 2:1 or 3:1 landside and waterside slopes (depending on the channel, past performance, and engineering analysis).

Landside levee toe access is needed during construction and all existing access points and routes would be used. In certain areas where levee raises are recommended, additional landside levee access would be acquired.

4.2.2 Construction Schedule and Project Implementation

Construction of the Recommended Plan is estimated to take approximately 10 years. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that would occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. The tentative construction sequence is shown in Table 4-2.

Standard practice for USACE civil works projects is to reflect an optimal design and construction schedule and assume that funding would be provided in time to support the schedule. The duration was determined based on a variety of factors including construction rates, air emissions, property acquisitions, and resource capacity to execute the design and construction of the features. The cost risk contingencies also considered the possibility of competition between flood risk projects in the same area.

[2] State Urban Levee Design Criteria (ULDC) is generally consistent with USACE Levee criteria. Any refinements would be conducted during PED. If the State is requesting a standard more stringent than what USACE is recommending, this would be a non-Federal expense.

To the extent that erosion occurs within the study area prior to implementation of bank protection within that area, repairs of these erosion sites may occur as part of the Sacramento River Bank Protection (Sac Bank) Project if determined to meet that project's criteria. For that to happen, the erosion sites would have to be determined to be within the Sac Bank authorization, be economically justified, be ranked on the prioritization list such that construction would occur, and funded accordingly.

Table 4-2: Tentative Construction Sequence for the Recommended Plan.

PRIORITY	WATERWAY	REACH	YEAR OF PROJECT CONSTRUCTION									
			1	2	3	4	5	6	7	8	9	10
1	Sacramento River	ARS F										
2	Sacramento River	ARS E										
3	American River	ARS A										
4	Sacramento River	ARS G										
5	Sacramento River	ARS D										
6	American River	ARS B										
7	American River	ARN A										
8	American River	ARS C										
9	American River	ARN B										
10	Sacramento Weir & Bypass	SBW										
11	Arcade Creek	ARN D										
12	NEMDC	ARN F										
13	Arcade Creek	ARN E										
14	NEMDC	ARN C										
15	Magpie Creek	ARN I										

As shown in the table above, the study reaches have been prioritized for construction based on a number of criteria which mainly focus on the condition of the levee in those areas and the associated consequences of a levee failure. This approach was a strategy to address the greatest risk drivers first. The greatest risk in the study area is the potential for a geotechnical levee failure along the Sacramento River from a relatively frequent event. Therefore these reaches are shown as a high priority in the construction schedule. Erosion along either the Sacramento or American Rivers also constitutes a significant risk and this is reflected in the reach prioritization as well.

4.2.3 Levee Accreditation

The Engineer Circular 1110-2-6067 serves as guidance for USACE to provide the necessary Risk and Uncertainty (R&U) rationale to certify/accredit levees for FEMA. FEMA certification was not determined at this time. The local sponsors have an interest in having the repaired levees brought up to the minimum requirements needed for FEMA accreditation. By traditional FEMA methodology (Title 44 CFR Section 65.10), it is likely that the local sponsors could achieve FEMA Certification in the study area using this proposed project, recent projects (Natomas PAC) and the local partners' ongoing efforts under the

Natomas Levee Improvement Program (NLIP). This would likely be completed by ensuring that there are three feet of freeboard above the 100-yr event for all the levees in the project area.

Urban Levee Design Criteria (ULDC) is a state standard established by the State of California Department of Water Resources. The ULDC requires urban levees to have at least three feet of freeboard above the mean 200-Year event or a combination of freeboard (2-3 feet) and assurance (90%-95%) to contain the mean 200-Year event.

4.2.4 Borrow Material

It is estimated that a maximum of 1 million cubic yards of borrow material could be needed to construct the project. Because this project is in the preliminary stages of design, detailed studies of borrow needs have not been completed. To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. Borrow sites would be lands that are the least environmentally damaging. The criteria used to determine potential locations were based on current land use patterns, soil types from U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), and Corps' criteria for material specifications. The data from land use maps and NRCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 20 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

4.2.5 Interior Drainage

The modifications to existing interior drainage facilities have been limited to bringing the facilities in compliance with Corps criteria for penetrations through levees (upgrading discharge lines, pumps, etc. to raise the drainage over the top of levee). An assessment of the capacity of existing facilities to address the residual flooding from interior runoff was accomplished for the GRR and will be refined during the design phase, at which time, justified interior drainage facilities will be identified in accordance with the specific USACE guidance. Additional information is located in Section 7.5 of the Hydraulic Appendix.

4.3 ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

The effects to the environment have been considered throughout the planning phase of the project and opportunities have been evaluated to reduce effects to resources within the project area. A vegetation variance will be sought for the project, which will allow vegetation to stay on the lower half of the waterside levee slope. The waterside vegetation is valuable Shaded Riverine Aquatic Habitat (SRA) habitat for many State and Federally listed fish species, and provides habitat for the Federally threatened Western yellow-billed cuckoo and the State-listed Swainson's hawk. Although mitigation for State listed species is not necessarily required for a Federal project, these impacts also affect Federally

listed species and would be required under Section 7 Endangered Species Act (ESA) consultation with National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). During the design phase of the project opportunities will be taken to choose a design that will minimize effects to the American River Parkway where feasible. The Parkway provides habitat for the Federally threatened valley elderberry longhorn beetle and Western yellow-billed cuckoo.

Additionally, in order to avoid jeopardizing the Federally listed green sturgeon, a number of additional measures have been incorporated in the project per the terms of the NMFS Biological Opinion to include modeling, monitoring, and mitigation for this species. The details of this effort are included in the NMFS Biological Opinion in Appendix J of the EIS/EIR, and in the Mitigation and Monitoring Plan in Appendix I of the EIS/EIR.

Table 4-3 lists the habitat impacts of the Recommended Plan and the proposed mitigation for those effects. The construction feature that provided the more conservative environmental effects was used for estimating mitigation. Due to the spatial loss of on-site habitat associated with off-site mitigation, and the temporal loss of habitat associated with on-site mitigation as the new habitat is establishing, the ecological value associated with the mitigation proposed was reduced below the level of the existing habitat that would be impacted by project construction. This reduction would be offset by mitigating additional acreages at the levels established by USFWS and NMFS in the Coordination Act Report and Biological Opinions for the project (Appendix A and Appendix J of the EIS/EIR, respectively).

During detailed design, efforts will be made to further reduce effects from what is projected in Table 4-3. A Cost Effectiveness Incremental Cost Analysis (CE/ICA) was conducted on the habitat mitigation features. Additional information on environmental effects and mitigation is located in Sections 3.6 to 3.8 in the accompanying EIS/EIR. The Habitat Mitigation and Monitoring Plan, including adaptive management planning, and the CE/ICA are included as Appendix I to the EIS/EIR. The Habitat Mitigation and Monitoring Plan focused specifically on habitat mitigation (i.e., habitat creation elements) and doesn't include other commitments in the NMFS Biological Opinion, including preconstruction modeling, fish monitoring, and fish passage at the Sacramento Weir. Additionally, in the HMMP there was no contingency included.

Table 4-3: Environmental Effects of and Proposed Mitigation for the Recommended Plan[1,2].

Habitat Type	Potential Impacts	Duration of Impact	Mitigation (Acres/Linear Feet)	Cost[3]
Giant Garter Snake Aquatic	15 Acres	Permanent	45 Acres	$2,250,000
Giant Garter Snake Uplands	30 Acres 75 Acres	Permanent Temporary	90 Acres 75 Acres	$4,500,000 N/A[5]
Western Yellow-billed Cuckoo Riparian	150 acres	Permanent	Restore 300 acres	$16,566,000
Shaded Riverine Aquatic Habitat (ESA Fish Species)	82,325 LF	Single Construction Season	Up to 82,325 LF self-mitigating with on-site planting[4]	
Elderberry Shrubs	3,292 stems	Permanent	70 Acres $85,000 per acre	$6,026,000
Vernal Pools	0.25 acre	Permanent	1 acre	$275,000
Green Sturgeon	20 Acres	Permanent	Restore Acres and conduct Habitat Monitoring	$16,259,000
Delta Smelt Spawning Habitat	32 acres	Permanent	32 acres	$4,160,000
Shallow Water Habitat (Delta Smelt)	14 acres	Permanent	42 acres	$5,460,000
Oak Woodland	2 acres	Permanent	4 acres	$200,000
Wetlands	0.4 acres	Permanent	1 acre	$130,000
Sub-Total				**$55,826,000**
Contingency				**$15,631,000**
Total				**$71,457,000**

Notes:

[1] Assumes variance from USACE's Levee Safety Policy is granted for Sacramento River and Compliance for American River will be completed under a SWIF

[2] Based on October 2015 price levels

[3] Costs shown are estimated costs. Environmental costs displayed in follow on tables reflects an additional cost for price escalation of 0.4% published in October 2015.

[4] SRA habitat mitigation is provided as a separate construction cost, since it is a feature of the bank protection designs and would be included as a part of the construction contract. The cost is displayed under the Fish and Wildlife Facilities account as "Construction" costs and is estimated to be approximately $231 per linear foot.

[5] 75 acres of temporary effects to GGS upland habitat from the relocation of the Sacramento Bypass levee toe drain would consist of standard site restoration erosion control features required by the SWPPP such as hydroseeding. This is contained within construction costs and is not a mitigation cost.

4.4 REAL ESTATE REQUIREMENTS

The Real Estate Appendix discusses, by reach, the real estate interests to support the construction, operation, and maintenance of the Recommended Plan. The real estate interests include the estates, number of ownerships, and estimated land values. The baseline cost estimates include a gross appraisal and the Federal and non-Federal costs associated with acquiring the lands for the project. The non-Federal administrative costs include right of way planning and management, securing rights of entry for engineering and environmental studies, surveying existing roadways for plats and legal descriptions, right of way field staking, appraisal services, independent appraisal review, acquisition services, relocation assistance, title and escrow support, and condemnation support. The Federal administrative costs include feasibility-level estimated costs associated with the areas and estates that are required for the construction, operation and maintenance for the project. Several of the features included in the plan alter the footprint of the existing Federal flood management system: a new setback levee would be constructed for the Sacramento Bypass and a new segment of the Sacramento Weir would be built.

Other land requirements for the project include temporary borrow areas, temporary construction areas, temporary staging areas, and permanent mitigation sites. The non-Federal sponsors will acquire adjacent land for relocation of infrastructure from the flood control corridor and planned improvements outside the flood control corridor, with appropriate easements provided to utility owners upon completion of the work. To meet its project footprint needs, the non-Federal sponsors must acquire fee title to fish and wildlife mitigation lands, permanent easements for levees, walls, and other permanent structures, flowage areas, waterway improvements, and right-of-way relocation of public highways and public utilities. Permits or temporary easements for excavated material or borrow areas are required during construction and adequate access thereto.

Finally, the plan requires relocations of many government owned utilities (City, County, Sacramento Municipal Utility District (SMUD)) in the study area. This project has received a waiver letter from the Assistant Secretary of the Army (ASA), dated 14 July 1998, relating to a cost sharing issue associated with utility relocations required for construction of the American River Common Features Project in Sacramento, California. Generally, USACE treats relocations as creditable items of non-Federal work and includes such costs in total project costs. The exception is when the sponsor has the authority to compel relocations at no cost to the sponsor.

Requiring the State to revoke permits issued to SAFCA's member agencies would recognize neither the highly interrelated sponsorship of the project that includes the State and SAFCA, nor equitably reflect the joint contributions these entities are making to project financing. The ASA determined that the removal and replacement of a utility, or other public facility, owned by the State of California, or a political subdivision thereof, and which delivers public services, should be treated as a relocation where such work is required as a direct result of the construction of the project. The Corps will include the costs incurred by the non-Federal sponsors in performing these relocations as part of shared total project costs and credit the non-Federal sponsors for such costs. Other relocations include a number of residential and nonresidential structures to accommodate the expanded project footprint along the

Sacramento River east levee. Privately owned infrastructure items need to be included in the lands category as a damage or severance cost, not a facility relocation for project cost sharing purposes. Table 4-4 lists the Real Estate costs for the Recommended Plan.

Table 4-4: Real Estate Costs for the Recommended Plan[1].

MII Account[2]	Category	Costs[3]
01 – Lands and Damages		
	Non-Federal Administrative Costs	$25,658,600
	Non-Federal Lands	$60,458,400
	Subtotal Non Fed Lands and Damages	**$86,117,000**
	Federal Administrative Costs	$9,216,000
	Subtotal Federal and Non-Federal Lands and Damages	**$95,333,000**
02 – Utility/Facility Relocations		$157,201,000
	Total Real Estate Costs (01 and 02 Accounts)[4]	**$252,534,000**

Notes:
[1] Based on October 2014 price levels
[2] MII is the software program and associated format used by USACE in developing cost estimates. Costs are divided into various categories identified as "accounts." Detailed costs estimates are presented in Appendix C, Attachment D, Cost Engineering.
[3] Costs shown are estimated costs. Real estate costs displayed in follow on tables reflects an additional cost for price escalation of 0.6% published in October 2015.
[4] *The total first cost presented here is the project first cost column from the Certified Cost TPCS.*

4.5 OPERATIONS, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION (OMRR&R) CONSIDERATIONS

The Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, approved April 1948, and supplements, will be supplemented for the work completed along the Sacramento River east levee and the American River north and south levees. Updated operation and maintenance manuals will be required as well for work completed along the NEMDC, Arcade and Magpie Creeks. The value of continued OMRR&R is considerable and the lack or partial completion of these activities could lead to additional increased risks over time.

4.5.1 Agencies and Organizations

The non-Federal sponsors will have ultimately responsibility for the OMRR&R of the recommended project. However, it is anticipated that in the non-Federal sponsors will contract with local maintaining agencies and organizations to perform certain maintenance activities. Table 4-5 below lists these maintaining agencies and the affiliated study reaches.

The City of Sacramento

The City of Sacramento (City) maintains the levee along the Sacramento River from the I Street Bridge to Sutterville Road. The City also ensures that the interior drainage systems work efficiently, monitors floodgates and maintains drainage canals and basins. In an emergency, the City installs floodgates and operates and monitors the flood management system.

American River Flood Control District (ARFCD).

The mission of the American River Flood Control District is to operate and maintain a total of 40 miles of levee along the American River and portions of NEMDC, Robla Creek, Arcade Creek, Dry Creek, and Magpie Creek. ARFCD also maintains the short stretch of the Sacramento River levee upstream of the I Street Bridge. The lands acquired by SAFCA and the State of California for levee improvements along NEMDC, Robla Creek, Arcade Creek, Dry Creek, and Magpie Creek would be conveyed to ARFCD in fee title.

By agreement with the State, ARFCD would operate and maintain the constructed facilities in accordance with the operation and maintenance requirements of the SRFCP. Typical flood control and drainage canal operation and maintenance activities would include mowing established grasslands along levee slopes, berms, and access areas; managing drainage canal bank vegetation, including noxious and invasive weeds; periodically removing sediment from the drainage canals; and maintaining and repairing levee and canal patrol roads. These efforts would be carried out under a long-term management agreement between the State and ARFCD.

California Department of Water Resources – Maintenance Area 9 (DWR-MA 9)

Maintenance Areas are formed for the purpose of providing maintenance when local agencies fail in their responsibilities. The maintenance work is provided by the State of California Department of Water Resources (DWR). The authorized services include levee maintenance, flood patrolling, and emergency repairs. Maintenance Area 9 is located on the east bank of the Sacramento River between Sutterville Road and Snodgrass Slough. DWR also provides maintenance on the existing Sacramento Weir and Bypass levees and would be the maintaining agency for the widened Sacramento Weir and Bypass. Table 4-6 displays maintaining agencies by study reach.

Table 4-5: Maintaining Agencies for Study Reaches.

Basins	Maintaining Agency	Reach Description
ARN	ARFCD	Right Bank American River
	ARFCD	Tributaries
ARS	ARFCD	Left Bank American River
	ARFCD	Sacramento River from confluence to I Street Bridge
	City of Sacramento	Sacramento River from I Street Bridge to Sutterville Road
	DWR-MA 9	Sutterville Road to Freeport
	DWR-MA 9	Widened Sacramento Weir and Bypass

4.5.2 Monitoring and Adaptive Management

Overall, after implementation of mitigation components, the mitigation sites would be monitored throughout the year, depending on the type of habitat, and as developed in negotiation with the appropriate resource agencies. USACE would be responsible for providing success monitoring, which, as required for ESA mitigation by the appropriate resource agencies, would be conducted by a qualified ecologist, botanist, or biologist. The monitor would be objective and independent from the installation contractor responsible for maintenance of the site. A mitigation and monitoring plan, including adaptive management planning, was developed and is included as Appendix I of the EIS/EIR. The plan is expected to be updated throughout the PED phase of the project in coordination with the USACE Engineer Research and Development Center (ERDC), NMFS, and USFWS.

All habitat types and mitigation sites would receive quantitative and qualitative monitoring. Quantitative monitoring would be performed in accordance with the performance criteria). Qualitative monitoring would provide an opportunity to document general plant health, overall plant community composition, hydrologic conditions, damage to the site, infestation of weeds, signs of excessive herbivory, signs of wildlife use, erosion problems, and signs of human disturbance and vandalism. These criteria would be assessed and noted for use in adaptive management of the mitigation sites, but they would not be used to determine project success. In addition, a complete list of all wildlife species encountered would be compiled for each mitigation site during each monitoring visit. Particular attention would be given to looking for evidence of listed species at the mitigation sites, including giant garter snake, valley elderberry longhorn beetle exit holes, Western yellow-billed cuckoo, salmonid and sturgeon presence, and Swainson's hawk nests.

USACE would prepare an annual report in conjunction with the resource managers that would be submitted to the USFWS, CDFW, NMFS, and the Central Valley RWQCB by December 31 of each year during the success monitoring period. Monitoring will continue until the Division Engineer determines that ecological success criteria have been met, which is expected to occur within 3-10 years, and after the District Engineer has consulted with appropriate Federal and State agencies. The report would assess the attainment of or progress toward meeting the success criteria for the mitigation sites.

4.5.3 Post Earthquake Remediation Strategies

A seismic evaluation was conducted as part of the ARCF GRR (USACE, 2010). For the Study Area, liquefactions analyses and seismic vulnerability analyses were performed for the most critical cross-section in each reach. Based on the seismic vulnerability analyses, the majority of reaches within the Study Area were classified as "Very Likely Compromised" with respect to post-seismic flood protection ability. As part of DWR's ULE Project, URS also performed a seismic evaluation. The ULE study provides results of seismic vulnerability evaluations, including liquefaction potential analysis and post-seismic vulnerability analyses. Based on the ULE seismic evaluations, the levees were identified as having "low to medium seismic vulnerability".

Therefore, for purposes of this study, it is assumed that if liquefaction of a segment of levee occurs as a result of an earthquake during the life of the project, agencies will perform the necessary inspections of the infrastructure for visible signs of damage. If there was a change in the structure's ability to perform as intended, an emergency flood fight would be initiated by state and local agencies. If the flood fight in the area exceeded the state's ability to respond, then PL 84-99 flood fight assistance could be requested through a governor's letter. Following the flood event, if necessary the request for PL 84-99 rehabilitation assistance could be requested/sought to address the areas with damage.

4.5.4 OMRR&R Costs

The Sacramento District developed operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs associated with the project features. The costs were developed with input and review from two of the local maintaining agencies (LMA). Specifically, several meetings and conversations between the District, the Department of Water Resource's Maintenance Area 9 (MA-9), and American River Flood Control District (ARFCD) staff resulted in a mutual understanding of the increased efforts and impact on costs. The increased efforts include additional mowing, rodent control, and vegetation management. Some of the OMRR&R costs were developed quantitatively, however, many of the costs were developed using qualitative judgment to determine the increase in cost beyond what is currently included in the existing O&M Manual. These costs are listed in Table 4-6 below.

Table 4-6: Annual Increase in OMRR&R Costs[1].

Maintaining Agency for Existing Feature	Existing OMRR&R Features	Existing OMRR&R Costs	Maintaining Agency for Recommended Feature	Description of New Recommended Feature	Increased Cost
MA-9	Sacramento Bypass	$250,000	MA-9	Weir Widening	$56,200
				North Bypass Levee	$137,400
				Bypass Channel	$15,000
	Levee Maintenance	$1,755,000		Levee Maintenance	49,400
City of Sacramento, ARFCD	Access Roads, Levee Main.	$884,700	City of Sacramento, ARFCD	Levee Maintenance	$236,000
Total		**$2,889,700**			**$494,000**

[1] Based on October 2014 price levels

4.6 SAFETY ASSURANCE REVIEW

Section 2035 of WRDA 2007 requires that flood damage reduction projects be reviewed by independent experts, where appropriate, to ensure public health, safety, and welfare. In determining whether such a safety assurance review is necessary the following factors must be considered:

- The failure of the project would pose a significant threat to human life;
- The project involves the use of innovative materials or techniques;
- The project design lacks redundancy; or
- The project has unique construction sequencing or a reduced or overlapping design construction schedule.

Safety assurance reviews must include participation by independent experts selected from among individuals who are distinguished experts in engineering, hydrology, or other appropriate disciplines, and who have not been involved in the design of the project, have no conflict of interest, and do not carry out or advocate for or against Federal water resources projects. The purpose of a review is to provide information on the adequacy, appropriateness, and acceptability of the design and construction activities so as to assure public health, safety, and welfare. The reviews should focus on whether the assumptions made for the hazards remain valid as additional knowledge is gained and the state of the art evolves. In addition, the review panel should advise whether project features adequately address redundancy, robustness, and resiliency, and whether the findings during construction reflect the assumptions made during design. Additional reviews should be completed periodically, on a regular schedule, until construction activities are completed.

Because failure of the proposed levee improvements around the Sacramento area would pose a significant threat to human life, independent review of the design and construction activities based on the Safety Assurance Review standards referenced above will be required.

4.7 RESIDUAL RISK

Residual Risk is the risk of inundation in the study area after implementation of the Recommended Plan. This section includes a discussion on the nature of residual risk in the study area, including levee superiority assumptions and an analysis of the post flood occupation of the study area. It also includes a discussion of measures included in the Recommended Plan to address residual risk along with additional actions by the non-Federal sponsors to address residual risk beyond the scope of this GRR.

4.7.1 Nature of the Residual Risk in the Study Area

The Chief's Report recommending authorization of the American River Common Features Project acknowledged that the implementation of those features would leave significant residual risk in the Sacramento area. The following is from the Chief's Report (House Doc. 105-151):

> *"I must emphasize, however, that implementation of the common elements should not be viewed as a permanent solution addressing all flood damage reduction issues in the Sacramento area. Construction of the common elements leaves relatively short flood warning times, significant depths and durations of flooding in the area, in the event levees are overtopped, problems with safe egress during a flood event and significant residual risk, both in term of monetary damages and hazards to human life…I will make further recommendations concerning implementation of a more comprehensive plan for the American River."*

While the implementation of the Folsom Dam Modifications and the Folsom Dam Raise Project will add significantly to the ability to manage releases from Folsom Dam, there still remains a chance that an unprecedented flood could overwhelm the ability of the dam to prevent flooding downstream. The dam modifications have given dam operators the ability to release amounts of water necessary to save the dam. However, releases of this magnitude would cause massive flooding in Sacramento. It is also important to note that as the population of the urbanized area continues to grow through infill and redevelopment, the consequences of a levee failure would continue to increase. It is of the utmost importance that public education efforts emphasize the residual risk inherent in any system of flood risk management. In order to continue to reduce the residual risk, the Recommended Plan includes continuation of non-structural measures by the sponsors as items of local cooperation, consisting of updating and adhering to the floodplain management plan, annual publication of residual risks to residents in the floodplain, updates and improvements to local building codes, and participation in the Federal flood insurance program. As part of the Recommended Plan, the sponsors would also be required to provide floodplain information to regulatory agencies.

Analysis indicates that there is still some chance of levee poor performance below the top of levee. Table 4-7 displays the probability of poor performance at various feet below the top of the levee at index points within the study area.

Table 4-7: Residual Risk at Index Points in the Study Area[1].

ARS Basin – American River		ARS Basin – Sacramento River		ARN Basin – American River		ARN Basin – Tributaries	
Feet Below TOL	Chance of Poor Performance	Feet Below TOL	Chance of Poor Performance	Feet Below TOL	Chance of Poor Performance	Feet Below TOL	Chance of Poor Performance
9.3	4%			6.7	3%	9.3	2%
4.7	8%	9.8	3%	4.8	6%	6.1	4%
3	13%	3	6%	3	12%	3	6%
0	17%	0	9%	0	16%	0	10%

Note: [1] Economic Damages associated with the Residual Risk are displayed in Appendix E (Economics) of the GRR.

Rivers in the study area can rise from low flow levels to damaging floods within one to three days. If a levee failure were to occur, the flood depths would range from several inches along the eastern limits of the floodplain near high ground, to more than 20 feet in areas immediately adjacent to the levees. The duration of the flooding is likely to be weeks after the water levels in the river have receded. Large amounts of pumping would be required since the water level in the rivers would be higher than the land behind the levees. The average expected residential and public displacement times as a result of flooding would range from weeks in areas of shallow flooding to much longer periods in areas of deep flooding where substantial damage to infrastructure and individual structures would be expected.

4.7.2 Levee Superiority

Superiority is the levee design approach that identifies an initial overtopping location in the least hazardous location of a levee reach. This can be achieved by specifically setting the top of levee lower in the chosen overtopping location.

According to ETL 1110-2-299, "Overtopping of Flood Control Levees and Floodwalls," two design types can be used to control initial overtopping. The first is the use of different levee heights relative to the design water surface from reach to reach to force overtopping in a desired location. The second design uses notches, openings, or weirs in the structure. The inverts for these features are at or above a design water surface elevation but below the neighboring top of levee. Examples are railroad or road crossings of levees and rock weirs.

For this study, the second option (the use of the weirs as described in ETL 1110-2-299) was applied. The two weirs on the Sacramento River in the project area, Fremont Weir and the Sacramento Weir, divert high flows away from Sacramento into the Yolo Bypass. The two weirs are the only designed flood relief

structures in the system. The levees in the project area have not been designed for overtopping, but there are incidental low areas that will likely overtop first.

4.7.3 Post-Flood Reoccupation of Sacramento

The levees surrounding Sacramento vary from approximately 10 feet tall to approximately 25 feet tall. A levee failure, depending on the location, could potentially inundate the majority of the basin where the levee failure occurred. Conditions in the impacted basin(s), if this were to occur, would be very similar to conditions in New Orleans after Hurricane Katrina.

Considerable infrastructure is required to support the population in the study area. Key infrastructure within the project area includes the California State Capitol and State offices, hospitals, many power transmission lines, water supply lines, sewage lines, interior drainage canals and pump stations, phone lines, and roadways. (See Chapter 2 for additional infrastructure information) In addition to the infrastructure flooding in the event of a levee failure, there are approximately 120,000 residential dwellings that would be inundated, in many cases with up to 25 feet of flooding.

In the event of significant flooding of the basin, numerous actions would have to be completed prior to reoccupation of the basin. Probably the most significant action would be reestablishment of interior drainage infrastructure. Interior drainage for the American River North and American River South Basins is accomplished by pump stations and canals. The affected pump stations would be inundated should a levee failure occur. Because of this, these pumps would not be available to dewater the basin during and immediately after the levee failure. Additionally, because the pump motors would likely be inundated for a considerable amount of time, the motors would have to either require a considerable amount of work, or would have to be completely replaced in order to restore interior drainage capability. Additionally, power to the pump stations will likely have been interrupted. In this case, generating capacity would have to be provided to operate the pumps until the power grid was reestablished. Due to these circumstances, the basin(s) will likely be under water for a considerable period of time, most likely multiple weeks or months. New, larger pumps would be brought in to dewater the basin, similar to what occurred in New Orleans following Hurricane Katrina.

After the basin has been dewatered, considerable additional work will be necessary prior to reoccupation of the basin. Water supply infrastructure, wastewater transport facilities, and power supply infrastructure will have been inundated for a considerable period of time. Once the water is removed, repair must be done to these facilities, including cleaning and disinfecting, prior to being usable. Roadways may be usable sometime after dewatering; however, considerable repair of these roadways would likely be necessary. Other infrastructure, such as phone lines and fiber optic lines, may need to be completely replaced after a flood.

Dwellings will be uninhabitable for some time after a flood. In many cases, the homes will be completely submerged. For these cases, houses will have to be completely removed and a new structure built.

Buildings damaged by flooding can become contaminated with mold and fungi if they do not dry out quickly enough. These molds and fungi can pose serious health risks. When a house can be salvaged, building materials inside of the structure that could harbor mold and fungi would have to be removed, including sheet rock and insulation. Because of the lack of contractors available to do this type of work, the duration period for rebuilding or repairing homes could be years.

4.7.4 Recommended Plan Actions to Reduce the Residual Risk in the Study Area

The Recommended Plan would substantially lessen the probability of a flood event in the study area due to levee failure; however, there will be a remaining chance of levee overtopping from a flood that exceeds the design event.

There are two types of residual risk that have been analyzed as part of this GRR: the residual risk associated with the recommended project features and the residual risk from physical conditions not related to the recommended project features. Figures 4-13 and 4-14 display the residual risk remaining in the study area after construction of the project features. The 1/100, 1/200 and 1/500 ACE events are displayed. These figures show the percent chance of a hypothetical levee failure and the resulting floodplain for the stated flood event. The second type of residual risk is related to the flanking of the American River levees for events larger than the 1/200 ACE. The Expected Annual Damages associated with this flanking are $29 million for the ARN Basin and $22 million for the ARS Basin. Figure 4-16 shows the resulting floodplains from this flanking by floodwaters in the 1/500 ACE event. When considering both of these types of residual risk, the average annual residual damages in the Study Area are presently estimated to be $112 million per year.

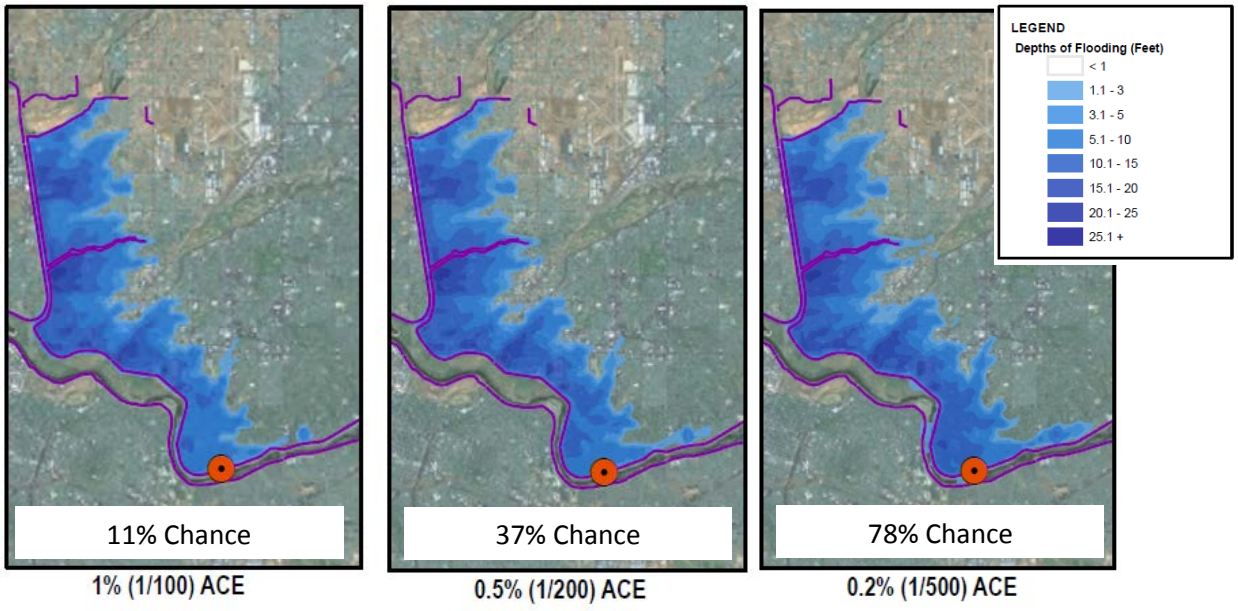

Figure 4-13: Residual Risk for the American River North Basin.

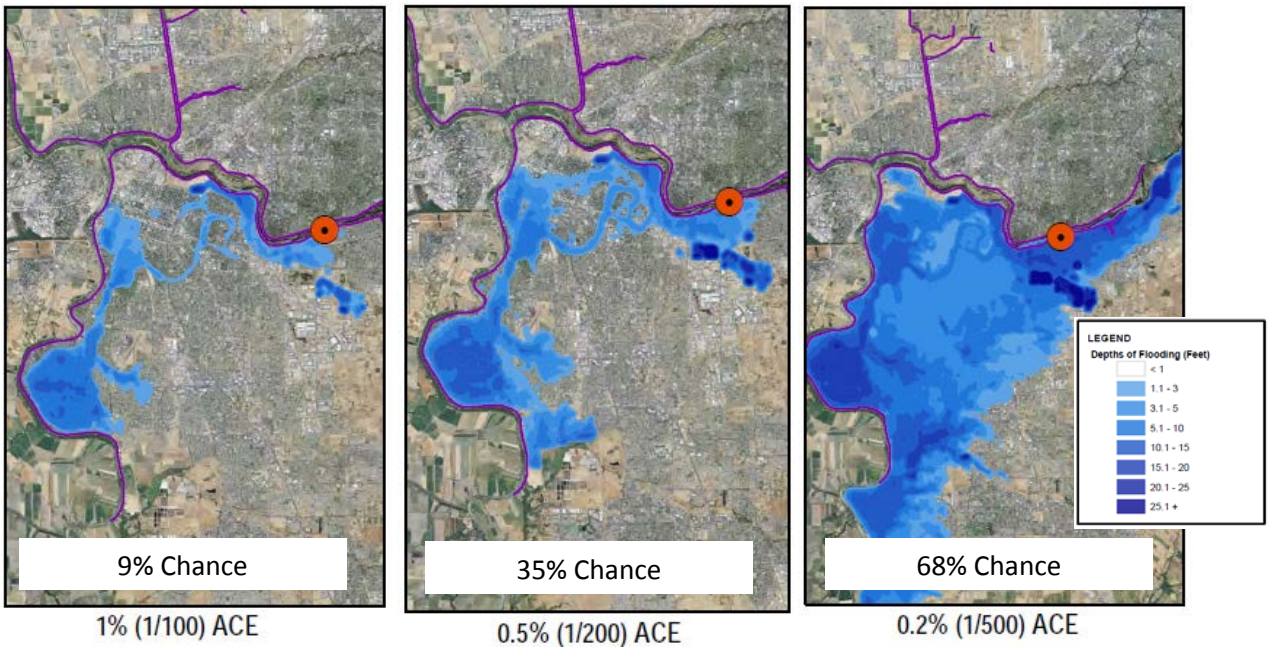

Figure 4-14: Residual Risk for the American River South Basin.

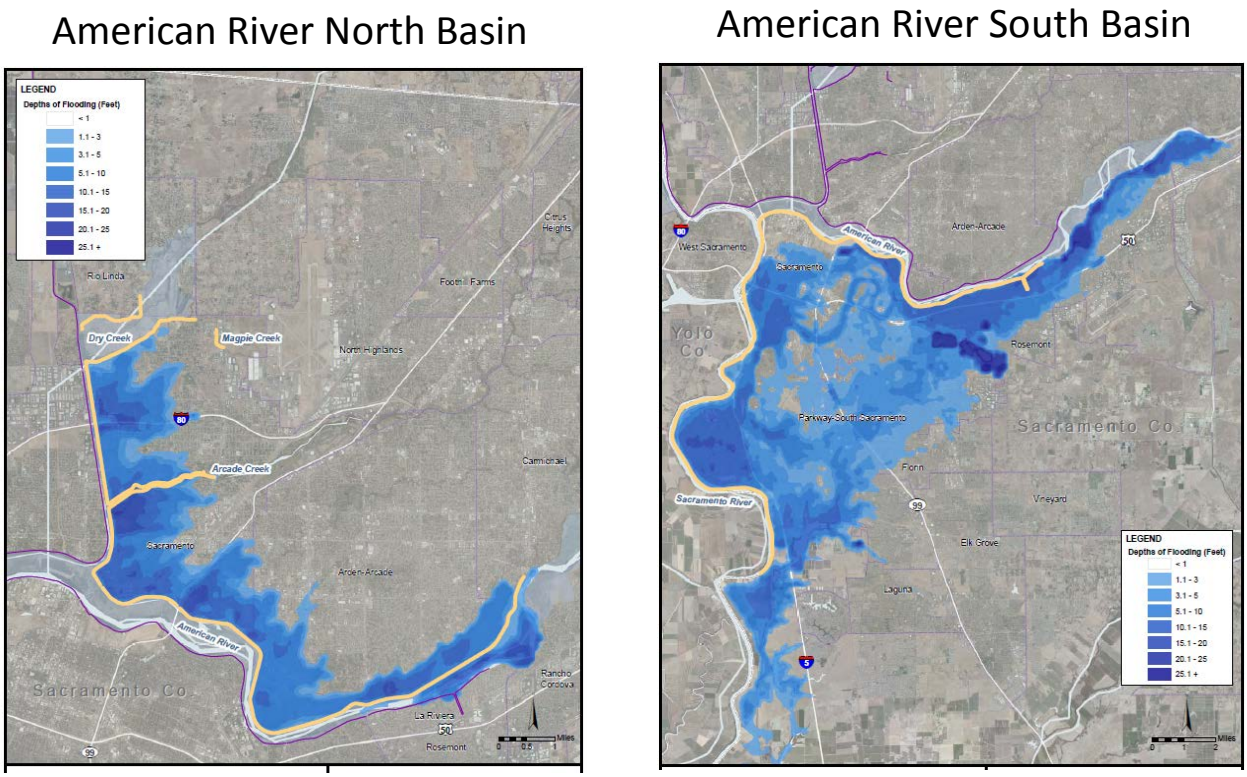

Figure 4-15: Residual Risk of Upstream Flanking of American River Levees for the 0.2% (1/500) ACE.

4.7.5 Additional Actions to Reduce the Residual Risk in the Study Area

The following sections discuss further actions being taken to address residual risk by the non-Federal sponsors and other local agencies that are outside the scope of this GRR.

Senate Bill 5

The California State Senate, in 2007, approved Senate Bill 5. There are various components included in Senate Bill 5. One element is the identification of the 100- and 200-year floodplains in the Sacramento and San Joaquin valleys. One additional feature establishes a standard for urban areas to have a 200-year level of protection, as defined by the State of California's methodologies. Even though it is not specifically stated, the intent of these features is to provide a higher level of flood protection for urban areas than for non-urban areas, thereby giving superiority to urban areas. The CVFPP was completed in 2012 and established urban and non-urban standard levels of protection as 200-year and 100-year, respectively.

SAFCA Development Impact Fee

The Recommended Plan would substantially lessen the probability of an uncontrolled flood in the basin due to levee failure. Nevertheless, with this protection in place, the consequences of a flood would increase over time as planned new development occurs in the Sacramento area in accordance with the Sacramento Area Council of Government's regional blueprint. To address residual risk, the SAFCA Board adopted a development fee program on May 15, 2008 that applies to new structures placed in the 200-year floodplain of SAFCA's capital assessment district. The objective of this program is to continue to reduce the risk of an uncontrolled flood as new development proceeds in the floodplain. The revenue generated by the fee program will be used to finance a program that will consist of the following measures, discussed in detail below: waterside levee strengthening; landside levee strengthening; and improved system operations.

Waterside Levee Strengthening

This action will consist of a long-term program of waterside bank and levee protection improvements along the Lower American and Sacramento Rivers designed to arrest retreat of the upper bank, preserve waterside berm width, and reduce the potential for destabilization of the adjacent levee foundation due to erosion or ground shaking. In addition, this action will minimize the long-term loss of mature trees and vegetation located along the affected berms and will provide opportunities for expansion of the Central Valley's remnant riparian forest while enhancing the public safety purposes of the levee system.

Landside Levee Strengthening

This action will focus on improvements to the crown and landside slope of critical segments of the levee system along the NCC and the Lower American and Sacramento rivers to increase the resistance of these levees to overtopping and extended elevated river stages. These improvements will involve hardening the crown and landside slope of portions of the NCC south levee in Natomas and American River north and south levees between Howe Avenue and Watt Avenue.

Improved System Operations

These actions will focus on opportunities to improve the operation of the Sacramento River Flood Control Project to reduce water surface elevations in the Lower American and Sacramento rivers and in the drainage channels around the Natomas Basin. These opportunities may include implementing weather forecast based operations at Folsom Dam and Reservoir and improving the conveyance capacity of the Yolo and Sacramento Bypass systems. It is assumed that SAFCA's development fee revenue will constitute only a portion of the revenue devoted to this measure, with the balance coming from the State and Federal governments as part of a State of California CVFPP.

4.8 FLOOD WARNING AND EVACUATION PLANS

Both Sacramento County and the City of Sacramento have websites containing links to information regarding flood preparation, notification, and evacuation. The information for Sacramento County, including a link to the Floodplain Management Plan, is located at: http://www.stormready.saccounty.net/Pages/Home.aspx. Additional information on preparing for a flood can be found at: http://www.sacramentoready.org/Emergencies/Pages/Floods-and-Rain.aspx. The information for the city of Sacramento is located at: http://portal.cityofsacramento.org/Utilities/Education/Flood-Ready/Your-Flood-Prep.

4.8.1 Flood Warning System

Sacramento County and the City of Sacramento have developed a comprehensive flood warning system and evacuation plan. The County of Sacramento, Department of Water Resources has developed an Automated Local Evaluation in Real Time (ALERT) system website that provides Sacramento County Rainfall and Stream Level Information. This system consists of stream level gauges, rainfall gauges, and weather sensors. Gauging stations collects rainfall and stream level data and provide website updates every 15 minutes. Local meteorologists and television stations utilize the ALERT website to keep residents informed. During a serious county wide flood emergency, Sacramento County will post alerts on both local radio and television stations. The ALERT system also provides links to National Weather Service websites that provide both weather and stream flow information.

The steam level gauge system includes a total of 50 stream level gauges spread over 8 stream or river groups. Information on the website indicates the current stream level, channel bottom, monitor stage, and flood stage.

A total of 61 rainfall gauges spread over 8 stream/river groups or areas provide current rainfall totals in durations including 30 minutes, one, three, six, twelve and twenty four hours, and five and ten days. The current rainfall totals report is updated every 15 minutes.

4.8.2 Evacuation Plan

The City and County monitor weather conditions and stream levels to determine the level of severity and evacuation triggers of potential flood events. Streams and locations that are monitored by the County to determine the level of emergency activation include the Sacramento River at the I Street Bridge, the American River at the H Street Bridge, Morrison Creek at Mack Road, Natomas East Main Drainage Canal at Arcade Creek, Arcade Creek at East Main Drainage Canal, and the Cosumnes River. The levels of emergency evacuation identified by the County ranging from less severe to most severe include: Situational Assessment, Low-Level Emergency, Medium-Level Emergency, and High-Level Emergency.

The following table indicates the activation triggers for the Sacramento River at the I Street Bridge and the American River at the H Street Bridge.

Table 4-8: Emergency Activation Triggers.

Location	Sacramento River at I Street Bridge	American River at H Street Bridge
Situational Assessment	River is rising and significant precipitation and/or Sierra snow melt is expected	River is rising and significant precipitation and/or Sierra snow melt is expected
Low-Level Emergency	I Street gauge is 19-24 feet and rising	H Street gauge is up to 30-39 feet and rising
Medium-Level Emergency	I Street gauge is up to 27 feet	H Street gauge is up to 41 feet
High-Level Emergency	I Street gauge is up to 31 feet; levee overtopping and flooding	H Street gauge is up to 42 feet; levee overtopping and flooding

4.8.3 Public Alert and Warning

The county has established a Public Alert and Warning System to increase public awareness of an impending threat and to provide clear instructions should an emergency situation require evacuations. The actual verbal or written messages that will be given are the responsibility of the Public Information Officer, the Joint Information Center, and the Emergency Operations Center.

4.8.4 Evacuation Routes

Emergency evacuation routes have been established throughout the county. Evacuation areas, evacuation routes, and rescue areas have been established for five levee breach locations in the American River North Basin, and eight levee breach locations in the American River South Basin. Evacuation route inundation times are color coded on the various levee breach location maps and vary depending on the location of the levee breach.

4.8.5 Mass Care and Shelter Management

A Mass Care and Shelter Management System has been established by the County to provide shelter, food, emergency first aid, disaster welfare information, and bulk distribution of emergency relief items in the event of an evacuation. Approximately 88 sites, including schools, churches and community centers have been identified throughout the County as Mass Care Shelters. Operation of the various shelters is dependent on where a levee break occurs and the associated flooding scenario.

4.8.6 Hypothetical Flood Depth and Rescue and Evacuation Area Maps

Hypothetical flood depth and rescue and evacuation area maps have been developed by the City/County of Sacramento for five different levee breach locations in the Natomas Basin, five levee breach locations in the American River North basin, and eight levee breach locations in the American River South basin as part of the Flood Emergency Evacuation Plan. The hypothetical flood depth maps depict both the maximum flood depths and the elapsed time from levee failure until an area is inundated with floodwaters to a depth of 1 foot for a total of 18 different levee failure locations on the levees surrounding Sacramento. Depending on the levee failure location the elapsed time to get to 1 foot flood depths can range from 6 minutes to over 240 hours.

4.9 HYDRAULIC EFFECTS EVALUATION

Widening the Sacramento Weir and Bypass will allow more flow from the Sacramento and American Rivers to be released into the Yolo Bypass which will reduce the water surface elevation in the river adjacent to the city of Sacramento. The purpose of this section is to provide a framework which examines the effects of this change in flow from both an incremental project standpoint and a cumulative perspective that takes into account the effects of the ongoing work at Folsom Dam.

4.9.1 Existing and Future Without Project Condition Assumptions

The future without project condition assumptions include construction and operation of all previously authorized work on the American River as part of the WRDA 1996 and 1999 Common Features authorizations, levee repairs as described in the Natomas PACR authorized in WRRDA 2014, the new JFP spillway under construction at Folsom Dam, and the future planned raise of Folsom Dam.

The existing condition for ARCF is different than the future without project condition. The existing condition describes the existing releases from Folsom Dam and is used to assess the overall effects of the combined Common Features and Folsom Dam improvements (spillway and raise) for a cumulative effects assessment. The existing condition assumes the Bureau of Reclamation and SAFCA reservoir operation agreement is in place which allows for greater flood storage in the reservoir beyond what the original operations manual designated.

The major hydrologic/hydraulic difference between the existing as compared to both the future without project condition and the with-project condition is that the peak flow on the American River is higher for frequent events but lower for less frequent events due to Folsom Dam routing changes. Table 4-9 displays the different flow releases from Folsom Dam for the Existing and the Future Without Project (with JFP and dam raise in place).

Table 4-9: Comparison of Existing and Future Without Project Flow Releases from Folsom Dam.

Frequency (Years)	Existing (Existing Releases, cfs)	Future Without Project (with JFP, cfs)
2	30,000	26,000
10	43,000	72,000
25	100,000	115,000
50	115,000	115,000
100	145,000	115,000
200	320,000	160,000
500	520,000	530,000

4.9.2 Discussion of Flow Changes

If the expanded Sacramento Weir were to be operated as the existing weir is operated, the Recommended Plan would result in a diversion of flows from the Sacramento River to the Yolo Bypass that would slightly raise water surface elevations in the Yolo Bypass during frequent events (10 year) compared to both the existing and future without project conditions. To avoid potential effects to the Yolo Bypass, the widened portion of the Sacramento Weir will only be operated when the release from Folsom Dam is increased to above 115,000 cfs. As a result of the increased flood storage space and anticipatory releases at Folsom Dam, this translates into a reduction of flows into the Yolo Bypass with the Recommended Plan in place compared to the existing conditions. See Table 4-10 for a comparison of the flows at various locations for the Existing, Future Without Project, and with the Recommended Plan.

Table 4-10: Comparison of 10, 100, and 200 Year Frequency Flows under Various Conditions.

10 year event	Existing	Future Without Project	Alt. 2 (Recommended Plan)
American River	43,000cfs	72,000cfs	72,000cfs
Sacramento Bypass	50,000cfs	66,000cfs	66,000cfs
Yolo Bypass below Sac Bypass	270,000cfs	296,000cfs	296,000cfs
100 year event	**Existing**	**Future Without Project**	**Alt. 2 (Recommended Plan)**
American River	145,000cfs	115,000cfs	115,000cfs
Sacramento Bypass	131,000cfs	115,000cfs	115,000cfs
Yolo Bypass below Sac Bypass	555,000cfs	535,000cfs	535,000cfs
200 year event	**Existing**	**Future Without Project**	**Alt. 2 (Recommended Plan)**
American River	320,000cfs	160,000cfs	160,000cfs
Sacramento Bypass	183,000cfs	149,000cfs	164,000cfs
Yolo Bypass below Sac Bypass	656,000cfs	631,000cfs	643,000cfs

4.9.3 Conclusion

The widening of the Sacramento Weir and Bypass diverts flood flows from the Sacramento and American River into the Yolo Bypass. The widened portion of the weir will only be operated when flood releases from Folsom Dam are above the existing objective release of 115,000 cfs which would occur during flood events greater than 1/100 ACE event. Therefore, for events up to the 1/100 ACE event, there would be no change in flow conditions in the Sacramento and Yolo Bypasses. For flood events greater than 1/100 ACE event when releases from Folsom Dam would go above 115,000 cfs (such as a 1/200 ACE event in which the Folsom release goes up to 160,000 cfs), because of the additional flood storage provided by anticipated operation and physical improvements to Folsom Dam coupled with the widened Sacramento Weir and Bypass, the net effect would be to slightly decrease the peak compared to the existing peak flow in the Yolo Bypass.

4.10 ENVIRONMENTAL SUMMARY

The Sacramento District published a notice of intent (NOI) to prepare the ARCF GRR EIS in the Federal Register (Vol. 73, No. 41) on February 29, 2008. A series of public scoping meetings were held in March 2008 to present information to the public and to receive public comments on the scope of the EIS. There is no mandated time limit to receive written comments in response to the NOI under NEPA. The Appendix F of the EIS contains the NOI, the one comment letter received in 2008, and copies of the posters for the March 2008 scoping meetings.

The draft GRR and EIS/EIR was circulated for a 45 day public review period, beginning in March 2015, to Federal, State, and local agencies, organizations, and individuals who have an interest in the project. A notice of availability of the draft EIS/EIR was published in the Federal Register when the document was released for public review. Public workshops were held during the review period to provide additional opportunities for comments on the draft document. All comments received during the public review

period were considered and incorporated into the final EIS/EIR, as appropriate. Appendix F includes the public comments received and the Sacramento District's response to those comments.

A biological assessment has been prepared and coordinated with the resource agencies. USACE has consulted, pursuant to Section 7 of the Endangered Species Act, with NMFS and USFWS. Biological opinions (BO) have been issued by USFWS and NMFS and are included as Appendix J to the EIS/EIR.

This project has been coordinated with USFWS under the Fish and Wildlife Coordination Act. The Fish and Wildlife Coordination Act Report (CAR) is included as Appendix A of the EIS. Mitigation recommended in the CAR and pursuant to the BOs is included in Table 4-10 which displays the potential effects and mitigation proposed for the Recommended Plan. This mitigation reflects what is in the BOs and has been coordinated with USFWS, NMFS, and the California Department of Fish and Wildlife (CDFW).

In accordance with 36 CFR § 800, the regulations implementing Section 106 of the NHPA, USACE has determined that the ARCF GRR will likely result in adverse effects to historic properties. In order to take into account the effects of the proposed undertaking on historic properties, USACE has executed a Programmatic Agreement (PA). USACE has consulted with interested parties, the SHPO, the ACHP, DWR, the CVFPP, SAFCA, and American Indian tribes and individuals in the development of the PA. The PA was sent to potentially interested Native Americans, requesting their comments and interest in signing the PA as concurring parties. All comments from all parties were considered in the development of the PA. The PA was executed by signature from USACE and the SHPO on September 10, 2015; as a result, USACE is in compliance with Section 106. The PA is included in Appendix C of the EIS.

A Section 401 Water Quality Certification would be obtained from the Regional Water Quality Control Board (RWQCB) during PED. Detailed, site-specific design is needed in order to conduct this consultation, and the current feasibility-level design on the ARCF study does not provide enough detail for this consultation. The Best Management Practices (BMPs) proposed should be sufficient to mitigate for potential water quality impacts, as they are consistent with what has been implemented on other local construction projects with similar potential effects as the proposed project, including the Sacramento River Bank Protection Project. The recommended plan includes costs for the expected required BMPs. The draft report was provided to the RWQCB for review. The comment letter received from the RWQCB concurred that a Section 401 certification was required prior to construction; however, no concerns regarding the proposed alternatives were indicated in the letter. As a result, obtaining a Section 401 certification in PED is considered feasible and low risk.

The Recommended Plan would also have a significant effect on Transportation and Circulation. In order to mitigate for this effect, a Traffic Control and Road Management Plan would be prepared and other BMPs listed in Section 3.10.6 of the EIS/EIR, would be implemented.

The temporary closure of recreation facilities in the American River Parkway during construction, including bike trail, walking trails, and boat launches would constitute a significant effect to recreational

resources. The possible closure of the Sacramento Bypass for construction during portions of hunting season would also be a significant effect. In order to mitigate for this effect, notification and coordination with recreation users and bike groups would be conducted. Flaggers, signage, detours, and fencing to notify and control recreation access and traffic around construction sites would be put in place.

The loss of vegetation and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River and is considered a significant effect on the visual and aesthetic resources in the study area. Trees would be planted after construction is completed on planting berms and on top of launchable rock trenches; however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.

A summary of the environmental effects and the associated mitigation measures are listed in Table 4-11.

Table 4-11: Summary of Environmental Effects and Mitigation Measures.

Potential Effects	Mitigation Measure	Effects with Mitigation
Land Use		
Acquisition of properties for levee easements along the Sacramento River and Arcade Creek. Conversion of agricultural lands to floodway.	Federal Relocation Assistance Act compliance.	Significant
Hydrology and Hydraulics		
No effect.	Not applicable.	Not applicable.
Water Quality		
Potential impacts include increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction.	Preparation of a Stormwater Pollution Protection Plan, Spill Prevention Control and Countermeasures Plan, and a Bentonite Slurry Spill Contingency Plan. Implementation of BMPs listed in Section 3.5.6 of the EIS/EIR.	Less than significant with mitigation.
Vegetation and Wildlife		
Construction of levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat on the landside of the Sacramento River levees, in the American River Parkway, and along Arcade Creek. Construction of the Sacramento Weir extension would require the removal of riparian vegetation.	When possible, compensation would be planted on planting berms, on top of launchable rock trenches, on other lands within the Parkway, or within the Sacramento Bypass. Additional mitigation sites are identified in Section 3.6.6 of the EIS/EIR.	Significant.

Fisheries		
Indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the placement of rock at bank protection sites, causing an increase in turbidity. Widening the Sacramento Bypass creates floodplain, which could provide a benefit to fish species.	Vegetation variance would allow waterside vegetation to remain on the Sacramento River. Bank protection sites and launchable rock trenches would be revegetated following construction. BMPs would be implemented to address turbidity, and are discussed in Section 3.5.6 of the EIS/EIR	Less than significant with mitigation.
Special Status Species		
Direct affects to GGS, fish species, and Swainson's Hawks during construction. Indirect effects due to loss of habitat. Vegetation variance for the waterside levee slopes would significantly limit the effects to endangered fish species.	Replace habitat for species either on-site or in close proximity to lost habitat. Implement BMPs discussed in Section 3.5.6 of the EIS/EIR during construction to prevent mortality.	Less than significant with mitigation
Cultural Resources		
Adverse effects to historic properties from construction of levee improvements and the bypass widening.	Preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans.	Significant.
Transportation and Circulation		
Increased traffic on public roadways.	Preparation of a Traffic Control and Road Management Plan and other BMPs listed in Section 3.10.6 of the EIS/EIR.	Significant.
Air Quality		
Emissions of criteria pollutants from construction equipment, haul trucks, and barges.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.11.6 of the EIS/EIR.	Less than significant with mitigation.
Climate Change		
Increased greenhouse gas emissions from construction equipment, haul trucks, and barges.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.12.6 of the EIS/EIR.	Less than significant with mitigation.
Noise		
Increased noise in proximity to sensitive receptors due to construction activities.	Coordination with local residents, compliance with noise ordinances, and other BMPs, as listed in Section 3.13.6 of the EIS/EIR.	Less than significant with mitigation.
Recreation		
Temporary closure of recreation facilities in the American River Parkway during construction, including bike trail, walking trails, and boat launches. Possible closure	Notification and coordination with recreation users and bike groups. Flaggers, signage, detours, and fencing to notify and control recreation access and traffic around construction sites.	Significant.

of the Sacramento Bypass during portions of hunting season.		
Aesthetics and Visual Resources		
Vegetation loss and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River.	Trees would be planted after construction is completed on planting berms and on top of launchable rock trenches; however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.	Significant.
Public Utilities and Services		
Temporary disruptions to utility services possible, particularly during relocation of utilities that penetrate the levee.	Notification of potential interruptions would be provided to the appropriate agencies and to landowners.	Less than significant.
Hazardous, Toxic, and Radiological Wastes		
No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction, including the Old Bryte Landfill.	Borrow material would be tested prior to use to ensure that no contaminated soils are used for this project.	Less than significant with mitigation.
Socioeconomics, Population, and Environmental Justice		
Disruption to residents alongside construction sites from traffic, noise, and dust. Acquisition of properties for flood control easements.	Federal Relocation Act compliance.	Less than significant.

4.11 EXECUTIVE ORDER 11988

Executive Order (EO) 11988 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities." The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in the Corps' ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The eight steps reflect the decision-making process required in Section 2(a) of the Order. The eight steps and responses to them are summarized below.

1. *Determine if the proposed action is in the base flood plain.*

The levees along the American River and Sacramento River as well as the Sacramento Weir and Bypass are in the base flood plain.

2. *If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain.*

The poor performance of the exiting levee systems in the study area highlights the need to address the flood risk with a worst first strategy. The most efficient and effective means of reducing this risk is to improve the levees. Any upstream or larger regional improvements to the flood management system do not reduce the water surface elevations to the point where these levee improvements are not needed. Therefore, there are not any practicable alternatives but to improve the existing levees.

3. *If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.*

The draft GRR and EIS/EIR documents were circulated for public review and public meetings were held during the comment period. Required notices have been mailed to affected property owners throughout the ARCF GRR environmental review process, soliciting input on the content of the environmental documents and noticing various public meetings. Additionally, notices have also been posted in the largest local newspaper, The Sacramento Bee, announcing various public meetings. USACE, the State of California and SAFCA have also participated in numerous stakeholder meetings to discuss project-related concerns. Public comments received on the NOI/NOP were considered and addressed, where appropriate in the draft EIS/EIR; public comments received on the draft EIS/EIR have been addressed in the final EIS/EIR; and public comments received on the final EIS/EIR will be addressed in the record of decision (ROD).

4. *Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified.*

The Recommended Plan proposes to widen the Sacramento Weir and Bypass which would reconnect about 300 acres of the floodplain to seasonal inundation thereby improving natural floodplain values. In addition, the Recommended Plan reduces the water surface elevation in the river adjacent to two urban areas, increases the regional flexibility of the flood management system, and provides benefits to downstream communities in the form of reduced water surface elevations in the Sacramento River. The Recommended Plan would cause adverse effects to Vegetation and Wildlife, Cultural Resources, Transportation, Recreation and Aesthetic and Visual resources; however, on balance, due to the expanded connection of the river to its floodplain through the widened Sacramento Weir and Bypass, other floodplain values are increased and therefore there is no net loss.

5. *If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists.*

The most effective and efficient method of reducing flood risk in the ARN and ARS Basins is to improve the levees that provide the first line of defense against flooding in the basins. Therefore, a practicable non-floodplain alternative does not exist.

Within the project area, population growth and urban development are driven by local, regional, and national economic conditions. Local land use decisions are within the jurisdiction of the City and County of Sacramento. Both of these agencies have adopted a general plan consistent with State law. These general plans provide an overall framework for growth and development within the jurisdiction of each agency, including the project area.

The American River North and American River South basins are fully urbanized. The City of Sacramento General Plan identifies areas that will be preserved and enhanced to maintain their current character, as well as areas that will improve and evolve, undergoing significant change through infill, reuse and redevelopment. There are several areas identified in the City of Sacramento General Plan that are identified as growth areas and envisioned to undergo significant changes as a result of major development and redevelopment. These include the River District and the Railyards.

The 773-acre River District Area proposes development of a transit-oriented mixed use urban environment that would include 8,144 dwelling units, 3.956 million square feet of office, 854,000 square feet of retail/wholesale, 1.463 million square feet light industrial, and 3,044 hotel units. The vision for the River District is that of an eclectic mix of uses that will evolve from a primarily light-industrial, low-intensity commercial district, to that of a series of distinctive walkable neighborhoods within a district that is contiguous to the American River and serves as the northern gateway into the Central City.

The 224-acre Railyards Area proposes development of a transit oriented mixed use urban environment that would include between 10,000 and 12,100 dwelling units, 2.3 million square feet of office, 1.3 million square feet of retail, 1,100 hotel rooms, and 46 acres of open space. The goal is to integrate and connect the Railyards area with the downtown business and government center with pedestrian and bicycle facilities, roadways, and public transportation routes.

Regional infrastructure planning reflects these growth plans. In December 2004, the Sacramento Area Council of Governments (SACOG), representing the Counties of El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba and their 22 constituent cities, adopted the “Preferred Blueprint Scenario” to guide land use and transportation choices over the next 50 years as the region’s population grows from its current population of 2 million to include more than 3.8 million people. The Blueprint project was initiated in 2002 to study future land use patterns and their potential effects on the region’s transportation system, air quality, housing, open space, and other resources.

The study found that continuing the recent practice of building large-lot, low-density housing would consume another 660 square miles of undeveloped land. Residents would face longer commutes, more vehicle trips, dirtier air, and a growing disconnect between where they live and where they work.

Through a series of Blueprint workshops at the neighborhood, city, county, and regional level, more than 5,000 residents, elected officials, business leaders, and environmental interests helped craft an alternative vision that integrates smart growth concepts such as higher-density, mixed-use developments and reinvestment in existing developed areas. The Preferred Blueprint Scenario assumes certain levels and locations of both "reinvestment" (i.e., additional development on already-built parcels) and greenfield development (i.e., large-scale development on vacant land). An analysis of this scenario showed that following smart growth principles would shorten future commute times, reduce traffic congestion, lessen dependence on automobiles, and provide for housing choices that more closely align with the needs of an aging population. The Preferred Blueprint Scenario will become part of SACOG's long-range transportation plan for the six-county region. It also will serve as a framework to guide local government in growth and transportation planning through 2050.

Using the above information, combined with an evaluation of residual flood damage, it was concluded that there is substantial evidence that the Recommended Plan as a whole would accommodate anticipated growth in the project area in a manner that would be consistent with adopted local and regional growth management plans and with the State's emerging State Plan of Flood Control. There is substantial evidence that the Recommended Plan would accommodate planned regional growth in a manner that would be consistent with emerging smart growth principles. Thus, the project, while accommodating planned regional growth, is not growth inducing itself and is compliant with EO 11988.

6. *As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the "no action" alternative.*

Mitigation measures are identified and will be implemented as part of the project to minimize the project's potentially adverse impacts. The project includes the creation of natural habitat that would serve ecological functions associated with natural floodplains. The No-Action Alternative would not restrict growth in the base floodplain in the short term. The 400,000 people living and working in the American River North and American River South Basins would remain at risk of flooding. However, the State of California's Senate Bill (SB) 5 stipulates that development in urban areas will be restricted if the localities have not made meaningful progress toward achieving a 200 year level of performance (per State of California standards) by 2025. Therefore, the No-Action Alternative would restrict growth in the base floodplain in the long term.

7. *If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings.*

The public has been advised of the recommendations contained in the GRR during the public comment period for the draft report. Public meetings were held during these time period.

8. *Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.*

The objective of the study is to reduce flood risk and its associated consequences on the public health, safety, and property in the study area. In order to achieve this objective, the study recommends improvements to the ARS and ARN basin levees. These two basins are essentially built-out; however, infill development is ongoing. There are no development restrictions in these basins and so this infill development would occur even without implementation of this recommended plan. Therefore, the project does not trigger or induce development that would not otherwise occur. The Recommended Plan recommendations are consistent with the requirements of the Executive Order since there is no practicable alternative to improving the levees which are the first line of defense for reducing the risk of flooding in the established urban area. The consistency of these recommendations is further demonstrated by the reduction in the probability of flooding in the study area and the associated societal, economic and environmental hazards posed by flooding. The Recommended Plan would reduce the risk associated with floods thereby minimizing the impacts of floods on human safety, health, and welfare. The Recommended Plan also recommends widening the Sacramento Weir and Bypass which would assist in the restoration and preservation of the natural and beneficial values of the base floodplain.

4.12 ENVIRONMENTAL OPERATING PRINCIPLES

The Recommended Plan supports each of the seven USACE Environmental Operating Principles (EOPs). The re-energized Environmental Operating Principles are:

1. Foster sustainability as a way of life throughout the organization.
2. Proactively consider environmental consequences of all Corps activities and act accordingly.
3. Create mutually supporting economic and environmentally sustainable solutions.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.
5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.
7. Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

The environmental operating principles are met in the following ways:

<u>Environmental balance and sustainability (EOP 1, 2, 3 &4)</u>

- Project avoids or minimizes environmental impacts while maximizing future safety and economic benefits to the community

Planning with the environment (EOP 1, 2, 4, and 5)

- Worked with resource agencies during planning phase to minimize impacts to the environment.
- The recommended plan allows for expanded floodplain flooding in widened bypass area.

Integrate scientific, economic and social knowledge base (EOP 6)

- Sought advice from panel of experts on the status and likelihood of erosion on the American River.

Seeks Public input and Comment (Win-win solutions) (EOP 7)

- Held stakeholder meetings and public workshops throughout the process
- Worked with local groups to achieve a balance of project goals and public concerns

4.13 USACE CAMPAIGN PLAN

The mission of the U.S. Army Corps of Engineers is to provide vital public engineering services in peace and war to strengthen the Nation's security, energize the economy and reduce risks from disasters. In order to meet this mission, the agency has developed the USACE Campaign Plan (FY13-18) as a component of the corporate strategic management process to establish priorities, focus on the transformation initiatives, measure and guide progress and adapt to the needs of the future. The goals and supporting objectives of the Campaign Plan are:

Goal 1 – Support National Security

Objective 1a – Support Combatant Commands and other U.S. government agencies

Objective 1b – Partner with Installation Management Communities

Objective 1c – Achieve National/Army energy security and sustainability goals

Objective 1d – Support the Engineer Regiment

Goal 2 - Transform Civil Works

Objective 2a – Modernize the Civil Works project planning program and process

Objective 2b – Enhance Civil Works budget development with a systems Watershed –Informed approach

Objective 2c – Deliver quality solutions and services

Objective 2d – Deliver reliable, resilient and sustainable infrastructure systems

Goal 3 - Reduce Disaster Risk

Objective 3a – Enhance interagency disaster response and risk reduction capabilities

Objective 3b - Enhance interagency disaster recovery capabilities

Objective 3c - Enhance interagency disaster mitigation capabilities

Objective 3d – Strengthen Domestic Interagency Support

Goal 4 - Prepare for Tomorrow

Objective 4a – Maintain and advance DoD and Army critical enabling technologies

Objective 4b – Build trust and understanding with strategic engagement, communication, and cyber-security

Objective 4c – Streamline USACE business, acquisition and governance processes

Objective 4d – Build ready and resilient people and teams through talent management / leader development

The American River Common Features GRR has been responsive to these goals and objectives by:

Deliver reliable, resilient and sustainable infrastructure systems:

- Designing a project which avoids or minimizes environmental impacts while maximizing future safety and economic benefits to the community
- The Recommended Plan allows for expanded floodplain flooding in the widened bypass area.

Deliver quality solutions and services*:*

- Coordinated with study sponsors and vertical team to identify a path forward on compliance with ETL 1110-2-583, *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*.

Build trust and understanding with strategic engagement, communication, and cyber-security:

- The Feasibility Study team organized and participated in stakeholder meetings and public workshops throughout the process and worked with local groups to achieve a balance of project goals and public concerns.

Build ready and resilient people and teams through talent management / leader development:

- The study successfully employed the use of District Quality Control (DQC), Agency Technical Review (ATR), Risk Analysis, and Independent External Peer Review (IEPR) to assist in the review of the development of a technically sound recommendation of Federal Interest.

4.14 PLAN ECONOMICS AND COST SHARING

The project first cost, estimated on the basis of October 2015 price levels, amounts to $1,565,750,000. Table 4-12 displays each cost by project feature. Estimated average annual costs were based on a 3.125% discount rate, a period of analysis of 50 years, and construction ending in 2030.

Table 4-12: Estimated First Costs of the Recommended Plan[1] ($1,000s).

MCACES Account[2]	Description	Total First Cost[9]
01	Lands and Damages[3]	$95,862
02	Relocations[4]	$158,437
06	Fish and Wildlife	$96,220
08	Roads, Railroads, & Bridges	$25,798
11	Levees and Floodwalls	$465,656
15	Floodway Control & Diversion Structure	$54,401
16	Bank Stabilization	$381,220
18	Cultural Resource Compliance Contingency[5]	$8,237
30	Planning, Engineering, Design[6]	$186,551
31	Construction Management[7]	$93,368
	Total First Cost[8]	$**1,565,750**

Notes:
[1]Based on October 2015 price levels, 3.125% discount rate, and a 50-year period of analysis.
[2]Micro Computer-Aided Cost Engineering System, 2nd Generation (MII) is the software program and associated format used by USACE in developing cost estimates. Costs are divided into various categories identified as "accounts." Total Project Cost Summaries are presented in Appendix C, Attachment D, Cost Engineering.
[3]Real Estate land costs, which include no damages.
[4]Relocations include relocating affected roads, railroads (at cutoff wall and utility crossings) and utilities.
[5]Contingency costs for cultural resource compliance is specifically for data recovery as needed.
[6]16 percent of 02, 11, and 18 accounts.
[7]9 percent of 02, 11, and 18 accounts.
[8] Numbers reported may be slightly different than those presented in the appendices due to rounding.

The estimated total project first cost for the Recommended Plan is $**1,565,750,000** (October 2015 price levels). The Federal portion of the estimated first cost is **$876,478,000** and is based on the cost sharing percentages established by the NED Plan. A summary of the cost sharing responsibilities is presented in Table 4-13 which displays the 65% Federal and 35% non-Federal cost share in accordance with WRDA 1986 as well as the costs attributable to the LPP increment and the resulting cost share.

Table 4-13: Summary of Cost Sharing Responsibilities for the Recommended Plan [1] (in $1,000s).

MCACES Account	Item	Federal[2]	Non-Federal	Total
NED (Alternative 1)				
01	Lands and Damages (LERRDs)[3]	$8,799	$119,160	$127,958
02	Relocations (LERRDs)	$0	$130,062	$130,062
06	Fish and Wildlife	$86,013	$0	$86,013
11	Levees and Floodwalls	$380,836	$0	$380,836
16	Bank Stabilization	$378,242	$0	$378,242
30	Planning, Engineering, Design[4]	$155,611	$0	$155,611
31	Construction Management	$77,033	$0	$77,033
	Subtotal	$1,086,534	$249,222	$1,335,755
	Non-Fed 5% Cash Contribution	-$66,788	$66,788	
	Non-Fed Cash Contribution	-$151,505	$151,505	
	Subtotal (NED Plan Cost Sharing)	$868,241	$467,514	$1,335,755
	Percentage	65%	35%	
18	Cultural Resource Compliance Contingency[5]	$8,237	$0	$8,237
	Total (NED Plan Cost Sharing)	**$876,478**	**$467,514**	**$1,343,992**
Recommended Plan /LPP (Alternative 2)				
01	Lands and Damages (LERRDs)[3]	$8,975	$86,887	$95,862
02	Relocations (LERRDs)	$0	$158,437	$158,437
06	Fish and Wildlife	$96,220	$0	$96,220
08	Roads, Railroads, & Bridges	$25,798	$0	$25,798
11	Levees and Floodwalls	$465,656	$0	$465,656
15	Floodway Control & Diversion Structure	$54,401	$0	$54,401
16	Bank Stabilization	$381,220	$0	$381,220
30	Planning, Engineering, Design[4]	$186,551	$0	$186,551
31	Construction Management	$93,368	$0	$93,368
	Subtotal	$1,312,189	$245,324	$1,557,513
	Non-Fed 5% Cash Contribution	-$77,876	$77,876	
	Non-Fed Cash Contribution	-$221,930	$221,930	
	Non-Fed Cash Contribution for LPP	-$144,142	$144,142	
	Subtotal (NED Plan Cost Sharing)	$868,241	$689,272	$1,557,513
	Percentage	55.7%	44.3%	
18	Cultural Resource Compliance Contingency[5]	$8,237	$0	$8,237
	Total (NED Plan Cost Sharing)	**$876,478**	**$689,272**	**$1,565,750**

Notes: [1] Based on October 2015 price levels, 3.125% discount rate, and a 50-year period of analysis.

[2] Federal Project First Costs are based on 65% of the NED Plan of $1,343,992,000.

[3] Non-Federal interests must provide all LERRDs and a minimum cash contribution of 5% of the total project cost. LERRDs include Lands, Easements, Rights-of-way, Relocations, and Disposal sites.

[4] Planning, Engineering, and Design. Includes supplemental environmental compliance work.

[5] Cultural Resource Compliance Contingency includes data recovery activities, if necessary.

The economic costs and benefits of the recommended plan are shown in Table 4-14.

Table 4-14. Economic Costs and Benefits of the Recommended Plan

Description	Cost (in $1,000s)
Investment Cost	
Recommended Plan First Cost[2]	$1,557,513
Interest During Construction	$309,230
Total Investment Cost	**$1,866,743**
Annual Cost	
Interest and Amortization	$74,283
OMRR&R[3]	$494
Total Annual Costs	$74,777
Annual Benefits	$344,695
Net Annual Benefits	$269,918
Benefit-Cost Ratio	4.6

[1] Based on October 2015 price levels, 3.125 percent discount rate, and a 50-year period of analysis. See Economic Appendix regarding economic uncertainty.
[2] Does not include Cultural Resources Data Recovery
[3] Operation, Maintenance, Repair, Replacement, and Rehabilitation.

4.15 VIEWS OF NON-FEDERAL SPONSORS AND OTHER AGENCIES

The non-Federal sponsors support the Recommended Plan. Throughout development of this GRR, there has been significant coordination with the State of California and SAFCA.

The Recommended Plan is a consistent and fundamental piece of the Lower Sacramento/Delta North Regional Flood Management Plan (RFMP), a non-Federal initiative by the State of California and local agencies that includes a concept for the expansion of the Fremont and Sacramento Weirs and the widening of the Sacramento and Yolo Bypasses. The Recommended Plan provides for Federal involvement in a critical piece of this plan by widening the Sacramento Weir and Bypass.

4.16 FINAL DOCUMENT APPROVAL

The Project Delivery Team (PDT) has responded to the comments on the Draft GRR & EIS/EIR and appendices received during concurrent Public Review, Agency Technical Review (ATR), Independent External Peer Review (IEPR) and HQUSACE Policy Review and revised the documents as appropriate. The Final GRR &EIS/EIR and Appendices were transmitted to the South Pacific Division (SPD) for endorsement and then forwarded to HQUSACE. A Civil Works Review Board (CWRB) was held on 8 December 2015 and the final GRR &EIS/EIR and appendices, along with the proposed Report of the Chief of Engineers were approved for release for State and Agency review. After State and Agency review, comments are incorporated in to the documents as appropriate and a Final Chief's Report will be signed

by the Chief of Engineers. The Chief's Report will then be sent to the chairpersons of the Senate Committee on Environment and Public Works and the House of Representative Committee on Transportation and Infrastructure. The Chief's Report, along with the GRR and the EIS/EIR and appendices, will then be sent to the Assistant Secretary of the Army for Civil Works (ASA(CW)) for review and approval. After approval by the ASA(CW), the documents will be sent to the Office of Management and Budget (OMB) for review.

4.17 POTENTIAL ADDITIONAL STUDIES

As mentioned in Chapter 1, this study would only partially address the American River Watershed authorization and is therefore called an "interim General Reevaluation Report" which indicates that the study is addressing the water resource issues of a specific area within the authority, rather than the entire area authorized for study. This GRR is not intended to be a complete resolution of all issues in the watershed that may require study and future studies may address further issues. Additional studies to address other water resource issues within the American River Watershed could be initiated if funding is appropriated by Congress.

5 - CHANGES TO COMMON FEATURES PROJECT

The chapter integrates the reevaluated Common Features Project with the other previously authorized and constructed portions of the project to describe proposed changes to the authorized Common Features Project. The economics, cost apportionment, fully funded cost estimate and implementation schedule must be determined for the integrated project to establish the changes.

5.1 UNCONSTRUCTED AMERICAN RIVER FEATURES

The Common Features project has installed roughly 23 miles of seepage cutoff wall up to depths of 110 feet, raised levees to provide adequate levee height, addressed slope stability issues, and corrected some erosion problems along the American River. The majority of levee work along the American River as authorized in WRDA 1996 and WRDA 1999 has been completed with the balance being completed in 2015. Work authorized in WRRDA 2014 for the Natomas Basin is just being initiated. Table 5-1 provides an overview of this work by reach.

Table 5-1: Common Features Project Work Sites and Status.

Item	Feature	Authorization, Overview, and Status
1	24 miles of slurry wall in the American River levees	Authorization: WRDA 1996. Overview: Approximately 24 miles of slurry wall for seepage and stability improvements in the levees along the lower American River. Status: approximately 20 miles of seepage cutoff wall, 0.15 miles of jet grout, and 0.20 miles of seepage berm constructed on the American River.
2	12 miles of levee improvements, Sac. River east levee in Natomas.	Authorization: WRDA 1996. Overview: Approximately 12 miles of seepage, stability, and height levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal. Status: completed by SAFCA as part of NLIP.
3	3 telemetry streamflow gages u/s of Folsom Dam	Authorization: WRDA 1996. Overview: Installation of three telemetry stream flow gauges upstream from Folsom Dam and Reservoir. Status: complete.
4	Modification of the existing flood warning system	Authorization: WRDA 1996. Overview: Modifications to the flood warning system along the Lower American River for the City of Sacramento. Status: completed by non-Federal sponsor.
5	Mayhew Levee upstream of the Mayhew Drain	Authorization: WRDA 1999. Overview: Seepage and stability improvements and raising by and average of 2.5 feet the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet and installing a closure structure on the Mayhew Drain to prevent the American River from backing up into the drain. Status: complete.
6	North Levee Raise Upstream of Howe Avenue	Authorization: WRDA 1999. Overview: Raising the right bank of the American River levee in the vicinity of Howe Avenue by an average of 1 foot. Status: complete.

Item	Feature	Authorization, Overview, and Status
7	5 miles of levee improvement, Natomas Cross Canal south levee in Natomas	Authorization: WRDA 1999. Overview: Modifying the south levee of the Natomas Cross Canal for a distance of 5 miles for seepage, stability, and to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River. Status: completed by SAFCA as part of NLIP.
8	5 miles of levee improvement, Natomas Cross Canal north levee across from Natomas	Authorization: WRDA 1999. Overview: Modifying the north levee of the Natomas Cross Canal for a distance of 5 miles for seepage, stability, and to ensure that the height of the levee is equivalent to the height of the south levee. Status: not complete. No sponsor has been identified to cost share this feature.
9	North Levee Strengthening between NEMDC and Business I-80	Authorization: WRDA 1999. Overview: Installing a slurry wall in the north levee of the American River from the east levee of the Natomas east Main Drain upstream for a distance of approximately 1.2 miles. Status: Complete.
10	North Levee upstream of Watt Avenue (Jacobs Lane)	Authorization: WRDA 1999. Overview: Installing a slurry wall in the north levee of the American River in the vicinity of Jacob Lane north for a distance of approximately 1 mile to the upstream end of the existing levee. Status: Complete.
11	Pocket Geotech Reaches 2 and 9, and Pioneer Reservoir	Authorization: 2006 Post-Authorization Change. Overview: Installing a total of 3.6 miles of discontinuous slurry wall at two levee sites on the Sacramento River in the Pocket Area and installing six relief wells and collector drains and appurtenant features and a landside berm on the Sacramento River at the levee toe in the Pioneer Reservoir area. Status: complete.
12	American River adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 2.0 miles of levee in place and install seepage cutoff wall through levee and foundation on the Lower American River. Status: In design.
13	Sacramento River adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 18.3 miles of existing levee by construction of an adjacent levee, install 12.3 miles of deep seepage cutoff walls, and install 8.3 miles of seepage berm, all on east bank of Sacramento River below Natomas Cross Canal. Status: 13 miles of adjacent levee, 9 miles of deep seepage cutoff walls, and 4 miles of seepage berm constructed by SAFCA as part of NLIP. Remaining construction to be completed by USACE, and schedule is under development.
14	Pleasant Grove Creek Canal adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet on the Pleasant Grove Creek Canal. Status: Construction to be completed by USACE, and schedule is under development.
15	NEMDC adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 12.8 miles of existing levee and installation of 10.7 miles of soil bentonite cutoff wall on NEMDC. Status: Lowest 5 miles under design for construction in 2017. Remaining construction to be completed by USACE and schedule is under development.

Item	Feature	Authorization, Overview, and Status
16	NCC adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 5.5 miles of existing levee in-place and install deep seepage cutoff walls on south bank of NCC. Status: Completed by SAFCA as part of NLIP with exception of 3 windows. Windows to be completed by USACE and schedule is under development

5.2 ECONOMIC SUMMARY.

The authorized project first costs, along with total annual costs, annual benefits, net economic benefits, and benefits-to-cost ratios are shown in Table 5-2 below. The estimated first costs, along with total annual costs, annual benefits, net economic benefits and the benefits-to-cost ratios of the total authorized project combined with the recommended plan from this study are shown on Table 5-3 below. These values are based on October 2015 price levels, a discount rate of 3.125% and a 50-year period of economic analysis, assuming initiation of USACE construction in FY 2018.

5.3 COST APPORTIONMENT

Cost apportionment for the existing authorized Common Features project (for WRDA 1996 and WRDA 1999 features, as well as WRRDA 2014 features), the Recommended Plan, and the Total Common Features Recommended Plan (authorized Common Features project plus the Recommended Plan) is shown in accordance with the authorized percentages. These percentages are as follows: WRDA 1996, WRDA 1999, and EWDAA 2004 all cost shared at 75% Federal and 25% non-Federal; WRRDA 2014 cost shared at 65% Federal and 35% non-Federal. The Recommended Plan from this GRR is a Locally Preferred Plan (LPP). USACE has received a policy waiver from the ASA(CW) to recommend this LPP with the stipulation that Federal participation be limited to 65% of the NED plan. Therefore, the cost apportionment of the Recommended Plan would be approximately 56% Federal and 44% non-Federal.

Table 5-2: Economic Analysis of the Authorized Project ($1,000s).

	WRDA 1996/1999 Features				
Construction Item	**Authorized Cost (2004) [1]**	**Reported to Congress (2010) [2]**	**Current Project Cost Estimate (2014) [3]**	**Natomas PAC Authorized Cost (WRRDA 2014) [4]**	**Total Current Estimate Authorized Cost[5]**
Lands and Damages	$5,750	$17,173	$15,668	$235,522	$251,190
Relocations	$460	$381	$381	$118,967	$119,348
Fish & Wildlife Facilities	$1,730	$2,075	$3,952	$18,956	$22,908
Levees & Floodwalls	$153,760	$169,497	$189,075	$396,462	$585,537
Pumping Plants	$0	$0	$0	$56,884	$56,884
Cultural Resource - Data Recovery[6]	$750	$1,190	$0	$6,701	$6,701
Planning Engineering & Design (PED)	$35,380	$71,604	$96,953	$152,609	$249,562
Construction Management	$7,170	$16,060	$14,671	$161,179	$175,850
Subtotal First Cost	**$205,000**	**$277,980**	**$320,700**	**$1,147,280**	**$1,467,980**
Subtotal First Cost less Cultural Resources Data Recovery	**$204,250**	**$276,790**	**$320,700**	**$1,140,579**	**$1,461,279**
Interest During Construction	$0	$17,998	$0	$131,000	$131,000
Total First Cost	**$204,250**	**$294,788**	**$320,700**	**$1,271,579**	**$1,592,279**
Interest and Amortization[7]	$0	$14,615	$0	$52,996	$52,996
OMRR&R	$0	$85	$0	$5,180	$5,180
Total Annual Costs	**$0**	**$14,700**	**$0**	**$58,176**	**$58,176**
Total Annual Benefits	$42,300	$59,500	$59,500	$443,000	$502,500
Net Annual Benefits	**NA**	**$44,800**	**NA**	**$384,824**	**$444,324**
Benefit to Cost Ratio	**NA**	**4.0**	**NA**	**7.6**	**8.6**

[1] Authorized Cost is as reflected in the 2001 Limited Reevaluation Report, and authorized by Congress in 2004 (EWDAA). This is the last authorization by Congress for the WRDA 1996/1999 features. Authorized costs/benefits are in October 2001 prices using a 6.125% discount rate, unless otherwise noted; source of data is the American River Watershed Project (Common Features), CA, Second Addendum to the Supplemental Information Report (SIR); benefits include those pertaining to the Natomas Basin.

[2] The Authorized Cost, adjusted for inflation, and last reported to Congress was in 2010 in the Natomas PACR. Reported to Congress estimate of cost and benefits are in October 2010 prices using a 4.375% discount rate, unless otherwise noted.

[3] The Authorized Cost, adjusted for inflation to 2014 is $320,700,000.

[4] The recommended plan contained in the Natomas GRR was authorized by WRRDA 2014 (Pub.L. No. 113-121). This document assumes the features described in the Natomas PAC are constructed.

[5] Authorized Cost Estimate (totaling $1,147,280,000) plus the current Project Cost Estimate for the WRDA 1996/1999 Authorized Project (totaling $320,700,000) for a total of $1,467,980,000.

[6] Cultural Resources data recovery costs will be removed from the Economic Cost calculations for the final version of this report

[7] Construction of WRDA 1996/1999 features will be complete in fiscal year 2016 and therefore no additional Interest and Amortization is included for this work. It is sunk cost. The Natomas PAC work substantially is work to be completed in the future so this reflects future investment and therefore includes interest and amortization.

Table 5-3: Economic Analysis of the Recommended Plan ($1,000s).

Account		Existing Authorized Common Features Project[1]	Recommended Plan[2,4]	Combined Plans
01	Lands and Damages	$251,190	$95,862	$347,052
02	Relocations	$119,348	$158,437	$277,785
06	Fish and Wildlife Facilities[3]	$22,908	$96,220	$119,128
08	Roads, Railroads, & Bridges	$0	$25,798	$25,798
11	Levees and Floodwalls	$585,537	$465,656	$1,051,193
13	Pumping Plants	$56,884	$0	$56,884
15	Floodway Control & Diversion Structure	$0	$54,401	$54,401
16	Bank Stabilization	$0	$381,220	$381,220
18	Cultural Resources – Data Recovery	$6,701	$8,237	$14,938
30	PED	$249,562	$186,551	$436,113
31	Construction Management	$175,850	$93,368	$269,218
	Subtotal First Cost	**$1,467,980**	**$1,565,750**	**$3,033,730**
	Subtotal First Cost less Cultural Resources Data Recovery	**$1,461,279**	**$1,557,513**	**$3,018,792**
	Interest During Construction	$131,000	$309,230	$440,230
	Total First Cost	**$1,592,279**	**$1,866,743**	**$3,459,022**
	Interest and Amortization	$52,996	$74,283	$127,279
	OMRR&R	$5,180	$494	$5,674
	Total Annual Costs	$58,176	$74,777	$132,953
	Total Annual Benefits	$502,500	$344,695	$847,195
Net Annual Benefits		**$444,324**	$269,918	$714,242
Benefit to Cost Ratio		8.6	4.6	6.4

[1] Authorized Cost is as reflected in the 2001 Limited Reevaluation Report, authorized by Congress in 2004 (EWDAA), and last updated in 2014, along with the Natomas PAC features authorized by Congress in 2014 (WRRDA). These are the last authorizations by Congress on the Common Features project.

[2]Recommended Plan calculated at October 2015 Price levels, 3.125% discount rate and a 50 year period of analysis.

[3]Recommended Plan Fish and Wildlife Facilities includes the habitat mitigation costs displayed in Table 4-3, in addition to construction costs associated with self-mitigating bank protection SRA habitat restoration, other NMFS Biological Opinion requirements such as modeling and fish monitoring, and associated contingency costs.

[4] The total first cost presented here is the project first cost column from the Certified Cost TPCS.

Table 5-4: Cost Apportionment ($1,000s).

Item	Federal Cost	Non-Federal Cost	Total Cost
Existing Authorized Common Features Project (includes WRDA 1996, WRDA 1999, and EWDAA 2004)			
Construction	$193,027	$0	$193,027
LERRD	$2,263	$13,786	$16,049
PED	$96,953	$0	$96,953
Construction Management	$14,671	$0	$14,671
Subtotal	$306,914	$13,786	$320,700
Minimum 5% cash contribution	-$16,035	$16,035	
Additional cash contribution	-$50,354	$50,354	
Subtotal FRM First Cost	$240,525	$80,175	$320,700
Percent of Total FRM	75.0%	25.0%	
Cultural Resources Data Recovery	$0	$0	$0
Total FRM First Cost	$240,525	$80,175	$320,700
Existing Authorized Common Features Project (includes WRRDA 2014)			
Construction	$472,302	$0	$472,302
LERRD	$19,572	$334,917	$354,489
PED	$132,370	$20,239	$152,609
Construction Management	$153,240	$7,939	$161,179
Subtotal	$777,484	$363,095	$1,140,579
Minimum 5% cash contribution	-$57,029	$57,029	
Additional cash contribution	$0	$0	
Subtotal FRM First Cost	$720,455	$420,124	$1,140,579
Percent of Total FRM	63.2%	36.8%	
Cultural Resources Data Recovery	$6,701	$0	$6,701
Total FRM First Cost	$727,156	$420,124	$1,147,280
GRR Recommended Plan[1]			
Construction	$1,023,295	$0	$1,023,295
LERRD	$8,975	$245,324	$254,299
PED	$186,551	$0	$186,551
Construction Management	$93,368	$0	$93,368
Subtotal	$1,312,189	$245,324	$1,557,513
Minimum 5% cash contribution	-$77,876	$77,876	
Additional cash contribution	-$366,072	$366,072	
Subtotal FRM First Cost	$868,241	$689,272	$1,557,513
Percent of Total FRM	55.7%	44.3%	
Cultural Resources Data Recovery	$8,237	$0	$8,237
Total FRM First Cost	$876,478	$689,272	$1,565,750
Combined Common Features Projects[2]			
Construction	$1,688,624	$0	$1,688,624
LERRD	$30,810	$594,027	$624,837
PED	$415,874	$20,239	$436,113
Construction Management	$261,279	$7,939	$269,218
Subtotal	$2,396,587	$622,205	$3,018,792
Minimum 5% cash contribution	-$150,940	$150,940	
Additional cash contribution	-$416,426	$416,426	
Subtotal FRM First Cost	$1,829,221	$1,189,571	$3,018,792
Percent of Total FRM	60.6%	39.4%	
Cultural Resources Data Recovery	$14,938	$0	$14,938
Total FRM First Cost	$1,844,159	$1,189,571	$3,033,730

[1]October 2015 Price Levels

[2]Costs shown for informational purposes only and not for establishing Section 902 limit.

5.4 FULLY FUNDED COST ESTIMATE

The required funding by fiscal year has been determined for the project. Table 5-5 shows the estimated project funding requirements by fiscal year for the recommended plan. This estimate of funding includes price escalation using Office of Management and Budget inflation factors.

Table 5-5: Funding by Fiscal Year ($1,000s).

	Fiscal Year									
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Federal										
Preconstruction Engineering and Design	$33,696	$33,696	$19,980	$35,818	$29,814	$25,421	$24,046	$17,062	$13,645	$817
Construction Management	$0	$4,928	$8,622	$14,421	$16,802	$19,069	$24,479	$12,075	$14,579	$10,766
Construction	$0	$43,387	$76,259	$126,698	$142,796	$164,099	$209,269	$101,399	$117,698	$87,784
Fish and Wildlife Facilities	$0	$6,349	$9,545	$13,937	$17,489	$16,410	$19,782	$10,185	$11,098	$6,964
Cultural Resources	$0	$398	$766	$766	$976	$1,113	$1,634	$1,120	$1,428	$1,059
Federal LERRD	$987	$987	$934	$1,884	$1,364	$1,266	$895	$902	$541	$326
Total Federal	$34,683	$89,745	$116,106	$193,524	$209,241	$227,378	$280,105	$142,743	$158,989	$107,716
Non-Federal Up Front Cash	$9,952	$32,748	$43,535	$70,547	$78,731	$88,082	$100,303	$39,843	$34,237	$20,702
Net Federal	$24,731	$56,997	$72,571	$122,977	$130,510	$139,296	$179,802	$102,900	$124,752	$87,014
Non-Federal										
Relocations	$0	$2,312	$5,080	$12,939	$16,209	$14,277	$34,939	$24,233	$48,258	$34,110
Non-Federal LERRD	$9,291	$9,291	$7,853	$12,204	$6,612	$6,029	$4,664	$15,992	$14,576	$12,894
Total Non-Federal	$9,291	$11,603	$12,933	$25,143	$22,821	$20,306	$39,603	$40,225	$62,834	$47,004
Non-Federal Up Front Cash	$9,952	$32,748	$43,535	$70,547	$78,731	$88,082	$100,303	$39,843	$34,237	$20,702
Total Non-Federal	$19,243	$44,351	$56,468	$95,690	$101,552	$108,388	$139,906	$80,068	$97,071	$67,706
Total Project	$43,974	$101,348	$129,039	$218,667	$232,062	$247,684	$319,708	$182,968	$221,823	$154,720

5.5 INSTITUTIONAL REQUIREMENTS

The schedule for project implementation assumes reauthorization of the Common Features Project in the proposed WRRDA 2016. After reauthorization, the project would be eligible for additional construction funding. The project would be considered for inclusion in the President's budget based: on national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal sponsors to fund its share of the project cost and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, the USACE and the non-Federal sponsors would enter into a project partnership agreement (PPA). This agreement would define the Federal and non-Federal responsibilities for implementing, operating and maintaining the project.

USACE would officially request the non-Federal partners to acquire the necessary real estate immediately after the signing of the project partnership agreement. The advertisement of the first construction contract by USACE would follow the certification of the real estate. The District Engineer would notify the non-Federal sponsors when the project is complete. The non-Federal sponsors would become responsible for the project following the delivery of the O&M manual and as-built drawings. The estimated schedule for project implementation is shown in the following table:

Table 5-6: Implementation Schedule.

Item	Completion Date
Plans and Specifications for First Contract Complete	2018
PPA Signed	2018
Real Estate Acquisitions Completed for First Contract	2019
Advertise First Construction Contract	2019
Completion of All Construction	2028

6 - PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

6.1 PUBLIC INVOLVEMENT PROGRAM

6.1.1 Public Scoping

To announce the start of the Common Features General Reevaluation Study, a notice of intent (NOI) to prepare the American River Common Features General Reevaluation Report (GRR) Environmental Impact Statement (EIS) was posted in the Federal Register (Vol. 73, No. 41) on February 29, 2008. The recipients were invited to comment on the results of the earlier completed reconnaissance study and to provide input to the feasibility study, including the scoping of the environmental issues that should be addressed throughout the study. The notice in 2008 announced a group of public workshops, where the public was given the opportunity to comment. The meeting locations, dates, and times were as follows:

- March 5, Scottish Rite Center—6 151 H Street, Sacramento (5-7 p.m.).
- March 10, Library Galleria—828 I Street, Sacramento (3-6 p.m.).
- March 12, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5-7 p.m.).
- March 13, Sierra Health Foundation— 1321 Garden Highway, Sacramento (5-7 p.m.).

There is no mandated time limit to receive written comments in response to the NOI under NEPA. Appendix F of the EIS/EIR contains the NOI, Notice of Preparation (NOP), the one comment letter received in 2008 (which is also summarized in Table 6.1), and copies of the posters for the March 2008 scoping meetings.

Table 6.1. Written Comments Received on the NOI.

Commenter	Date
California Department of Transportation	April 1, 2008
• Requests clarification as to which portions of the project will use trucks to haul materials and which will use waterside barges for hauling materials. • Requests a Traffic Management Plan including necessary mitigation, haul routes, dates of operation, and truck trip volumes be prepared in order for review. • Notes that an encroachment permit will be required if electronic warning signs will be used within State right-of-way at work sites to warn public of trucks entering or leaving state highways. • Expresses concern about piezometer locations and wells near the subgrade section of I-5 (the Boat Section) and requests these sites be identified and not be disturbed during levee improvement. • Requests maps describing the project "activity areas" and clarification of the scope of the project and potential impacted highway and bridge structure areas. • Requests identification and notification of any work near State right-of-way.	

USACE responded to CalTrans' scoping comments as follows:

- The Corps considered the use of waterside barges to construct the bank protection sites on the Sacramento River in order to reduce damages to roadways associated with the hauling of rock.
- Maps of the study area were provided to CalTrans through the submittal of the draft EIS/EIR to public review, as discussed in Section 6.1.2 below.
- A Traffic Management Plan and all appropriate permits would be prepared and coordinated during the project's design phase and would be in place, as appropriate, prior to the start of construction.

6.1.2 Public Review of the Draft Report

The draft GRR and EIS/EIR were circulated for public review beginning on March 13, 2015. The notice of availability (NOA) was published in the Federal Register on March 13, 2015. The draft GRR and EIS/EIR were made available both on the Sacramento District, Corps of Engineers website as well as the website for the CVFPB. Hard copies of the draft GRR and EIS/EIR were provided to area libraries. Letters and/or DVD copies of the GRR and EIS/EIR were sent to interested parties, local residents, and to the agencies and elected officials listed in Section 6.4 of the EIS/EIR. Public workshops were held during the review period to provide additional opportunities for comments on the draft documents. All comments received during the public review period were considered and incorporated into the final GRR and EIS/EIR as appropriate. The meeting locations, dates and times were as follows:

- April 8, Hagginwood Community Center—3270 Marysville Blvd, Sacramento (5-7 p.m.).
- April 9, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5-7 p.m.).

- April 15, Library Galleria—828 I Street, Sacramento (3-5 p.m.).
- April 17, Arden-Dimick Library— 891 Watt Ave., Sacramento (5-7 p.m.).

6.2 PUBLIC FEEDBACK

There were 46 people who attended the four scoping meetings in 2008. A total of 137 people attended the four meetings during the review period of the draft report in April 2015. Comments were solicited at the meetings and documented through the use of court reporters. Additionally, comments could be submitted through mail or electronic mail. Oral and written comments were made throughout the series of meetings by local, State, and Federal agencies, community organizations, and individuals. The comments and associated responses are included in the Public Involvement Appendix of the EIS/EIR (Appendix F).

6.3 OTHER PUBLIC INVOLVEMENT

To help the community stay informed about current project activities, information is provided in a variety of ways:

- Representatives of the Sacramento District attend and report on the status of the GRR at the American River Task Force meetings which occur quarterly and are open to the public;
- GRR updates are provided at the monthly SAFCA Board of Directors meetings, which typically occur on the third Thursday of each month. These meetings are held at the Sacramento County Board of Supervisors Chambers at 700 H Street, Sacramento, California, 95814, begin at 3 p.m., and are open to the public.
- The Sacramento District briefs the CVFPP on the status of the GRR upon request. The CVFPP meets monthly on the last Friday of the month beginning at 9 a.m. at various locations including the Sacramento City Hall, 915 I Street, Sacramento, California, 95814, and are open to the public. Archived video footage of previous meetings is located at the following link: http://www.cvfpb.ca.gov/meetings/2013/videos/index.cfm
- Quarterly coordination meetings are held with the United Auburn Indian Community of the Auburn Rancheria and the Shingle Springs Band of Miwok Indians.

6.4 INSTITUTIONAL INVOLVEMENT

6.4.1 Study Team

During the preparation of the GRR, staff from the State of California and SAFCA participated along with the Corps as members of the study team. They participated directly in the study effort and on the Executive Committee.

6.4.2 Agency Participation

The Corps has coordinated with USFWS throughout the planning phase of the study to help analyze potential effects to endangered species and biological resources under the Fish and Wildlife Coordination Act. The CAR is included as Appendix A of this document. A biological assessment was prepared and transmitted to USFWS and NMFS on April 3, 2015 (Appendix G). Consultation pursuant to Section 7 of the Endangered Species Act (ESA) has been on-going as part of the ARCF GRR study phase. The Biological Opinion from NMFS was received on September 9, 2015. The Biological Opinion from USFWS was received on September 11, 2015. With receipt of these opinions from the services, and implementation of the enclosed reasonable and prudent measures and terms and conditions, the ARCF GRR is in full compliance with the Federal ESA. In addition, the Corps coordinated with NMFS under the Magnuson-Stevens Fishery and Conservation Act to address impacts to Essential Fish Habitat. The final Biological Opinions from both agencies are included with this document as Appendix J.

6.5 PUBLIC VIEWS AND RESPONSES

Public comments on the draft documents focused in part on: 1) access to recreational features during and after construction; 2) design, placement and justification for rock erosion protection along the American and Sacramento Rivers; 3) effects to vegetation as a result of the recommendations; 4) clear presentation of the anticipated level of the performance of the project; and 5) coordination with stakeholders in future phases of the project. The public comments and USACE responses to those comments are included in the Public Involvement Appendix of the EIS.

6.6 IMPACT ON RECOMMENDATIONS

Comments on the draft documents received from reviewers and the public were incorporated in to the final documents as appropriate. Many of the comments requested greater clarity and the documents were modified in response to these requests. The comments did not result in a recommendation of a different plan.

7 - RECOMMENDATIONS

I recommend modifying the authorized American River Common Features project to include the following: the construction of levee improvement measures to address seepage, stability, erosion and overtopping concerns identified for the Sacramento River, Natomas East Main Drainage Canal (NEMDC), Arcade Creek, and Magpie Creek as well as erosion measures for specific locations along the American River, and widening of the Sacramento Weir and Bypass to divert more flood flows into the Yolo Bypass. The estimated first cost of these recommended improvements is $1,565,750,000. The NED cost component of the LPP recommended in this Report will be cost shared in accordance with Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. § 2213), with a minimum non-Federal share of 35 percent, not to exceed 50 percent, of total NED costs. The non-Federal share will also include 100 percent of the LPP increment above the NED costs. Applying these requirements, the Federal portion of the estimated total first cost is $876,478,000 and the non-Federal portion is $689,272,000, or a Federal share of 56 percent and a non-Federal share of 44 percent. Federal implementation of the LPP would be subject to the non-Federal Sponsors agreeing to comply with applicable Federal laws and policies, including but not limited to the following:

a. Provide a minimum of 35 percent, but not to exceed 50 percent, of total NED costs as further specified below:
    1. Provide 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
    2. Provide, during construction, a contribution of funds equal to 5 percent of total project costs which must be in the form of cash;
    3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;
    4. Provide, during construction, any additional funds necessary to make its total contribution equal to at least 35 percent of total project costs;
b. Provide 100 percent of the LPP increment above total NED costs.
c. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;
d. Not less than once each year, inform affected interests of the extent of protection afforded by

the project;

e. Agree to participate in and comply with applicable Federal flood plain management and flood insurance programs;

f. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. §§ 701b-12), which requires a non-Federal interest to prepare a flood plain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the project;

g. Publicize flood plain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

h. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

i. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. §§ 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

k. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsors own or control for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

l. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

m. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the

extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 C.F.R. § 33.20;

n. Comply with all applicable federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; the Age Discrimination Act of 1975 (42 U.S.C. 6102); the Rehabilitation Act of 1973, as amended (29 U.S.C. 794) and Army Regulation 6007 issued pursuant thereto; and 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (labor standards originally enacted as the Davis-Bacon Act, the Contract Work Hours and Safety Standards Act, and the Copeland Anti-Kickback Act);"

o. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. §§ 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsors with prior specific written direction, in which case the non-Federal sponsors shall perform such investigations in accordance with such written direction;

p. Assume, as between the Federal Government and the non-Federal sponsors, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

q. Agree, as between the Federal Government and the non-Federal sponsors, that the non-Federal sponsors shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

r. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. §§ 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. § 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsors, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

15 DEC 2015

Date

Michael Farrell
Colonel, U.S. Army
District Engineer

8 - REFERENCES

The following list of references is pertinent to the documentation preceding this chapter. Many of the references are actually cited throughout the documentation. However, some references are not cited. They are included in this list of references because they give an overall background and context to this study.

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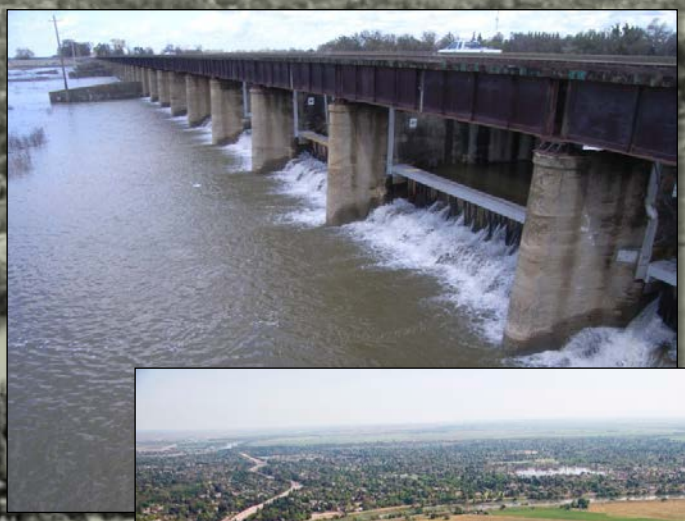
American River Watershed

Common Features
General Reevaluation Report



Appendix A
Plan Formulation

October 2015

Sacramento Area Flood Control Agency

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:

Sacramento Weir during operation

Sacramento River facing south near the Pocket and Little Pocket neighborhoods

High flows on the American River at the Highway 160 overcrossing

Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Appendix A

Plan Formulation

U.S. Army Corps of Engineers
Sacramento District

October 2015

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AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

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Attachment 1:
American River Common Features
and West Sacramento General Reevaluation Reports Bridging Document

1.0 BACKGROUND

Document Purpose

The purpose of this document is to demonstrate that formulation and identification of the National Economic Development (NED) plans for the American River Common Features (ARCF) and West Sacramento (WS) projects is not affected by investigating the two areas separately. The U.S. Army Corps of Engineers (USACE) is completing General Reevaluation Reports (GRRs) for the ARCF and WS projects. This bridging document accompanies each GRR to explain how the two projects function both independently and together by summarizing the following:

- Existing flood risk management system in the greater Sacramento area
- Flood history of the greater Sacramento urban area
- Future without project conditions for the study area
- Potential system-wide flood risk management alternatives considered
- NED Plan for the ARCF GRR
- NED Plan for the WS GRR
- Effects of Re-evaluating ARCF and WS Projects Separately
- Conclusions

Existing Flood Risk Management System in the Greater Sacramento Area

The city of Sacramento sits along the east bank of the Sacramento River at the confluence with the American River. Immediately across the Sacramento River lies the city of West Sacramento. The cities of Sacramento and West Sacramento are collectively referred to as the greater Sacramento urban area.

Sacramento sits within three distinct basins each protected by a system of levees. The American River South (ARS) basin is protected by 25 miles of levee including the south levee of the American River and the east levee of the Sacramento River. The American River North (ARN) basin is protected by 25 miles of levee including the north levee of the American River, the east levee of the Natomas East Main Drainage Canal (NEMDC), the north and south levee of Arcade Creek, the north and south levee of Dry/Robla Creeks, and the west levee of the Magpie Creek Diversion Channel. The Natomas (NAT) basin is not included in the ARCF GRR.

West Sacramento sits within one distinct basin protected by a system of levees. This basin is split in two by a navigation project. This basin is protected by 50 miles of levee including the west levee of the Sacramento River, the south levee of the Sacramento Bypass, the east levee of the Yolo Bypass, and a canal embankment levee on the south. Refer to Plate 1 for a map of the greater Sacramento urban area.

The Sacramento River comes from the far north portion of California and passes between the cities of Sacramento and West Sacramento. Upstream of the greater Sacramento urban area, major tributaries to the Sacramento River includes the Feather River, the Colusa Basin Drain, and Butte Creek. Within the urban study area, the major tributary is the American River. Up until the flood of 1909, engineers attempted to keep all flow within the Sacramento River. The 1909 flood, along with other floods previously, caused levee failures. After the 1909 flood, the State of California and the Federal government decided to build a bypass system. Over the next 20 years, the bypass system was constructed.

The Sacramento River's bypass system starts approximately 100 miles above the Natomas basin where flow spills out of the Sacramento River to the east upstream of the project levees and into the Butte Basin. Flow in the Butte Basin feeds into the Sutter Bypass. The Sutter Bypass then flows into and across the Sacramento River and is then called the Yolo Bypass. The Fremont Weir sits at the very upper limit of the Yolo Bypass and controls when flow starts to spill into the Yolo Bypass. Continuing downstream, the Yolo Bypass passes just to the west of the city of West Sacramento.

Further down the Sacramento River in the city of Sacramento, the American River comes into the Sacramento River from the east. The Sacramento Weir and Bypass is located approximately three miles upstream of the American River. The primary purpose of the Sacramento Weir and Bypass is to take high flows from the American River over to the Yolo Bypass.

Below the greater Sacramento urban area, the Yolo Bypass and the Sacramento River come back together near the town of Rio Vista. Combined flow then continues out to San Francisco Bay and the Pacific Ocean. Refer to Plate 2 for a map of the Sacramento River Flood Control System.

History of Flooding in the Greater Sacramento Area

The city of Sacramento last flooded in 1909. Folsom Dam and the north levee of the American River, as well as the rest of the Sacramento River Flood Control Project, were all completed by the mid-1950s. 1955 marked a flood of record in the Sacramento Valley. 1964 was also a somewhat significant flood event on the American River. 1986 was a significant flood event that replaced the flood of record. And 1997 was a flood event that was almost as significant as the 1986 event. The 1955, 1964, 1986, and 1997 flood events caused much distress to the levees protecting the greater Sacramento urban area. The main causes of distress included seepage, stability, and erosion. Figure 1 below shows seepage and stability distress on the Sacramento River during the 1986 event that required flood fighting to prevent a full levee breach. Figure 2 below shows erosion distress on the American River that occurred during the 1986 event but was not known about until after flow receded.

For the 1986 flood event, potential levee overtopping became a significant threat on the American River because of Folsom Dam releases having to be ramped up above the objective release of 115,000 cfs and up to 134,000 cfs, which caused flow to be within one foot of the top of levee in certain locations along the American River. Some of these deficiencies have been addressed by seepage and stability improvements authorized in WRDA 1996, WRDA 1999, EWDAA 2004, and WRRDA 2014 for the city of Sacramento as part of the ARCF project, seepage and stability improvements authorized in WRDA 1992 for the city of West Sacramento as part of the WS project, and storage and release improvements

for Folsom Dam authorized in WRDA 1999 and EWDAA 2004. Many deficiencies remain which are the subject of the ARCF and WS GRRs.

Figure 1. Seepage and stability distress in Natomas during the 1986 flood event

Figure 2. Erosion distress on the American River after the 1986 flood event

2.0 FUTURE WITHOUT PROJECT CONDITIONS2.1 Legacy of Historic Levee Construction Techniques

The Sacramento River Flood Control Project, including the portion within the greater Sacramento urban area, was constructed using either a clamshell dredge or a suction dredge retrieving material from the adjacent river and piling it up along the levee alignment. Figures 3 and 4 show typical levee construction by both clamshell dredge and suction dredge methodology.

Figure 3. Typical clamshell dredge levee construction on the Sacramento River system

Figure 4. Typical suction dredge levee construction on the Sacramento River system

The material dredged from the adjacent river was predominately sand with very little silt that tends to be non-cohesive. Additionally, the land on which the levees were constructed tended to be materials similar to the material dredged from the adjacent river. These materials are very poor for levee safety. Water is able to freely move through and under the levee causing severe seepage

problems. Water seeping through the levee tends to carry levee material with it, weakening the levee. Additionally, in much of the study area, the levees have narrower crown widths and steeper side slopes than current engineering standards. In some locations, the waterside slope is steeper than 2 to 1 and the landside slope approaches 1 to 1, which coupled with the nature of the levee fill material, causes a significant stability issue as well.

In addition to the inherent seepage and stability issues of the levees and levee foundations, the potential for an erosion induced levee failure is significant. In many cases, the levees were built somewhat set back from the main channel of the adjacent river. Over the course of about a hundred years, much of the waterside berm left during initial construction has eroded away. This occurred because flow was confined between the levees to much higher stages and velocities than would have occurred prior to the levee construction. In some locations, 100 feet of berm has eroded away making it necessary to armor the waterside levee slope to stop additional erosion into the levee foundation and undermining of the levee. The Sacramento River Bank Protection Project constructs rock riprap bank protection at damaged sites. The problem with this approach is it reacts to erosion after it happens. Erosion has led to partial levee failures at very frequent events.

2.2 Legacy of Historic Levee System Configuration

Reclamation of the Sacramento Valley began around 1850. Up until the flood of 1909, all reclamation activities focused on forcing all flow to be confined to the main rivers. This was a trial and error period with frequent levee failures, including failures in the 1909 event. After this event, the State of California and the Federal Government decided on the need for the bypass system. The State approved the bypass system and the overall Sacramento River Flood Control Project in 1911 and the Federal Government authorized it in 1917. The bypass system and overflow weirs were then constructed over the next 15 years.

The flood of 1909 and a flood that occurred in 1907 were the only significant flood events for which detailed streamflow gage data is available. Initial design of the State and Federally authorized flood control system was developed around the floods of 1907 and 1909. In 1927, a new flood of record occurred for a portion of the Sacramento River system. The larger magnitude flow on these reaches was incorporated into the overall design of the entire flood control system. The entire Sacramento River Flood Control Project was completed in the mid 1950s.

In 1955, a new flood of record occurred for the entire Sacramento River system. This flood event caused a levee failure that inundated Yuba City, as well as a few other levee failures into relatively rural areas. Another flood event occurred in 1964 that was more substantial than every other event that occurred prior to the 1955 event. In 1986, again a new flood of record occurred for the entire Sacramento River system. This flood event caused a levee failure that flooded smaller communities around the City of Marysville, as well as a few other levee failures into relatively rural areas. In 1997, a flood event occurred that was nearly as significant as the 1986 event. This flood event caused a levee failure that nearly flooded the small community of Meridian, as well as a few other levee failures into relatively rural areas.

With the increasing size and frequency of storms since the mid 1950s, the levee system has been stressed by conveying more flow than it was intended to convey. This has partially been mitigated by the construction of various reservoirs around the Sacramento Valley. However, there are numerous

unregulated tributaries that contribute flow to the Sacramento River system. Therefore, the effect the reservoirs have on attenuation of flow in the Sacramento River system is minimal.

2.3 Prior Decisions on Folsom Dam

The 1986 flood event nearly caused the inundation of the cities of Sacramento and West Sacramento. After this event, the Corps was directed to complete a feasibility study to identify Federal interest in flood risk reduction measures. For American River, studies were completed in 1991 and 1996, with each identifying a new dam to be constructed on the north fork of the American River near the town of Auburn, plus levee improvements in the greater Sacramento area, as the NED plan. For various reasons, Congress chose not to authorize Auburn Dam and instead authorized modifications to Folsom Dam.

The Folsom Dam Modifications and Raise Projects are intended to control a 200-year flood event with a peak release of 160,000 cfs. The current objective release from Folsom Dam is 115,000 cfs. The original intent was to modify the existing Folsom Dam to be able to accomplish this higher objective release, however, due to technical complexities, it was decided to build an auxiliary spillway and control structure to accomplish this. This project is also combined with a USBR dam safety project and is therefore referred to as the Folsom Dam Joint Federal Project (JFP).

Prior authorizations in WRDA 1996, WRDA 1999, and EWDAA 2004 for the ARCF project were intended to improve the conveyance capacity of the levee system in the greater Sacramento area to safely convey the new release of 160,000 cfs. The 1997 flood event along with subsequent investigation combined with Hurricane Katrina, the inundation of New Orleans, and subsequent investigation have all illustrated that much more work needs to occur to the levee system protecting the greater Sacramento urban area.

2.4 General Problem Identification for the Greater Sacramento Urban Area

There are four main problems with the levee system for the greater Sacramento urban area: seepage, stability, erosion, and height. In general, three of these problems are a result of levee construction techniques (seepage, stability, and erosion). The other problem (height) is a result of the design conveyance capacity of the overall Sacramento River system based primarily on the 1907, 1909, and 1927 flood events.

Levee Construction Technique Problems

Seepage: Water traveling through and/or under a levee carries soil particles with it, greatly weakening the entire structure. If this condition is not corrected, it will likely lead to a levee failure. Even with flood fighting efforts, this condition occasionally leads to a levee failure. Figure 5 below shows a general seepage condition on the Sacramento River system.

Stability: Because the levees are built out of relatively non-cohesive materials (sand), and are in general built to a poor geometry, stability problems cause much distress in flood conditions. Like seepage, if this condition is not corrected, it will likely lead to a levee failure. Figure 6 below shows sloughing of a levee as a result of stability problems.

Figure 5. General seepage condition on the Sacramento River system

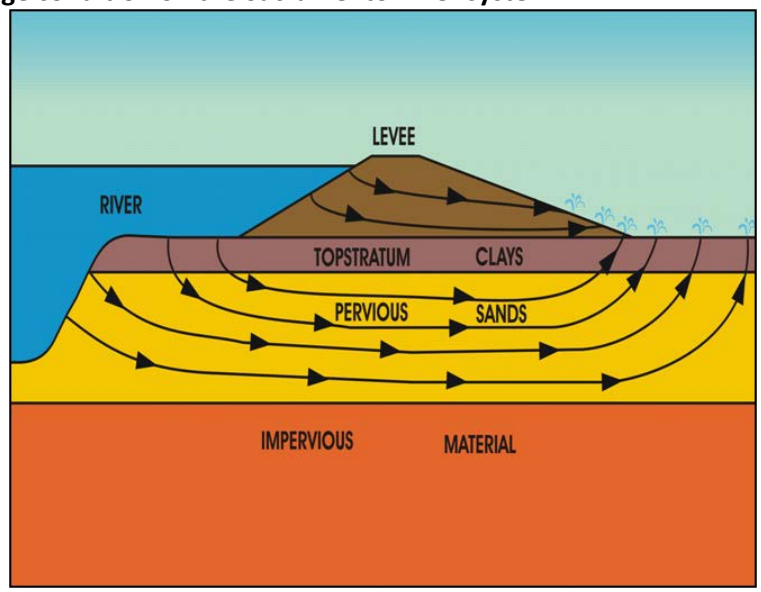


Figure 6. Sloughing of levee slope as a result of stability problem

Erosion: Because the levees are built out of relatively non-cohesive materials (sand), and are subjected to very severe (12 feet per second) river currents in some cases, erosion of the berm and levee slope is an ongoing concern. When erosion is occurring during a flood event, it is not evident and does not become evident until a full levee failure is in progress. Figure 7 below shows erosion on the Sacramento River at a site in the city of Sacramento.

Levee System Configuration Problem

The Sacramento River and Yolo Bypass combined were designed to convey 469,000 cfs, based primarily on the floods of 1907, 1909, and 1927. In 1986, that flow was exceeded by over 100,000 cfs. The American River was designed to convey 115,000 cfs. This amount was based on the hydrology used to design Folsom Dam and the north levee of the American River in the late 1940s. In 1986, there was

nearly 20,000 cfs more than that amount in the American River. The 1986 flood event was approximately an 80-year event.

The 1986 and 1997 flood events each stressed the levee system for the greater Sacramento urban area beyond what it was intended to convey. With the urbanization of the greater Sacramento urban area, the design conveyance capacity past the cities is insufficient to minimize the risk of catastrophic flood damages.

Figure 7. Erosion of the levee slope on the Sacramento River.

2.5 General Probability of Levee Failures into the Cities of Sacramento and West Sacramento

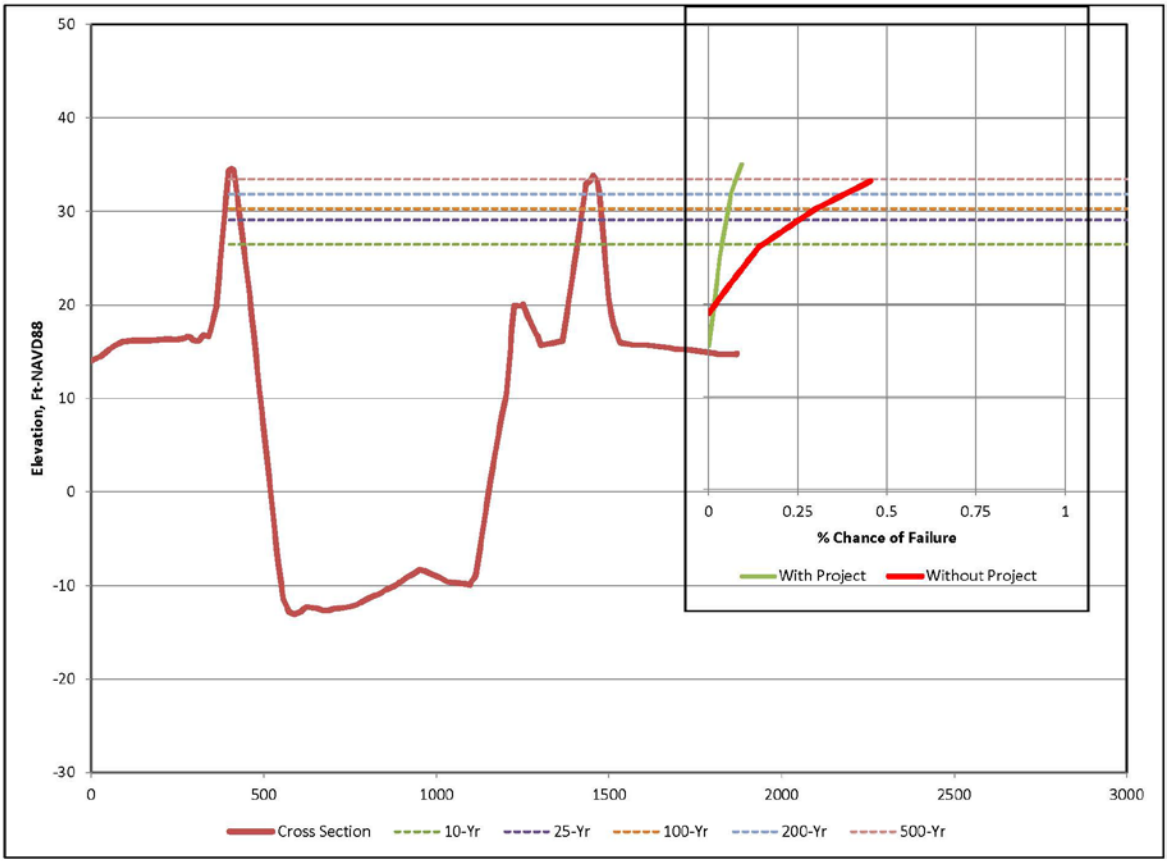
The GRRs for both ARCF and WS have been developed using consistent methodology and tools. For hydrology, both studies are using the updated Sacramento/San Joaquin Rivers Comprehensive Study hydrology. For hydraulics, both studies are using a HEC-RAS model of the entire Sacramento River Flood Control Project. For geotechnical, both studies are using accepted seepage and stability model software with inputs based on site specific geotechnical explorations. For risk analysis and economics, both studies are using the HEC-FDA software. For cultural resources, environmental, real estate, and civil design, methodologies are the same between the two studies.

The analysis for both studies has calculated water surface elevations for various frequency events along all levees adjacent to the greater Sacramento urban area. The analysis for both studies has also developed levee performance curves for typical reaches within each city.

Figure 8 below shows a cross section of the Sacramento River in the Pocket Area of Sacramento, along with the levee performance curve for that location. In the cross section, Sacramento is to the left side of the left levee and channel and West Sacramento is to the right side of the right levee and channel. Also shown on the cross section is the calculated water surface elevation for a 10-, 25-, 100-,

200-, and 500-year event. Elevations on the levee performance curve are at the same level as the cross section so that the water surface elevations in the channel can be compared to the levee performance curve.

Figure 8. Cross Section of the Sacramento River in the Pocket Area Along With the Levee Performance Curve for that Location



Based on this graphic, it can be seen that the 10-year water surface elevation has approximately a 15% chance of causing a levee failure into Sacramento. For the 25-, 100-, 200-, and 500-year events, the chances of have a levee failure into the city is 25%, 30%, 40%, and 45% respectively.

The without project condition levee performance curve is a composite curve that includes a component for through and under seepage, stability, and judgment. At this particular location, through seepage is not a concern because a shallow seepage cutoff wall was constructed there in the early 1990s. Additionally, stability in general is not a concern because of the presence of this same wall. Therefore, the drivers for the levee performance curve at this particular location are underseepage and judgment. Between the two, approximately 60% of the risk is driven by judgment and 40% is driven by underseepage. Judgment is a composite curve representing risk from vegetation, encroachments, rodent activity, access, and erosion. The risk from each of these components is significant but the single largest driver of the judgment curve is erosion.

The levee performance curve shown above is for the Sacramento side of the Sacramento River. The levee performance curve for the West Sacramento side of the river is very similar. Therefore, relative risk of levee failure is similar for West Sacramento as it is for Sacramento.

3.0 SYSTEM-WIDE IMPROVEMENT ALTERNATIVES

System-wide flood risk management alternatives for the Sacramento River were evaluated to determine if they would provide a cost-efficient solution without levee improvements for individual basins in the greater Sacramento urban area. Following is a brief description of each of the system-wide alternatives considered, the flood risk reduction effects of each alternative, and the reason each alternative was excluded from further consideration.

American River Upstream Storage

Studies completed in 1991 and 1996 identified Auburn Dam as the NED Plan to address flooding on the American River. Auburn Dam would be able to control a much larger flood event than Folsom Dam alone and would provide a higher level of flood risk reduction to the greater Sacramento urban area.

For Auburn Dam to be effective, the combined objective release from Auburn and Folsom Dams would need to be maintained at 115,000 cfs to leave storage available for the flood peak in each reservoir. With an objective release of 115,000 cfs, almost all of the levee improvements included in the NED Plans for both the ARCF and WS GRRs would still be necessary because the existing levee system is unreliable even at relatively low flow stages above the levee toe.

Specific levee improvements that would be required in conjunction with Auburn Dam include all seepage and stability improvements, all of the levee raising, probably the Sacramento Weir and Bypass widening, and almost all of the erosion protection improvements included in the ARCF and WS TSPs. Additionally, levee raising along the Sacramento River and Yolo Bypass would be required to protect against upstream Sacramento River driven floods of similar magnitude as Auburn Dam would be designed to control (approximately 400-year level of performance as identified in the 1996 report). This levee raising, possibly coupled with widening the Sacramento Weir and Bypass would be beyond the level needed for the two NED Plans because it would need to convey a 400-year flood event from the Sacramento River as opposed to an approximately 200-year event, which is the level of the NED Plans.

This alternative was excluded from further consideration in the GRRs because it would require almost all (if not all) of the features of both NED Plans. The levee improvements in the greater Sacramento urban area and the conveyance improvements of widening the Sacramento Weir and Bypass are required components of a comprehensive flood risk reduction alternative involving upstream storage on the American River and are therefore “no regrets” features. The currently proposed levee and conveyance improvements would be necessary and would provide benefits whether or not additional upstream storage is constructed in the American River watershed.

Transitory Storage In Rural Basins Upstream of the Greater Sacramento Urban Area

A possible way to improve flood risk for the greater Sacramento urban area is to temporarily store flood volume in some of the rural area adjacent to the Sacramento River, the Feather River, the Yolo Bypass, and/or the Sutter Bypass.

This temporary or transitory storage has the effect of reducing water surface elevations at the northwest corner of Natomas for various frequency events by between 2 and 3 feet. Further down the Sacramento River and Yolo Bypass, this decrease in stage reduces to zero, essentially giving no benefit to most of the greater Sacramento urban area. There are two primary reasons why this is the case. First, there is a tremendous volume of water coming down the Sacramento Valley towards the greater Sacramento urban area and when a basin is used for temporary storage, the volume of water taken out of conveyance in the river channels and put into storage is relatively small and insignificant. Second, the contribution of the Folsom Dam flood releases being conveyed down the American River eliminates any small decrease in stages that might have been experienced by transitory storage.

Therefore, with transitory storage, all of the levee improvements included in both NED Plans for ARCF and WS are still necessary, with transitory storage not providing nearly enough economic benefit to justify the very large cost. Therefore, transitory storage was excluded from further consideration.

Yolo Bypass Widening and Conveyance Capacity Improvements

Another possible way to reduce flood risk for the greater Sacramento urban area is to improve the amount of conveyance and the reliability of conveyance of the Yolo Bypass. This alternative would likely include widening the Yolo Bypass by setting back the east levee from Fremont Weir down to the Sacramento Bypass, widening the Fremont Weir, removal of embankment within the bypass at the Yolo Shortline Railroad, the Union Pacific Railroad, and Interstate Highway 80, construction of a diversion structure from the Yolo Bypass into the Sacramento River Deep Water Ship Channel (DWSC), construction of a closure structure on the DWSC, and construction of seepage and stability improvements of all of the existing levees along the bypass.

Yolo Bypass conveyance improvements have the effect of reducing water surface elevations at the northwest corner of Natomas for various frequency events by up to 3 feet. Further down the Sacramento River and Yolo Bypass, this decrease in stage reduces to nearly zero, essentially giving no benefit to most of the greater Sacramento urban area. The primary reasons why there is not more of a stage reduction is the same as for the transitory storage alternative.

Therefore, with Yolo Bypass conveyance improvements, all of the levee improvements included in both TSPs for ARCF and WS are still necessary, with Yolo Bypass conveyance improvements not nearly providing enough economic benefit to justify the very large cost. Therefore, for purposes of these two studies, it was screened out. It is important to note that the Yolo Bypass widening does potentially provide benefits elsewhere and is being looked at by the State of California as part of the Central Valley Flood Protection Plan (CVFPP), and this feature is still being analyzed by others but would not affect (strand)levee improvement in the greater Sacramento urban area.

Reoperation of Upstream Reservoirs

Another possible way to reduce flood risk for the greater Sacramento urban area is to reoperate upstream reservoirs to provide more flood flow attenuation within existing reservoirs. There are three

main reservoirs upstream of Folsom Dam that are intended for hydropower, including Union Valley, French Meadows, and Hell Hole, that could be reoperated for flood flow attenuation. Surrounding the Sacramento Valley to the north of the greater Sacramento urban area, Shasta, Oroville, Bullards Bar, Englebright, and Black Butte are all reservoirs that have some flood flow attenuation but also have a water supply and hydropower component; some of the water supply and hydropower storage space could be converted to flood flow attenuation at these reservoirs as well.

On the American River, the three hydropower reservoirs are relatively small compared to Folsom Dam. Therefore, unless significant storage space was to be converted to flood control, very little benefit is provided by reoperation of these reservoirs.

On the Sacramento River to the north, as pointed out in a previous section, there are many tributaries to the Sacramento Valley that are unregulated. Therefore the effect of reoperation of the existing reservoirs is quickly made irrelevant as the non-regulated streams and rivers contribute flow to the Sacramento Valley.

Therefore, with reoperation of upstream reservoirs, all of the levee improvements included in both NED Plans for ARCF and WS are still necessary, with reoperation of these reservoirs not providing nearly enough economic benefit to justify the very large cost. Therefore, the reoperation of upstream reservoirs was excluded from further consideration.

Overall Conclusions of System-Wide Improvement Alternatives

Every system-wide improvement alternative has minimal to no impact on stage reduction in the greater Sacramento urban area and requires almost all (if not all) of the levee improvements included in each of the NED Plans in order to significantly reduce the flood risk for the greater Sacramento urban area. Consequently, levee improvements in the greater Sacramento urban area are a first increment to any system-wide improvement plan. The State of California is formulating the "Central Valley Flood Protection Plan" (CVFPP) which is considering some or all of these system-wide plans. For purposes of their plan formulation efforts, they consider the levee improvements in these two GRRs to be "early implementation projects" and necessary integral increments to the overall CVFPP.

In Figure 8 above, if the water surface elevations were dropped by a half of foot on the stage reduction (which is an upper limit at this location as a result of the system-wide alternatives considered), very little risk reduction is provided to the greater Sacramento urban area. Therefore, the conclusions from evaluation of the system-wide alternatives are: 1) There is not a system-wide alternative that alone significantly reduces the flood risk to the greater Sacramento urban area; 2) Any system-wide plan still requires levees to be improved so that they can more reliably convey even moderate flows; and 3) Almost all of the levee improvements proposed in the ARCF and WS GRRs are integral to any system-wide plan that may be implemented in the future.

4.0 AMERICAN RIVER COMMON FEATURES NED PLAN AND LPP PLAN

After the system-wide plans were determined to alone not significantly reduce flood risk for the Sacramento urban area, levee improvements within the urban area were determined to be required for significant flood risk reduction. The NED Plan and a Locally Preferred Plan (LPP) were identified with the most substantial difference between the two being inclusion of a widened Sacramento Weir and Bypass

in the LPP but not the NED Plan. Following are details of the NED Plan for the ARCF GRR, identified by basin.

American River South (ARS) Basin

- Sacramento River: Approximately 9 miles of seepage cutoff walls, 2.5 miles of geotextile stabilized slope, 2 miles of slope flattening, 10 miles of rock riprap protection, and 9 miles of levee raising will be constructed.
- American River: Approximately 7 miles of rock riprap protection will be constructed.

American River North (ARN) Basin

- American River: Approximately 4 miles of rock riprap protection will be constructed.
- Natomas East Main Drainage Canal (NEMDC): Approximately 1 mile of seepage cutoff walls will be constructed.
- Arcade Creek: Approximately 4 miles of seepage cutoff walls, 4 miles of geotextile stabilized slope, and 4 miles of existing floodwall will be raised.
- Magpie Creek Diversion Channel: Approximately 0.5 miles of the Magpie Creek Diversion Channel west levee will be raised and the levee will be extended approximately 1,000 feet upstream.

For the NED plan, specific locations for the seepage, stability, erosion, and overtopping improvements for both basins are shown on Figure 9 below. Figure 8 above shows the with-project levee performance curve, and by comparing to the without project condition curve, the relative risk reduction provided by the plan features can be seen.

Following are details of the LPP for the ARCF GRR, identified by basin.

- Sacramento River: Construction of about 9 miles of slurry cutoff walls and about 10 miles of rock bank protection along the Sacramento River east levee, as well as about 2.5 miles of geotextile stabilized slope, 2 miles of slope flattening, and less than 1 mile of levee raise.
- Eastside Tributaries: Construction of about 4 miles of slurry cutoff walls and 4 miles of levee raises along the NEMDC and Arcade Creek levees.
- American River: Construction of rock bank protection and launchable rock trenches along 4 miles of the north bank and 7 miles of the south bank of the American River.
- Sacramento Bypass: Widen the Sacramento Weir and Bypass by 1,500 feet.

For the LPP, specific locations for the seepage, stability, erosion and overtopping improvements for both basins along with the widening of the Sacramento Weir and Bypass are shown on Figure 10 below.

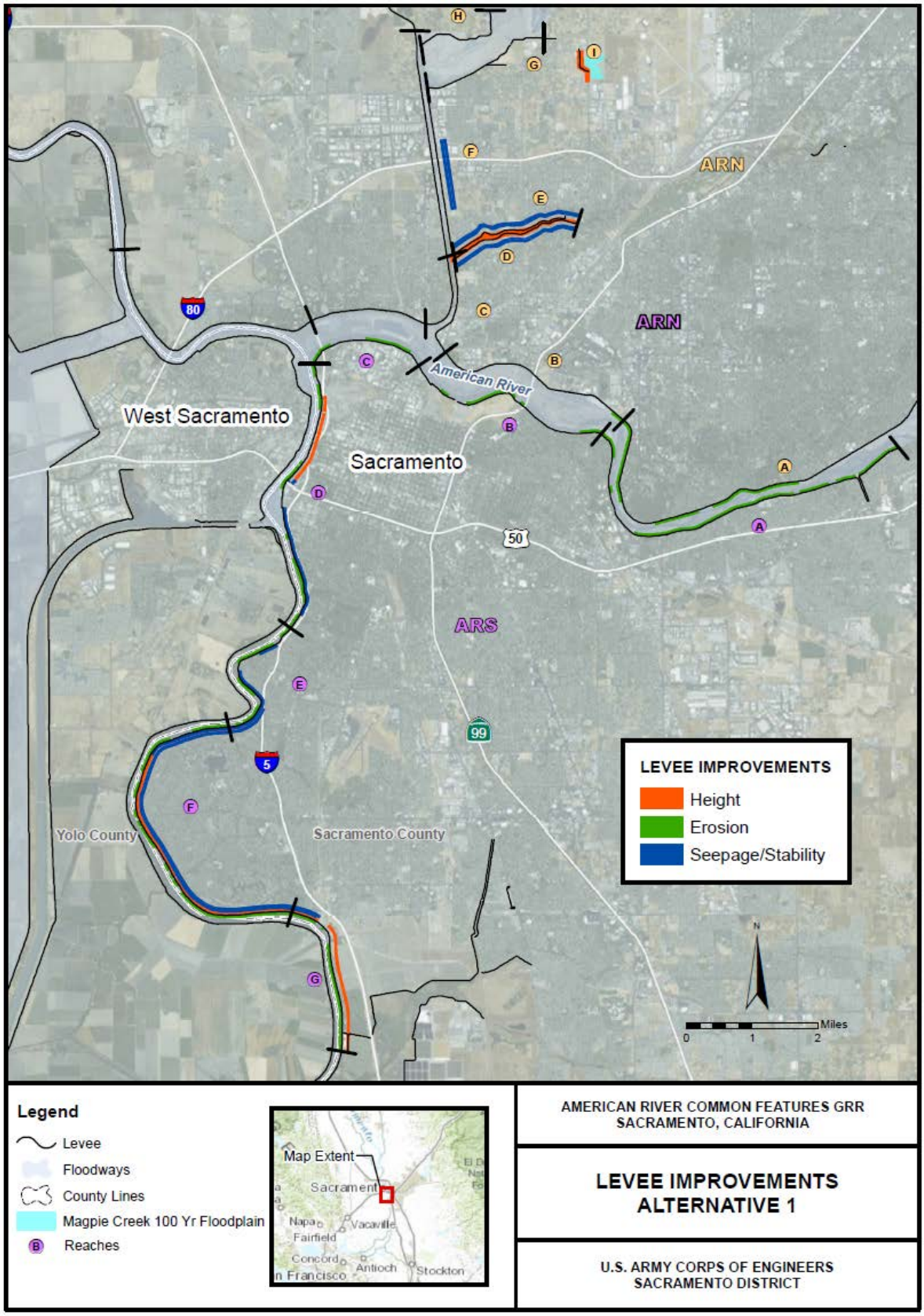


Figure 9. NED Plan Features for the American River Common Features GRR

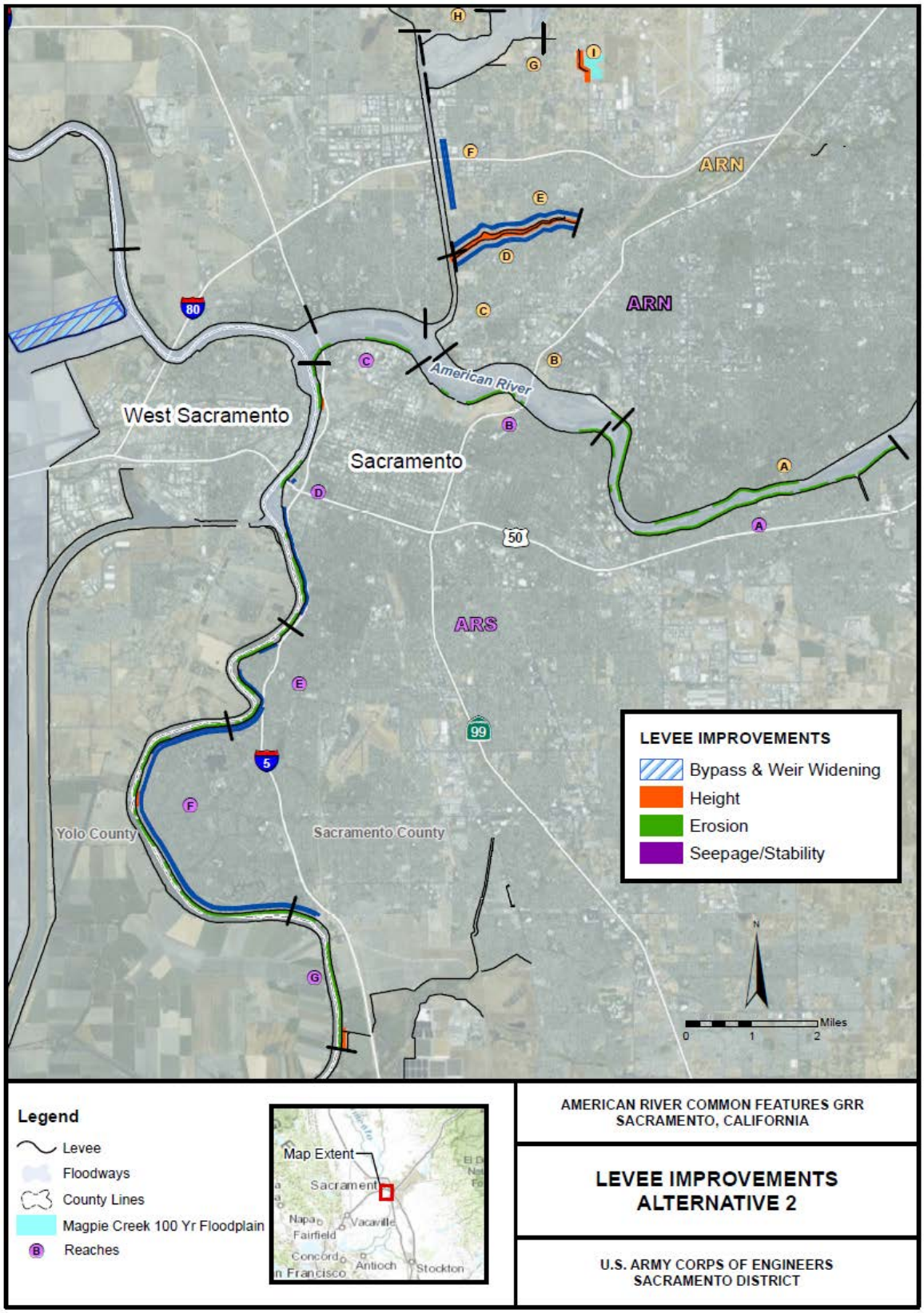


Figure 10. LPP Plan Features for the American River Common Features GRR

5.0 WEST SACRAMENTO NED PLAN

After the system-wide plans were determined to alone not significantly reduce flood risk for West Sacramento, levee improvements within the city were determined to be required for significant flood risk reduction. Alternatives for West Sacramento included improvement of the existing levees, construction of setback levees, construction of a widened Sacramento Bypass and Weir, construction of a diversion structure from the Yolo Bypass into the Deep Water Ship Channel, and construction of a Deep Water Ship Channel Closure Structure. Following are details of the NED Plan for the WS GRR, identified by basin. For West Sacramento, the NED Plan is also the TSP.

West Sacramento North Basin

- Sacramento River: Approximately 6 miles of rock riprap protection will be constructed.
- Yolo Bypass: Approximately 1 mile of seepage cutoff walls will be constructed.
- Port of Sacramento: The obsolete navigation lock from the DWSC to the Sacramento River will be removed and the Sacramento River west levee between the north and the south basins will be made continuous.
- Sacramento Bypass: Approximately 3,000 feet of rock riprap protection will be constructed.

West Sacramento South Basin

- Sacramento River: Approximately 6 miles of setback levee with seepage cutoff walls will be constructed.
- Port of Sacramento: Approximately 1,000 feet of seepage cutoff walls will be constructed. Also, the obsolete navigation lock from the DWSC to the Sacramento River will be removed and the Sacramento River west levee between the north and the south basins will be made continuous.
- Sacramento River DWSC: Approximately 1 mile of seepage cutoff walls will be constructed.
- Yolo Bypass: Approximately 5 miles of seepage cutoff walls and 19 miles of rock riprap protection will be constructed.
- South Cross Levee: Approximately 1 mile of relief wells and 0.2 miles of stability berm will be constructed.

Specific locations for the seepage, stability, and erosion improvements for both basins are shown on Figure 11 below.

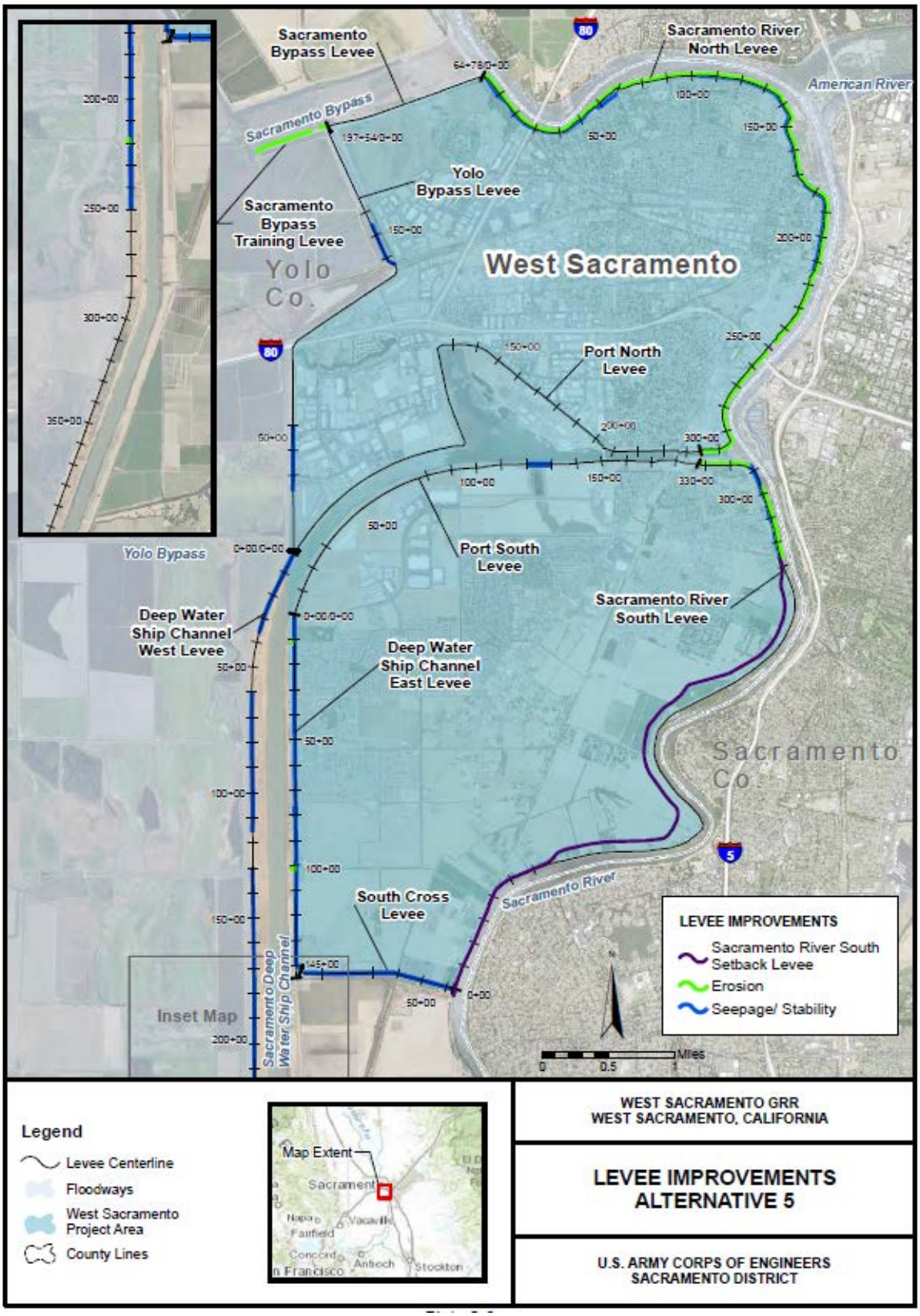


Figure 11. TSP Recommended Features for the West Sacramento GRR

6.0 EFFECTS OF RE-EVALUATING ARCF AND WS PROJECTS SEPARATELY

To determine the effects of improving levees in various basins, hydraulic analysis of the ARCF and WS study areas was performed as follows: (1) without project conditions for Sacramento and West Sacramento; (2) system-wide plans were developed and screened because they did not significantly reduce the flood risk of the two cities; (3) the ARCF TSP was considered in place but not the WS TSP; (4) the WS TSP was considered in place but not the ARCF TSP; and (5) the two TSPs were evaluated together. Details of this hydraulic analysis can be found in the Hydraulic Attachment to the Engineering Appendix for each of the two GRRs.

Step (1) in the above process confirmed the existing flood risk of the two cities as described in the background presented previously in this document. Step (2) established that there is no system-wide plan that has a significant effect on flood risk reduction in Sacramento and West Sacramento; therefore, system-wide plans were screened out. Plan formulation then proceeded to evaluate flood risk reduction measures within both cities. In carrying out steps (3), (4), and (5), it became clear that it does not matter whether the two cities are evaluated separately or together, the identification of the NED Plan would be the same

USACE engineering and economics models were used to evaluate without- and with-project conditions for each of the four hydraulic basins in the ARCF and WS study areas. Due to the practical limitations of models, the use of simplifying methods is necessary in representing the complexities of the real world. One of those methods is to evaluate each hydraulic basin separately from other basins whether those other basins are part of the same study or not. In the evaluation of each basin, it is assumed that there are no failures of levees in other basins under both without- and with-project conditions. Consequently, the proposed strengthening of an existing levee in any basin is assumed to have no effect on the probability of a levee failure in any other hydraulic basin, whether the other basin is part of the same study or not.

There is both empirical and analytical support for the assumption that there are no levee failures in other hydraulic basins. Since completion of the Sacramento River Flood Control Project in the mid 1950s, levee failures have occurred during the 1955,1983, 1986, and 1997 flood events. Detailed streamflow data necessary to determine the effect of the levee failure on stage reduction in the greater Sacramento urban area is only available for the 1997 event. An analysis was performed on the 1997 event to determine effect of the levee failures. This analysis showed that the levee failures on the Sutter Bypass and the Feather River reduced the highest stage recorded at the very upper limit of the Natomas Basin by 0.4 feet, and that reduction tapered down to zero further south within the cities of Sacramento and West Sacramento. The limited reduction in stage was due in part to the levee failures occurring near the peak of the flood. Also, the American River flows overwhelmed any minimal reduction in the Sacramento River stage that might have otherwise reached the Sacramento urban area. The levee failures that occurred during 1955, 1983, and 1986 all occurred around the peak of the flood and therefore would have resulted in similar minimal reductions in stage in the Sacramento urban area.

Analysis was performed to estimate the potential risk reduction on one side of the Sacramento River if the levee failed on the other side of the river. The specific analysis considered a levee failure into the city of Sacramento and what the stage reduction would be affecting West Sacramento. The analysis estimated that there is a 0.4 foot of stage reduction. The analysis assumed that the failure started to occur slightly before the peak of the hydrograph and developed rapidly. Actual levee failures

have happened very near the peak or somewhat after the peak and have taken considerable time to develop to their full width. Therefore, the estimate of 0.4 foot is likely an upper limit.

If the worst case scenario occurred with a breach sufficiently before the peak to lead to a 0.4 foot stage reduction, the probability of a levee failure on the West Sacramento side of the river would be reduced from 23% to 18%. Because there is only a 39% chance of levee failure on the Sacramento side during a 1 in 200 (0.5%) AEP event under without-project conditions, strengthening the levee on only the Sacramento side would have an insignificant effect on expected flood damages on the West Sacramento side. For smaller, more frequent flood events, the effect of a levee failure on flood stages, and consequently on the probability of a levee failure on the opposite bank, would be even less. If the period of time before the West Sacramento levee was also strengthened was relatively short (e.g., 10 years or less), the chance of a significant flood event occurring during that period would be minimized, and the already insignificant increase in expected flood damages in West Sacramento would be even further reduced. In the reverse scenario, a single levee failure on the West Sacramento side during a 1 in 200 ACE event under without-project conditions (which has a probability of only 23%) would cause a stage reduction of about 0.4 foot, and the probability of a levee failure on the Sacramento side of the river would then be reduced from 39% to 37%. Because three low probability events are involved, strengthening the levee on only the West Sacramento side would have an insignificant effect on the expected flood damages on the Sacramento side, particularly over a relatively short period of time.

To determine the effect of re-evaluating the ARCF and WS projects separately, hydraulic analysis of the two project areas was performed in three ways: (1) without-project conditions; (2) the two TSPs were evaluated separately; and (3) the two TSPs were evaluated together. Comparison of those three scenarios indicated that combining the two projects would not result in the selection of different plans (Tech Memo, Common Features GRR and West Sacramento GRR TSP Comparison, 16 October 2014).

Table 1: Tentative Regional Construction Sequence for ARCF and West Sacramento.

REGIONAL PRIORITY	WATERWAY	REACH	YEAR OF PROJECT CONSTRUCTION										
			1	2	3	4	5	6	7	8	9	10	11-17
1	JFP/Dam Raise												
2	ARCF Sacramento River	ARS F											
3	ARCF Sacramento River	ARS E											
4	ARCF American River	ARS A											
5	WS Yolo Bypass Levee												
6	ARCF Sacramento River	ARS G											
7	ARCF Sacramento River	ARS D											
8	ARCF American River	ARS B											
9	ARCF American River	ARN A											
10	ARCF American River	ARS C											
11	ARCF American River	ARN B											
12	ARCF Sac Weir & Bypass	--											
13	WS Sacramento River North												
14	WS Port North Levee												
15	WS Sac Bypass Training Levee												
16	WS Sacramento River South												
17	WS Port South Levee												
18	ARCF Arcade Creek	ARN D											
19	ARCF NEMDC	ARN F											
20	ARCF Arcade Creek	ARN E											
21	ARCF NEMDC	ARN C											
22	ARCF Magpie Creek	ARN I											
23	WS Deep Water Ship Ch. East												
24	South Cross Levee												
25	WS Deep Water Ship Ch. West												

7.0 CONCLUSIONS

There is no system-wide flood risk management alternative that would avoid the need for levee improvements in the ARCF and WS project areas. The effect of levee improvements in one of the four hydraulic basins in the ARCF and WS project areas on any other basin is insignificant relative to plan formulation or implementation. Consequently, combining all four hydraulic basins into a single evaluation rather than two evaluations would not change the plan formulation process or identification of the NED plan for either project.

Attachment 2: DEVELOPMENT OF COSTS AND BENEFITS FOR THE FOCUSED ARRAY OF ALTERNATIVES

COST BASIS FOR FOCUSED ARRAY OF ALTERNATIVES

This document describes the basis for the costs estimates for the alternatives identified in Table 3-14 of the GRR.

The alternatives included in the focused array are effectively building blocks that start with fixing levees. It was determined that to reduce the flood risk for the City of Sacramento, fixing the levees is the first increment.

Alternative 0.5: Alternative 0.5 included improvements to the levees protecting Sacramento to address seepage, stability, and erosion. Levee raising or other conveyance improvements were not included in this alternative. This alternative provides somewhere around a 1/100 ACE performance before overtopping would occur. The cost estimate for this alternative is the Alternative 1 cost estimate from the 2013 time frame (2012 price levels) with the quantities and cost for levee raising removed. The total cost for this alternative at this level of analysis was $1,262,915,000. The cost for Alternative 1 is shown in the following Table 1. The reduction of Alternative 1 costs as a result of removing the levee raising on the Sacramento River and the Natomas Basin is shown on Table 2. The costs as shown on Table 2 included with the total cost of the additional levee improvement construction is shown on Table 3. Table 3 also includes supporting economic information (interest during construction and average annual costs).

Alternative 1: Alternative 1 adds levee raising to the previous alternative and got to approximately a 1/200 ACE level of performance. There is a spreadsheet estimate for this alternative in 2012 price levels that is the basis of the cost estimate in Table 3-14. That estimate is included in the following Table 1. The total cost for this alternative at this level of analysis was $1,426,055,000.

Alternative 2: Alternative 2, includes the levee improvements described in Alternative 1 and adds widening of the Sacramento Weir and Bypass which negates the need to include most of the levee raising in Alternative 1. It accomplishes this by rerouting flow that would have gone down the Sacramento River instead to the widened Sacramento Weir and Bypass. A spreadsheet estimate for this alternative in 2012 price levels is the basis for the cost estimate in Table 3-14 and is also included in the following Table 4. The total cost for this alternative at this level of analysis was $1,567,746,000. Supporting economic information (interest during construction and average annual costs) are shown on Table 5.

Alternative 3: Alternative 3 includes the levee work and widening of the Sacramento Weir and Bypass described in Alternative 2, and then adds the I Street Diversion Structure which negates the need to do all levee raising work on the Sacramento River, plus most of the erosion, seepage, and stability work downstream of the Diversion Structure. Diverting this much flow from the Sacramento River into the Sacramento Weir/Bypass and into the Yolo Bypass had very severe impacts. The hydraulic impacts to the Yolo Bypass were large and it was obvious that many features would need to be added to mitigate for the effects. The cost includes the cost of Alternative 2 with all of the work for ARS Reaches D-G removed, , plus the cost of Yolo Bypass mitigation features, approximately estimated at $1,131,880,900

(shown on Table 8), and the cost of the I-Street Diversion structure itself at $122,161,763 (shown on Table 9). The total cost for the alternative is $2,122,000 and is shown in Table 6. This alternative did not have the support of the environmental community or the local partners and stakeholders. Once it was shown that Alternative 3 was not on the rising limb of the net benefits curve, no further effort on this alternative was performed.

Alternative 4: Alternative 4 added Auburn Dam to the levee improvements proposed in Alternative 1. This feature did not negate the need to do any of the levee improvements in Alternative 1. The cost estimate developed for Auburn Dam in 1996 was inflated to 2014 dollars, and added to the cost of Alternative 1. The benefit provided by including Auburn Dam would be that instead of the overall project providing approximately a 1/200 ACE-year level of performance, it would provide approximately a 1/400 ACE-year level of performance. The cost of Auburn Dam, inflated from 1996 to 2014 is approximately $1,800,000,000. It does provide additional benefits beyond Alternative 1, however not enough to keep it on the rising limb of the net benefits curve. Moving forward with the TSP does not preclude the possible future justification of Auburn Dam; the features of the TSP are no-regrets actions with regards to the possibility of Auburn Dam ever being built. Once it was shown that Auburn Dam was not on the rising limb of the net benefits curve, no further effort on this alternative was performed. The total cost for Alternative 4 is shown on Table 10.

Alternative 5: This alternative was developed to show a maximum level of flood risk reduction for the City of Sacramento. It basically includes all building block steps including levee improvements from Alternative 1, the Sacramento Weir and Bypass widening of Alternative 2, the I Street Diversion Structure from Alternative 3 (including the Yolo Bypass mitigation work), and the Auburn Dam from Alternative 4. Taking the cost of all of these features and adding them together is the background for the cost of this alternative. The total cost for Alternative 5 is shown on Table 11.

Alternative 6: This alternative is non-structural and therefore there is no significant cost, but also no significant flood risk reduction.

The analysis conducted on the Focused Array of Alternatives displayed that Alternatives 1 and 2 would be the most efficient alternatives and would be carried forward for further analysis. This further analysis is shown in the GRR in the tables following Table 3-14. Additionally, the costs for these alternatives were updated to reflect 2015 price levels.

Cost and associated economic information is shown on Table 12.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

CECW-SPD

OCT 30 2014

MEMORANDUM FOR THE ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS)

SUBJECT: American River Common Features (ARCF) Project, California, Deviation from the National Economic Development (NED) Plan

1. PURPOSE: To request that you grant an exception to the requirement to recommend the NED plan. The exception would allow the U.S. Army Corps of Engineers (USACE) to recommend the Locally Preferred Plan (LPP) for flood risk management for the American River Common Features General Reevaluation Study.

2. BACKGROUND: The Sacramento District and South Pacific Division have completed the Tentatively Selected Plan milestone. The district has resolved legal, policy and technical issues raised by the District Support Team and Office of Water Project Review. HQUSACE policy and legal review of the LPP Exemption Request is complete and we support the request to allow a recommendation that deviates from the NED plan.

3. DISCUSSION - General:

This report was prepared as a general reevaluation study of the American River Common Features Project, which was authorized by Section 101(a) (1) of the Water Resources Development Act (WRDA) 1996 (P. L. No. 104-303) and amended by Section 366 of WRDA 1999 (P. L. No. 106-53).

a. The effects of the 1986 storms raised concerns over the adequacy of the existing flood management system. These concerns led to a series of study authorizations and investigations into the need for additional reduction of flood risk for the Sacramento area. These investigations have resulted in the recommendation and subsequent authorization of the Folsom Dam Modification Project (now known as the Joint Federal Project or JFP), the Folsom Dam Raise Project, and incremental improvements to the network of levees along the American and Sacramento Rivers surrounding the city of Sacramento authorized in WRDA 1996 and WRDA 1999. Recommendations for levee improvements in the Natomas Basin are the subject of a Chief's Report signed in 2010 and are included in the Water Resources Reform and Development Act of 2014. The American River Common Features General Reevaluation Report (GRR) identifies the remaining flood risk to the city of Sacramento and the surrounding areas and alternatives to reduce this flood risk.

CECW-SPD
SUBJECT: American River Common Features Project, California – Deviation from the National Economic Development (NED) Plan

b. The identified NED plan involves the construction of levee improvement measures to address seepage, slope stability, erosion, and overtopping concerns identified for the Sacramento River levees, Natomas East Main Drainage Canal (NEMDC), Arcade, Dry/Robla, and Magpie Creeks. It includes erosion protection measures for the American River levees. American River seepage, stability, and overtopping issues were addressed in the WRDA 1996 and 1999 construction projects. Due to environmental, real estate, and hydraulic constraints within the American River North and South basins, the plan proposes to improve the levees within the existing footprint to the extent practical. The purpose of this would be to improve the flood risk management system to safely convey flows to a level that maximizes net benefits.

c. The LPP includes all the levee improvements contained in the NED Plan, except for 8 miles of flood walls or levee raises along the Sacramento River. The Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. This would reduce the amount of levee raising required on the Sacramento River levees to address Hydraulic and Hydrologic uncertainty and meet the state's criteria for levee performance that would equal or exceed the 200 year water surface elevation plus 3 feet. As previously described under the NED, the levees along the American River, NEMDC, Arcade, Dry/Robla, and Magpie Creeks, would be improved to address identified seepage, stability, erosion, and height concerns. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns as described under the NED. Due to environmental, real estate, and hydraulic constraints within the American River North and South basins, the majority of the levees would be fixed in place.

Widening of the Sacramento Weir and Bypass, and enhancing the flood system capacity, are key features of the system-wide improvements identified in the state of California's 2012 Central Valley Flood Protection Plan. Widening of the Sacramento Weir and Bypass reduces the river stage downstream of the American River confluence in the Sacramento and West Sacramento urban areas by diverting more water into the rural Yolo Bypass. The downstream stage reduction also decreases the risk to life safety and reduces flood damages to the rural communities located downstream of Sacramento. These communities include Clarksburg, Hood, Courtland, Walnut Grove, Ryde, and Isleton. Preliminary information from the Delta Islands Feasibility Study indicates existing expected annual damages for these communities to be around $10 million, and stage reductions would be expected to reduce damages by approximately 10% -30%.

The Central Valley Flood Protection Board and the Sacramento Area Flood Control Agency are the non-federal sponsors. They agree to pay the full incremental cost of the LPP above the NED Plan cost. The LPP is supported by the non-federal sponsors and the state of California because it allows the city of Sacramento and the surrounding

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SUBJECT: American River Common Features Project, California – Deviation from the National Economic Development (NED) Plan

areas to meet the requirements of Senate Bill 5 which stipulates that urban and urbanizing areas (with a population of 10,000 or greater) must achieve 1/200 Annual Chance Exceedence level of flood risk management in order to qualify for state funding of flood management projects.

4. DISCUSSION – NED vs. LPP:

The total costs, annual costs, annual benefits, net benefits and benefit to cost ratios for the NED and LPP are presented below.

	NED	LPP
Investment Costs:		
Flood Risk Management First Costs	$1,387,928,000	$1,547,833,000
Interest During Construction	361,375,000	489,447,000
Total	**1,749,303,000**	**2,037,280,000**
Annual Cost		
Interest and Amortization	74,573,000	86,849,000
OMRR&R	300,000	500,000
Total	**74,873,000**	**87,349,000**
Annual Benefits	414,553,000	410,928,000
Net Annual Flood Risk Management Benefits	339,680,000	323,579,000
Benefit to Cost Ratio	5.5	4.7

The LPP total first cost is about $160 million greater than the NED. The total federal cost contribution to the LPP will be limited to the federal share of the identified NED plan. The non-federal sponsor will be responsible for all operation, maintenance, repair, replacement and rehabilitation costs of the LPP.

5. RECOMMENDATION:

The LPP is recommended to further reduce the probability of catastrophic levee failure. The LPP achieves this by enhancing levee performance based on its ability to reduce the water surface elevation in the river adjacent to two urban areas, increase the regional flexibility of the flood management system, provide benefits to downstream communities in the form of reduced water surface elevations in the Sacramento River, and improve natural floodplain values by increasing the areas exposed to overbank flooding in the expanded bypass area. The LPP is a critical initial component of a larger regional plan under development by the state and local interests. The reduction in water surface elevation against these levees would reduce the probability of levee

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SUBJECT: American River Common Features Project, California – Deviation from the National Economic Development (NED) Plan

failure in the urban areas. The results of such a levee failure would be catastrophic due to the minimal warning time for evacuation and deep flooding that would occur. The LPP reduces those consequences in alignment with the state of California Central Valley urban flood risk standards and long term flood risk management strategy. I request that you grant an exception to the requirement to recommend the NED plan to allow USACE to recommend the LPP for flood risk management for the American River Common Features General Reevaluation Report.

6. If you have any questions, please contact my action officer, Mrs. Pauline Acosta, Civil Engineer for the South Pacific Division Regional Integration Team, at (202) 761-4085.

STEVEN L. STOCKTON, P.E.
Director of Civil Works

Encls
1. SPD EndorsementLletter
2. SPK Exception Request
3. Non-federal Sponsor Letter Request
4. TSP Milestone MFR

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

MAR -9 2015

MEMORANDUM FOR DEPUTY COMMANDING GENERAL FOR CIVIL AND EMERGENCY OPERATIONS

SUBJECT: American River Common Features - Policy Waiver – Request to Deviate from the National Economic Development (NED) Plan

I am responding to a request from the Director of Civil Works that I grant an exception to the requirement to recommend the national economic development (NED) plan and instead allow the U.S. Army Corps of Engineers (Corps) to recommend Federal participation in the locally preferred plan (LPP) for the American River Common Features, California project.

My staff has reviewed the memorandum, the background information and the supporting documentation. The primary difference between the NED plan and the LPP is that the LPP includes all the levee improvements contained in the NED Plan, except for 8 miles of flood walls or levee raises along the Sacramento River. In place of those levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The LPP provides outputs and benefits similar to the NED plan within the study area but the LPP would result in lower water surface elevations against existing levees both within and beyond the study area.

The benefits provided by the 2 alternatives within the study area are very close. The costs and benefits of Alternatives 1 and 2 are still preliminary and will continue to be refined as the study progresses and the plan with the greatest average net annual benefits is re-affirmed. However, Alternative 1 has consistently achieved greater net benefits and, therefore, has been identified as the NED plan. The non-Federal sponsor supports the LPP and agrees to pay 100 percent of the LPP costs in excess of the NED plan. Therefore, I approve the requested policy exception to recommend the LPP provided that the sponsor shall have the sole responsibility for all additional costs above the NED plan.

If there are any questions, your staff may contact Mr. Henri Langlois, Project Planning and Review at (202) 761-0038.

jo-ellen darcy

Jo Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

CF: CECW-P

Table 1

****** TOTAL PROJECT COST SUMMARY ****** 3/4/2013

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE DRAFT FEASIBILITY REPORT, NED PLAN
PROJECT: ARCF GRR - Alt 1 **U. S. ARMY CORPS OF ENGINEER, SACRAMENTO DISTRICT**
LOCATION: CALIFORNIA **P.O.C.: JEREMIAH FROST, CHIEF, COST ENGINEERING SECTION**

Current MCACES Estimate Prepared: 1-Mar-2012 | **PROGRAM YEAR(BUDGET EC) 2014** | **TOTAL PROJECT COST (FULLY FUNDED)**
Effective Price Level (EPL): 1-Oct-2012 | **EFF. PRICE LEVEL DATE:1-Oct-2013** | **SPENT THRU: 1-Oct-2012**

WB NO.	Civil Works Feature\Sub-Feature Description	ESTIMATED COST COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	PROJECT FIRST COST OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	TOTAL PROJECT COST (FULLY FUNDED) COST ($K)	COST ($K)	CNTG ($K)	FULLY FUNDED ($K)
		Contingency Applied To Remaining Cost Only								Sunk Cost Price Level (EPL): 1-Oct-2012			
	FEDERAL COSTS												
6	FISH & WILDLIFE FACILITIES	22,466	5,282		27,748		22,823	5,364	28,187	0	0	0	0
	ARN - Reaches D-I	660	150		810		672	150	822	0	0	0	0
	ARN - Reaches A-C	9,660	2,273		11,933		9,813	2,309	12,122	0	0	0	0
	ARS - Reaches A-C	10,886	2,561		13,447		11,059	2,600	13,659	0	0	0	0
	ARS - Reaches D-G	1,260	298		1,558		1,279	305	1,584	0	0	0	0
11	LEVEES & FLOODWALLS	723,798	164,143		887,941		734,817	166,739	901,556	26,215	0	0	0
	Natomas - Reaches B-H	71,017	10,542		81,559		71,724	10,709	82,433	26,215	0	0	0
	ARN - Reaches D-I	57,104	13,438		70,542		58,006	13,651	71,657	0	0	0	0
	ARN - Reaches A-C	82,837	19,492		102,329		84,145	19,800	103,945	0	0	0	0
	ARS - Reaches A-C	141,943	33,401		175,344		144,186	33,929	178,115	0	0	0	0
	ARS - Reaches D-G	370,897	87,270		458,167		376,756	88,650	465,406	0	0	0	0
18	CULT. RESRC PRESERV. (1	7,410	1,747		9,157		7,541	1,775	9,316	0	0	0	0
	Natomas - Reaches B-H	764	105		869		774	107	881	0	0	0	0
	ARN - Reaches D-I	687	134		821		700	136	836	0	0	0	0
	ARN - Reaches A-C	794	164		958		809	166	975	0	0	0	0
	ARS - Reaches A-C	1,253	256		1,509		1,276	260	1,536	0	0	0	0
	ARS - Reaches D-G	3,912	1,088		5,000		3,982	1,106	5,088	0	0	0	0
	SUBTOTAL FEDERAL & NON-FEDERAL CONSTRUCTION COSTS	753,674	171,172		924,846		765,181	173,878	939,059	26,215	0	0	0
1	LANDS & DAMAGES, Admin (2	9,325	469		9,794		9,597	485	10,082	0	0	0	0
	ARN - Reaches D-I	2,575	130		2,705		2,649	135	2,784	0	0	0	0
	ARN - Reaches A-C	525	27		552		540	29	569	0	0	0	0
	ARS - Reaches A-C	350	17		367		361	17	378	0	0	0	0
	ARS - Reaches D-G	5,875	295		6,170		6,047	304	6,351	0	0	0	0
30	PLAN/ENGINEERING/DESIGN	107,973	7,557		115,530		111,138	7,779	118,917	0	0	0	0
	Natomas - Reaches B-H	6,721	470		7,191		6,919	482	7,401	0	0	0	0
	ARN - Reaches D-I	8,631	604		9,235		8,884	622	9,506	0	0	0	0
	ARN - Reaches A-C	13,874	972		14,846		14,280	1,001	15,281	0	0	0	0
	ARS - Reaches A-C	22,924	1,604		24,528		23,596	1,652	25,248	0	0	0	0
	ARS - Reaches D-G	55,823	3,907		59,730		57,459	4,022	61,481	0	0	0	0
31	CONSTRUCTION MANAGE'MT	61,188	4,285		65,473		62,980	4,412	67,392	0	0	0	0
	Natomas - Reaches B-H	3,808	267		4,075		3,919	276	4,195	0	0	0	0
	ARN - Reaches D-I	4,891	344		5,235		5,035	353	5,388	0	0	0	0
	ARN - Reaches A-C	7,862	551		8,413		8,092	568	8,660	0	0	0	0
	ARS - Reaches A-C	12,992	909		13,901		13,373	935	14,308	0	0	0	0
	ARS - Reaches D-G	31,635	2,214		33,849		32,561	2,280	34,841	0	0	0	0
	SUBTOTAL FEDERAL & NON-FEDERAL CONTRIBUTION	932,160	183,483		1,115,643		948,896	186,554	1,135,450	26,215	0	0	0
	NON-FEDERAL CONTRIBUTION (-)	191,077	8,879		199,956		194,804	9,075	203,879	5,398	0	0	0
	TOTAL FEDERAL COSTS	**$741,083**	**$174,604**		**$915,687**		**$754,092**	**$177,479**	**$931,571**	**$20,817**	**$0**	**$0**	**$0**
	NON-FEDERAL COSTS												
1	LANDS AND DAMAGES	123,551	76,215		199,766		125,504	77,417	202,921	0	0	0	0
	ARN - Reaches D-I	13,888	8,237		22,125		14,108	8,366	22,474	0	0	0	0
	ARN - Reaches A-C	3,204	1,040		4,244		3,255	1,056	4,311	0	0	0	0
	ARS - Reaches A-C	1,730	467		2,197		1,757	475	2,232	0	0	0	0
	ARS - Reaches D-G	104,729	66,471		171,200		106,384	67,520	173,904	0	0	0	0
2	RELOCATIONS	75,589	16,393		91,982		76,690	16,654	93,344	5,811	0	0	0
	Natomas - Reaches B-H	30,108	5,692		35,800		30,491	5,783	36,274	5,811	0	0	0
	ARN - Reaches D-I	22,592	5,315		27,907		22,948	5,400	28,348	0	0	0	0
	ARN - Reaches A-C	2,385	561		2,946		2,423	570	2,993	0	0	0	0
	ARS - Reaches D-G	20,504	4,825		25,329		20,828	4,901	25,729	0	0	0	0
30	PLAN/ENGINEERING/DESIGN	10,466	733		11,199		10,632	746	11,378	0	0	0	0
	Natomas - Reaches B-H	3,645	254		3,899		3,702	259	3,961	0	0	0	0
	ARN - Reaches D-I	3,387	238		3,625		3,441	242	3,683	0	0	0	0
	ARN - Reaches A-C	358	25		383		364	25	389	0	0	0	0
	ARS - Reaches D-G	3,076	216		3,292		3,125	220	3,345	0	0	0	0
31	CONSTRUCTION MANAGE'MT	6,978	487		7,465		7,090	494	7,584	0	0	0	0
	Natomas - Reaches B-H	2,429	171		2,600		2,468	173	2,641	0	0	0	0
	ARN - Reaches D-I	2,260	156		2,416		2,296	159	2,455	0	0	0	0
	ARN - Reaches A-C	238	17		255		242	17	259	0	0	0	0
	ARS - Reaches D-G	2,051	143		2,194		2,084	145	2,229	0	0	0	0
	SUBTOTAL NON-FEDERAL (INCLUDES FED IRRIGATION SHARE)	216,584	93,828		310,412		219,916	95,311	315,227	5,811	0	0	0
	NON-FEDERAL CONTRIBUTION (+)	191,077	8,879		199,956		194,804	9,075	203,879	5,398	0	0	0
	Natomas - Reaches B-H	5,886	870		6,756		5,961	884	6,845	5,398	0	0	0
	ARN - Reaches D-I	5,799	1,431		7,230		5,902	1,454	7,356	0	0	0	0
	ARN - Reaches A-C	36,145	7,092		43,237		36,820	7,213	44,033	0	0	0	0
	ARS - Reaches A-C	65,059	13,168		78,227		66,259	13,388	79,647	0	0	0	0
	ARS - Reaches D-G	78,188	(13,682)		64,506		79,862	(13,864)	65,998	0	0	0	0
	TOTAL NON-FEDERAL COSTS	**$407,661**	**$102,707**		**$510,368**		**$414,720**	**$104,386**	**$519,106**	**$11,209**	**$0**	**$0**	**$0**
	TOTAL FEDERAL & NON-FEDERAL COSTS	**$1,148,744**	**$277,311**		**$1,426,055**		**$1,168,812**	**$281,865**	**$1,450,677**	**$32,026**	**$0**	**$0**	**$0**

**** TOTAL PROJECT COST SUMMARY(CONT'ED) ****

Current MCACES Estimate Prepared: 1-Mar-2012 Effective Price Level (EPL): 1-Oct-2012		ESTIMATED COST				PROGRAM YEAR(BUDGET EC) 2014 EFF. PRICE LEVEL DATE:1-Oct-2013 PROJECT FIRST COST				TOTAL PROJECT COST (FULLY FUNDED) SPENT THRU: 1-Oct-2012			
WB NO.	Civil Works Feature\Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	COST ($K)	COST ($K)	CNTG ($K)	FULLY FUNDED ($K)
		Contingency Applied To Remaining Cost Only								Sunk Cost Price Level (EPL): 1-Oct-2012			

GENERAL NOTES

(1 Cultural Resources Preservation costs associated with mitigation and/or data recovery up to one percent of the total Federal cost are not subject to cost sharing.
(2 Federal administrative costs for non-Federal land acquisition.
(3 01 Account for Land and Damages cost are from Real Estates.

Table 2

ARCF GRR
ARS Reaches D-G
Subset of Costs for Alternative 0.5 (without levee raising)

Feature	Alternative 1 Cost ($1,000s)			Alternative 0.5 Cost ($1,000s)	
	Seepage, Stability, Erosion	Levee Raising 1/	Total	Seepage, Stability, Erosion	Total
6 Fed - Fish & Wildlife Facilities	1,503	55	1,558	1,503	1,503
11 Fed - Levees & Floodwalls	441,940	16,227	458,167	441,940	441,940
18 Fed - Cultural Resource Preservation	4,823	177	5,000	4,823	4,823
1 Fed - Lands & Damages	5,951	219	6,170	5,951	5,951
30 Fed - PED	57,615	2,115	59,730	57,615	57,615
31 Fed - CM	32,650	1,199	33,849	32,650	32,650
1 NF - Lands & Damages	165,137	6,063	171,200	165,137	165,137
2 NF - Relocations	24,432	897	25,329	24,432	24,432
30 NF - PED	3,175	117	3,292	3,175	3,175
31 NF - CM	2,116	78	2,194	2,116	2,116
	739,342	27,147	766,489	739,342	739,342

1/ Costs for levee raising based on quantities and construction cost equating to 3.67% of total construction cost and this percentage being used for all other accounts.

Table 3

Alternative 0.5 – Costs

BASIN	RISK SOURCE	FIRST COSTS	IDC	TOTAL COSTS	AVERAGE ANNUAL COSTS (AAC)	O&M	TOTAL AAC
		ALTERNATIVE 0.5: FIX IN PLACE-NO LEVEE RAISE (IN $1,000s, OCTOBER 2012 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS, 3.75% DISCOUNT RATE)					
ARS	American	231,293	86,646	317,939	14,171	TBD	14,171
	Sacramento	739,342	234,786	974,128	43,417	TBD	43,417
	Total Basin	**970,635**	**321,432**	**1,292,067**	**57,588**	**0**	**57,588**
ARN	American	146,859	23,405	170,264	7,589	TBD	7,589
	Tributaries[2]	145,421	17,309	162,730	7,253	TBD	7,253
	Total Basin	**292,280**	**40,714**	**332,994**	**14,842**	**TBD**	**14,842**
GRAND TOTAL	**All Basins**	**1,262,915**	**362,146**	**1,625,061**	**72,430**	TBD	**72,430**

Alternative 1 – Costs

BASIN	RISK SOURCE	FIRST COSTS	IDC	TOTAL COSTS	AVERAGE ANNUAL COSTS (AAC)	O&M	TOTAL AAC
		ALTERNATIVE 1: FIX IN PLACE (IN $1,000s, OCTOBER 2012 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS, 3.75% DISCOUNT RATE)					
ARS	American	231,293	86,646	317,939	14,171	TBD	14,171
	Sacramento	739,342	234,786	974,128	43,417	TBD	43,417
	Sac Raises	27,147	7,572	34,719	1,547	TBD	1,547
	Total Basin	**997,782**	**329,004**	**1,326,786**	**59,135**	**TBD**	**59,135**
ARN	American	146,859	23,405	170,264	7,589	TBD	7,589
	Tributaries[2]	145,421	17,309	162,730	7,253	TBD	7,253
	Total Basin	**292,280**	**40,714**	**332,994**	**14,842**	**TBD**	**14,842**
NATOMAS	All sources[3]	135,993	8,391	144,384	6,435	TBD	6,435
	Total Basin	**135,993**	**8,391**	**144,384**	**6,435**	**TBD**	**6,435**
GRAND TOTAL	**All Basins**	**1,426,055**	**378,109**	**1,804,164**	**80,412**	TBD	**80,412**

Table 4

****** TOTAL PROJECT COST SUMMARY ****** 3/4/2013

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE DRAFT FEASIBILITY REPORT, NED PLAN

PROJECT: ARCF GRR - Alt 2 — **U. S. ARMY CORPS OF ENGINEER, SACRAMENTO DISTRICT**

LOCATION: CALIFORNIA — **P.O.C.: JEREMIAH FROST, CHIEF, COST ENGINEERING SECTION**

Current MCACES Estimate Prepared: 1-Mar-2013 — **PROGRAM YEAR(BUDGET EC) 2014** — **TOTAL PROJECT COST (FULLY FUNDED)**

Effective Price Level (EPL): 1-Oct-2012 — **EFF. PRICE LEVEL DATE:1-Oct-2013** — **SPENT THRU: 1-Oct-2012**

WB NO.	Civil Works Feature\Sub-Feature Description	ESTIMATED COST COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	PROJECT FIRST COST COST ($K)	CNTG ($K)	TOTAL ($K)	TOTAL PROJECT COST (FULLY FUNDED) COST ($K)	CNTG ($K)	CNTG ($K)	FULLY FUNDED ($K)
		Contingency Applied To Remaining Cost Only								Sunk Cost Price Level (EPL): 1-Oct-2012			
	FEDERAL COSTS												
6	FISH & WILDLIFE FACILITIES	22,466	5,506		27,972		22,823	5,591	28,414	0	0	0	0
	ARN - Reaches D-I	660	156		816		672	156	828	0	0	0	0
	ARN - Reaches A-C	9,660	2,369		12,029		9,813	2,406	12,219	0	0	0	0
	ARS - Reaches A-C	10,886	2,670		13,556		11,059	2,711	13,770	0	0	0	0
	ARS - Reaches D-G	1,260	311		1,571		1,279	318	1,597	0	0	0	0
11	LEVEES & FLOODWALLS	744,342	176,233		920,575		755,687	179,020	934,707	26,215	0	0	0
	Natomas - Reaches B-H	71,017	10,995		82,012		71,724	11,169	82,893	26,215	0	0	0
	ARN - Reaches D-I	57,104	14,015		71,119		58,006	14,237	72,243	0	0	0	0
	ARN - Reaches A-C	82,837	20,329		103,166		84,145	20,652	104,797	0	0	0	0
	ARS - Reaches A-C	141,943	34,834		176,777		144,186	35,385	179,571	0	0	0	0
	ARS - Reaches D-G	346,429	85,014		431,443		351,903	86,356	438,259	0	0	0	0
	Sac Bypass Widening	45,012	11,046		56,058		45,723	11,221	56,944	0	0	0	0
15	FLDWAY CONTRL & DIV STRUCTURE	54,713	13,427		68,140		55,577	13,640	69,217	0	0	0	0
	Sac Bypass Widening	54,713	13,427		68,140		55,577	13,640	69,217	0	0	0	0
18	CULT. RESRC PRESERV. (1	8,127	1,954		10,081		8,270	1,986	10,256	0	0	0	0
	Natomas - Reaches B-H	764	110		874		774	111	885	0	0	0	0
	ARN - Reaches D-I	687	140		827		700	142	842	0	0	0	0
	ARN - Reaches A-C	794	170		964		809	173	982	0	0	0	0
	ARS - Reaches A-C	1,253	266		1,519		1,276	270	1,546	0	0	0	0
	ARS - Reaches D-G	3,714	1,071		4,785		3,780	1,089	4,869	0	0	0	0
	Sac Bypass Widening	915	197		1,112		931	201	1,132	0	0	0	0
	SUBTOTAL FEDERAL & NON-FEDERAL CONSTRUCTION COSTS	829,648	197,120		1,026,768		842,357	200,237	1,042,594	26,215	0	0	0
1	LANDS & DAMAGES, Admin (2	9,575	482		10,057		9,854	499	10,353	0	0	0	0
	ARN - Reaches D-I	2,575	130		2,705		2,649	135	2,784	0	0	0	0
	ARN - Reaches A-C	525	27		552		540	29	569	0	0	0	0
	ARS - Reaches A-C	350	17		367		361	17	378	0	0	0	0
	ARS - Reaches D-G	5,875	295		6,170		6,047	304	6,351	0	0	0	0
	Sac Bypass Widening	250	13		263		257	14	271	0	0	0	0
30	PLAN/ENGINEERING/DESIGN	119,262	8,348		127,610		122,757	8,593	131,350	0	0	0	0
	Natomas - Reaches B-H	6,721	470		7,191		6,919	482	7,401	0	0	0	0
	ARN - Reaches D-I	8,631	604		9,235		8,884	622	9,506	0	0	0	0
	ARN - Reaches A-C	13,874	972		14,846		14,280	1,001	15,281	0	0	0	0
	ARS - Reaches A-C	22,924	1,604		24,528		23,596	1,652	25,248	0	0	0	0
	ARS - Reaches D-G	52,153	3,651		55,804		53,681	3,758	57,439	0	0	0	0
	Sac Bypass Widening	14,959	1,047		16,006		15,397	1,078	16,475	0	0	0	0
31	CONSTRUCTION MANAGE'MT	67,585	4,733		72,318		69,565	4,872	74,437	0	0	0	0
	Natomas - Reaches B-H	3,808	267		4,075		3,919	276	4,195	0	0	0	0
	ARN - Reaches D-I	4,891	344		5,235		5,035	353	5,388	0	0	0	0
	ARN - Reaches A-C	7,862	551		8,413		8,092	568	8,660	0	0	0	0
	ARS - Reaches A-C	12,992	909		13,901		13,373	935	14,308	0	0	0	0
	ARS - Reaches D-G	29,555	2,069		31,624		30,421	2,129	32,550	0	0	0	0
	Sac Bypass Widening	8,477	593		9,070		8,725	611	9,336	0	0	0	0
	SUBTOTAL FEDERAL & NON-FEDERAL CONTRIBUTION	1,026,070	210,683		1,236,753		1,044,533	214,201	1,258,734	26,215	0	0	0
	NON-FEDERAL CONTRIBUTION (-)	213,346	15,319		228,665		217,511	15,621	233,132	5,398	0	0	0
	TOTAL FEDERAL COSTS	**$812,724**	**$195,364**		**$1,008,088**		**$827,022**	**$198,580**	**$1,025,602**	**$20,817**	**$0**	**$0**	**$0**
	NON-FEDERAL COSTS												
1	LANDS AND DAMAGES	126,573	77,459		204,032		128,574	78,680	207,254	0	0	0	0
	ARN - Reaches D-I	13,888	8,237		22,125		14,108	8,366	22,474	0	0	0	0
	ARN - Reaches A-C	3,204	1,040		4,244		3,255	1,056	4,311	0	0	0	0
	ARS - Reaches A-C	1,730	467		2,197		1,757	475	2,232	0	0	0	0
	ARS - Reaches D-G	104,729	66,471		171,200		106,384	67,520	173,904	0	0	0	0
	Sac Bypass Widening	3,022	1,244		4,266		3,070	1,263	4,333	0	0	0	0
2	RELOCATIONS	85,907	19,630		105,537		87,171	19,942	107,113	5,811	0	0	0
	Natomas - Reaches B-H	30,108	5,936		36,044		30,491	6,031	36,522	5,811	0	0	0
	ARN - Reaches D-I	22,592	5,544		28,136		22,948	5,633	28,581	0	0	0	0
	ARN - Reaches A-C	2,385	585		2,970		2,423	594	3,017	0	0	0	0
	ARS - Reaches D-G	20,504	5,033		25,537		20,828	5,112	25,940	0	0	0	0
	Sac Bypass Widening	10,318	2,532		12,850		10,481	2,572	13,053	0	0	0	0
30	PLAN/ENGINEERING/DESIGN	12,014	841		12,855		12,204	856	13,060	0	0	0	0
	Natomas - Reaches B-H	3,645	254		3,899		3,702	259	3,961	0	0	0	0
	ARN - Reaches D-I	3,387	238		3,625		3,441	242	3,683	0	0	0	0
	ARN - Reaches A-C	358	25		383		364	25	389	0	0	0	0
	ARS - Reaches D-G	3,076	216		3,292		3,125	220	3,345	0	0	0	0
	Sac Bypass Widening	1,548	108		1,656		1,572	110	1,682	0	0	0	0
31	CONSTRUCTION MANAGE'MT	8,010	559		8,569		8,138	567	8,705	0	0	0	0
	Natomas - Reaches B-H	2,429	171		2,600		2,468	173	2,641	0	0	0	0
	ARN - Reaches D-I	2,260	156		2,416		2,296	159	2,455	0	0	0	0
	ARN - Reaches A-C	238	17		255		242	17	259	0	0	0	0
	ARS - Reaches D-G	2,051	143		2,194		2,084	145	2,229	0	0	0	0
	Sac Bypass Widening	1,032	72		1,104		1,048	73	1,121	0	0	0	0
	SUBTOTAL NON-FEDERAL (INCLUDES FED IRRIGATION SHARE)	232,504	98,489		330,993		236,087	100,045	336,132	5,811	0	0	0

**** TOTAL PROJECT COST SUMMARY(CONT'ED) ****

Current MCACES Estimate Prepared: 1-Mar-2013
Effective Price Level (EPL): 1-Oct-2012

PROGRAM YEAR(BUDGET EC) 2014
EFF. PRICE LEVEL DATE:1-Oct-2013

TOTAL PROJECT COST (FULLY FUNDED)
SPENT THRU: 1-Oct-2012

WB NO.	Civil Works Feature\Sub-Feature Description	ESTIMATED COST COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	PROJECT FIRST COST COST ($K)	CNTG ($K)	TOTAL ($K)	COST ($K)	COST ($K)	CNTG ($K)	FULLY FUNDED ($K)
		Contingency Applied To Remaining Cost Only								Sunk Cost Price Level (EPL): 1-Oct-2012			
	NON-FEDERAL CONTRIBUTION (+)	213,346	15,319		228,665		217,511	15,621	233,132	5,398	0	0	0
	Natomas - Reaches B-H	5,886	905		6,791		5,961	920	6,881	5,398	0	0	0
	ARN - Reaches D-I	5,799	1,472		7,271		5,902	1,495	7,397	0	0	0	0
	ARN - Reaches A-C	36,145	7,403		43,548		36,820	7,530	44,350	0	0	0	0
	ARS - Reaches A-C	65,059	13,708		78,767		66,259	13,936	80,195	0	0	0	0
	ARS - Reaches D-G	67,611	(14,742)		52,869		69,092	(14,945)	54,147	0	0	0	0
	Sac Bypass Widening	32,846	6,573		39,419		33,477	6,685	40,162	0	0	0	0
	TOTAL NON-FEDERAL COSTS	**$445,850**	**$113,808**		**$559,658**		**$453,598**	**$115,666**	**$569,264**	**$11,209**	**$0**	**$0**	**$0**
	TOTAL FEDERAL & NON-FEDERAL COSTS	**$1,258,574**	**$309,172**		**$1,567,746**		**$1,280,620**	**$314,246**	**$1,594,866**	**$32,026**	**$0**	**$0**	**$0**

GENERAL NOTES

(1 Cultural Resources Preservation costs associated with mitigation and/or data recovery up to one percent of the total Federal cost are not subject to cost sharing.
(2 Federal administrative costs for non-Federal land acquisition.
(3 01 Account for Land and Damages cost are from Real Estates.

Table 5

Alternative 2

BASIN	LPP : SACRAMENTO BYPASS WIDENING (IN $1,000s, OCTOBER 2012 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS, 3.75% DISCOUNT RATE)						
	RISK SOURCE	FIRST COSTS	IDC	TOTAL COSTS	AVERAGE ANNUAL COSTS (AAC)	O&M	TOTAL AAC
	American	232,845	110,958	343,803	15,323	TBD	15,323
	Sacramento	733,620	308,925	1,042,545	46,466	TBD	46,466
	Sac Bypass	170,525	30,895	201,420	8,977	TBD	8,977
ARS	**Total Basin**	**1,136,990**	**450,778**	**1,587,768**	**70,767**	**TBD**	**70,767**
	American	147,822	32,421	180,243	8,033	TBD	8,033
	Tributaries	146,239	17,406	163,645	7,294	TBD	7,294
ARN	**Total Basin**	**294,061**	**49,827**	**343,888**	**15,327**	**TBD**	**15,327**
	All sources	136,695	8,431	145,126	6,468	TBD	6,468
NATOMAS	**Total Basin**	**136,695**	**8,431**	**145,126**	**6,468**	**TBD**	**6,468**
GRAND TOTAL	**All Basins**	**1,567,746**	**509,036**	**2,076,782**	**92,562**	TBD	**92,562**

Table 6

ARCF GRR
Costs for Alternative 3

Civil Works Feature Description	ESTIMATED COST		
	COST ($K)	CNTG ($K)	TOTAL ($K)
ARN - Reaches A-C	114,000	20,000	134,000
ARN - Reaches D-I	112,000	26,000	138,000
ARS - Reaches A-C	185,000	33,000	218,000
Natomas - Reaches B-H	118,000	15,000	133,000
Sac Bypass Widening	157,000	28,000	185,000
Sac River Diversion Structure	122,000	61,000	183,000
Yolo Bypass, I-80 Railroad Relocation	277,000	55,000	332,000
Yolo Bypass, I-80 Causeway Improvement	475,000	95,000	570,000
Yolo Bypass, DWSC Overflow Weir	42,000	8,000	50,000
Yolo Bypass, DWSC Control Structure	144,000	29,000	173,000
Yolo Bypass, Pump Stations	5,000	1,000	6,000
	1,751,000	371,000	2,122,000

Table 7

****** TOTAL PROJECT COST SUMMARY ****** 2/1/2013

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE DRAFT FEASIBILITY REPORT, NED PLAN

PROJECT: ARCF GRR - Alt 3 — **U. S. ARMY CORPS OF ENGINEER, SACRAMENTO DISTRICT**

LOCATION: CALIFORNIA — **P.O.C.: JEREMIAH FROST, P.E., CHIEF, COST ENGINEERING SECTION**

Current MCACES Estimate Prepared: 17-Sep-2012
Effective Price Level (EPL): 1-Oct-2012

PROGRAM YEAR(BUDGET EC) 2013
EFF. PRICE LEVEL DATE:1-Oct-2012

TOTAL PROJECT COST (FULLY FUNDED)
SPENT THRU: 1-Oct-2011

WB NO.	Civil Works Feature\Sub-Feature Description	ESTIMATED COST COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	PROJECT FIRST COST COST ($K)	CNTG ($K)	TOTAL ($K)	COST ($K)	COST ($K)	CNTG ($K)	FULLY FUNDED ($K)
		Contingency Applied To Remaining Cost Only								Sunk Cost Price Level (EPL): 1-Oct-2011			
	FEDERAL COSTS												
6	FISH & WILDLIFE FACILITIES	51,911	4,227		56,138		51,911	4,227	56,138	0	0	0	0
	ARN - Reaches D-I	660	126		786		660	126	786	0	0	0	0
	ARN - Reaches A-C	9,660	1,928		11,588		9,660	1,928	11,588	0	0	0	0
	ARS - Reaches A-C	10,886	2,173		13,059		10,886	2,173	13,059	0	0	0	0
	Yolo Bypass Improvements	30,705	0		30,705		30,705	0	30,705	0	0	0	0
11	LEVEES & FLOODWALLS	453,196	101,821		555,017		453,196	101,821	555,017	26,215	0	0	0
	Natomas - Reaches B-H	71,017	8,945		79,962		71,017	8,945	79,962	26,215	0	0	0
	ARN - Reaches D-I	55,357	11,056		66,413		55,357	11,056	66,413	0	0	0	0
	ARN - Reaches A-C	76,723	15,322		92,045		76,723	15,322	92,045	0	0	0	0
	ARS - Reaches A-C	136,705	27,300		164,005		136,705	27,300	164,005	0	0	0	0
	Sac Bypass Widening	58,273	11,637		69,910		58,273	11,637	69,910	0	0	0	0
	Yolo Bypass Improvements	55,121	27,561		82,682		55,121	27,561	82,682	0	0	0	0
15	FLDWAY CONTRL & DIV STRUCTURE	251,161	50,156		301,317		251,161	50,156	301,317	0	0	0	0
	Sac River Diversion Structure	196,448	39,230		235,678		196,448	39,230	235,678	0	0	0	0
	Sac Bypass Widening	54,713	10,926		65,639		54,713	10,926	65,639	0	0	0	0
18	CULT. RESRC PRESERV. (1	8,043	1,261		9,304		8,043	1,261	9,304	0	0	0	0
	Natomas - Reaches B-H	764	90		854		764	90	854	0	0	0	0
	ARN - Reaches D-I	668	111		779		668	111	779	0	0	0	0
	ARN - Reaches A-C	742	132		874		742	132	874	0	0	0	0
	ARS - Reaches A-C	1,210	213		1,423		1,210	213	1,423	0	0	0	0
	Sac River Diversion Structure	1,596	280		1,876		1,596	280	1,876	0	0	0	0
	Sac Bypass Widening	1,022	184		1,206		1,022	184	1,206	0	0	0	0
	Yolo Bypass Improvements	2,041	251		2,292		2,041	251	2,292	0	0	0	0
	SUBTOTAL FEDERAL & NON-FEDERAL CONSTRUCTION COSTS	764,311	157,465		921,776		764,311	157,465	921,776	26,215	0	0	0
1	LANDS & DAMAGES, Admin (2	3,775	191		3,966		3,775	191	3,966	0	0	0	0
	ARN - Reaches D-I	2,575	130		2,705		2,575	130	2,705	0	0	0	0
	ARN - Reaches A-C	525	27		552		525	27	552	0	0	0	0
	ARS - Reaches A-C	350	17		367		350	17	367	0	0	0	0
	Sac River Diversion Structure	75	4		79		75	4	79	0	0	0	0
	Sac Bypass Widening	250	13		263		250	13	263	0	0	0	0
30	PLAN/ENGINEERING/DESIGN	122,348	19,635		141,983		122,348	19,635	141,983	0	0	0	0
	Natomas - Reaches B-H	6,721	470		7,191		6,721	470	7,191	0	0	0	0
	ARN - Reaches D-I	8,369	585		8,954		8,369	585	8,954	0	0	0	0
	ARN - Reaches A-C	12,957	908		13,865		12,957	908	13,865	0	0	0	0
	ARS - Reaches A-C	22,138	1,550		23,688		22,138	1,550	23,688	0	0	0	0
	Sac River Diversion Structure	29,467	2,063		31,530		29,467	2,063	31,530	0	0	0	0
	Sac Bypass Widening	16,948	1,186		18,134		16,948	1,186	18,134	0	0	0	0
	Yolo Bypass Improvements	25,748	12,873		38,621		25,748	12,873	38,621	0	0	0	0
31	CONSTRUCTION MANAGE'MT	63,325	8,122		71,447		63,325	8,122	71,447	0	0	0	0
	Natomas - Reaches B-H	3,808	267		4,075		3,808	267	4,075	0	0	0	0
	ARN - Reaches D-I	4,743	331		5,074		4,743	331	5,074	0	0	0	0
	ARN - Reaches A-C	7,343	514		7,857		7,343	514	7,857	0	0	0	0
	ARS - Reaches A-C	12,545	879		13,424		12,545	879	13,424	0	0	0	0
	Sac River Diversion Structure	16,699	1,168		17,867		16,699	1,168	17,867	0	0	0	0
	Sac Bypass Widening	9,604	672		10,276		9,604	672	10,276	0	0	0	0
	Yolo Bypass Improvements	8,583	4,291		12,874		8,583	4,291	12,874	0	0	0	0
	SUBTOTAL FEDERAL & NON-FEDERAL CONTRIBUTION	953,759	185,413		1,139,172		953,759	185,413	1,139,172	26,215	0	0	0
	NON-FEDERAL CONTRIBUTION (-)	251,510	42,029		293,539		251,510	42,029	293,539	5,398	0	0	0
	TOTAL FEDERAL COSTS	**$702,249**	**$143,384**		**$845,633**		**$702,249**	**$143,384**	**$845,633**	**$20,817**	**$0**	**$0**	**$0**
	NON-FEDERAL COSTS												
1	LANDS AND DAMAGES	32,357	11,091		43,448		32,357	11,091	43,448	0	0	0	0
	ARN - Reaches D-I	13,888	8,237		22,125		13,888	8,237	22,125	0	0	0	0
	ARN - Reaches A-C	3,204	1,040		4,244		3,204	1,040	4,244	0	0	0	0
	ARS - Reaches A-C	1,730	467		2,197		1,730	467	2,197	0	0	0	0
	Sac River Diversion Structure	423	103		526		423	103	526	0	0	0	0
	Sac Bypass Widening	3,022	1,244		4,266		3,022	1,244	4,266	0	0	0	0
	Yolo Bypass Improvements	10,090	0		10,090		10,090	0	10,090	0	0	0	0
2	RELOCATIONS	266,178	11,756		277,934		266,178	11,756	277,934	5,811	0	0	0
	Natomas - Reaches B-H	30,108	4,831		34,939		30,108	4,831	34,939	5,811	0	0	0
	ARN - Reaches D-I	20,802	4,461		25,263		20,802	4,461	25,263	0	0	0	0
	ARN - Reaches A-C	2,024	404		2,428		2,024	404	2,428	0	0	0	0
	Sac Bypass Widening	10,318	2,060		12,378		10,318	2,060	12,378	0	0	0	0
	Yolo Bypass Improvements	202,926	0		202,926		202,926	0	202,926	0	0	0	0
30	PLAN/ENGINEERING/DESIGN	59,348	4,154		63,502		59,348	4,154	63,502	0	0	0	0
	Natomas - Reaches B-H	3,645	254		3,899		3,645	254	3,899	0	0	0	0
	ARN - Reaches D-I	3,119	220		3,339		3,119	220	3,339	0	0	0	0
	ARN - Reaches A-C	304	21		325		304	21	325	0	0	0	0
	Sac Bypass Widening	1,548	108		1,656		1,548	108	1,656	0	0	0	0
	Yolo Bypass Improvements	50,732	3,551		54,283		50,732	3,551	54,283	0	0	0	0
31	CONSTRUCTION MANAGE'MT	26,036	1,823		27,859		26,036	1,823	27,859	0	0	0	0
	Natomas - Reaches B-H	2,429	171		2,600		2,429	171	2,600	0	0	0	0
	ARN - Reaches D-I	2,080	145		2,225		2,080	145	2,225	0	0	0	0
	ARN - Reaches A-C	202	15		217		202	15	217	0	0	0	0

**** TOTAL PROJECT COST SUMMARY(CONT'ED) ****

Current MCACES Estimate Prepared: 17-Sep-2012
Effective Price Level (EPL): 1-Oct-2012

PROGRAM YEAR(BUDGET EC) 2013
EFF. PRICE LEVEL DATE:1-Oct-2012

TOTAL PROJECT COST (FULLY FUNDED)
SPENT THRU: 1-Oct-2011

WB NO.	Civil Works Feature\Sub-Feature Description	ESTIMATED COST COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	PROJECT FIRST COST COST ($K)	CNTG ($K)	TOTAL ($K)	COST ($K)	COST ($K)	CNTG ($K)	FULLY FUNDED ($K)
		Contingency Applied To Remaining Cost Only								**Sunk Cost Price Level (EPL): 1-Oct-2011**			
	Sac Bypass Widening	1,032	72		1,104		1,032	72	1,104	0	0	0	0
	Yolo Bypass Improvements	20,293	1,420		21,713		20,293	1,420	21,713	0	0	0	0
	SUBTOTAL NON-FEDERAL (INCLUDES FED IRRIGATION SHARE)	383,919	28,824		412,743		383,919	28,824	412,743	5,811	0	0	0
	NON-FEDERAL CONTRIBUTION (+)	251,510	42,029		293,539		251,510	42,029	293,539	5,398	0	0	0
	Natomas - Reaches B-H	5,886	747		6,633		5,886	747	6,633	5,398	0	0	0
	ARN - Reaches D-I	5,580	1,264		6,844		5,580	1,264	6,844	0	0	0	0
	ARN - Reaches A-C	33,796	5,582		39,378		33,796	5,582	39,378	0	0	0	0
	ARS - Reaches A-C	62,794	10,868		73,662		62,794	10,868	73,662	0	0	0	0
	Sac River Diversion Structure	84,666	14,796		99,462		84,666	14,796	99,462	0	0	0	0
	Sac Bypass Widening	38,578	6,287		44,865		38,578	6,287	44,865	0	0	0	0
	Yolo Bypass Improvements	20,210	2,485		22,695		20,210	2,485	22,695	0	0	0	0
	TOTAL NON-FEDERAL COSTS	**$635,429**	**$70,853**		**$706,282**		**$635,429**	**$70,853**	**$706,282**	**$11,209**	**$0**	**$0**	**$0**
	TOTAL FEDERAL & NON-FEDERAL COSTS	**$1,337,678**	**$214,237**		**$1,551,915**		**$1,337,678**	**$214,237**	**$1,551,915**	**$32,026**	**$0**	**$0**	**$0**

GENERAL NOTES

(1 Cultural Resources Preservation costs associated with mitigation and/or data recovery up to one percent of the total Federal cost are not subject to cost sharing.
(2 Federal administrative costs for non-Federal land acquisition.
(3 01 Account for Land and Damages cost are from Real Estates.

Table 8

Combined w/New and Edited Features

Description	Construction	Right-of-Way	Environmental Mitigation	Project Development	Additional Compensation	All Features Total Cost	Needed for I-Street Diversion Mitigation	Costs for Mitigation
Fremont Weir Extension (Alternative B)	$27,831,600	$3,861,000	$3,608,000	$11,133,000	$0	$46,433,600	No	$ -
Upper Elkhorn Setback Levee	$149,741,900	$24,325,000	$10,947,000	$59,896,000	$0	$244,909,900	No	$ -
Lower Elkhorn Setback Levee	$129,346,100	$10,970,000	$11,733,000	$ -	$0	$152,049,100	No	$ -
Little Holland Tract - Liberty Island	$1,989,200	$1,050,000	$3,170,000	$795,000	$0	$7,004,200	No	$ -
Lower Egbert Tract	$74,209,500	$8,265,000	$25,537,100	$29,684,000	$0	$137,695,600	No	$ -
Sac R Bypass Setback Levee	$80,099,100	$3,260,000	$3,231,000	$32,040,000	$0	$118,630,100	No	$ -
Sac R Bypass Weir Extension	$156,790,830	$660,000	$1,748,000	$62,717,000	$0	$221,915,830	No	$ -
Shortline Railroad Relocation	$41,250,000	$3,660,000	$11,393,000	$16,501,000	$0	$72,804,000	No	$ -
Yolo Bypass West Levee	$555,434,500	$29,610,000	$83,477,000	$221,493,000	$0	$890,014,500	No	$ -
Sac River West Levee	$56,048,400	$3,507,000	$12,197,500	$22,419,500	$0	$94,172,400	No	$ -
I-80 Railroad Relocation	$243,536,600	$135,800	$3,527,800	$85,237,900	$0	$332,438,100	Yes	$ 332,438,100
I-80 Causeway Improvement	$418,655,300	$121,100	$5,271,300	$146,529,400	$0	$570,577,100	Yes	$ 570,577,100
DWSC Overflow Weir	$35,199,600	$235,000	$892,000	$14,080,000	$0	$50,406,600	Yes	$ 50,406,600
DWSC Control Structure	$120,044,100	$50,000	$1,740,000	$48,018,000	$3,000,000	$172,852,100	Yes	$ 172,852,100
Yolo East Pump Stations	$3,766,500	$403,500	$118,500	$1,318,500	$0	$5,607,000	Yes	$ 5,607,000
Yolo Bypass East Levee Improvements & DWSC Erosion Protection	$843,437,400	$40,020,000	$155,374,400	$337,375,200	$0	$1,376,207,000	No	$ -
						$4,493,717,200		$ 1,131,880,900

Table 9

Description	UOM	Quantity	ProjectCost
Summary			**122,161,762.85**
15 Floodway Control and Diversion Structures	**LS**	**1.0000**	**122,161,762.85**
15 01 Mob & Demob	**LS**	**1.0000**	**4,418,243.29**
15 02 Excavation	**LS**	**1.0000**	**5,834,078.51**
			35.4977
02 Channel/Bypass Channel Excavation	**CY**	**164,351.0000**	**5,834,078.51**
15 03 Phase 1 Internaly Braced Cofferdam	**LS**	**1.0000**	**5,952,570.42**
			48.4618
01 Sheet Piling PZ-35	**SF**	**64,000.0000**	**3,101,554.93**
			5.0705
02 Strut, Wales & Bracing	**LB**	**388,852.0000**	**1,971,679.57**
			200.7697
03 Tremie Slab	**CY**	**1,348.0000**	**270,637.62**
04 Dewatering System	**LS**	**1.0000**	**286,195.90**
			1,213.2413
05 Timber Guidewall (Temp Bypass)	**LF**	**216.0000**	**262,060.12**
			30,221.1409
06 7 Pile Dolphin Cluster (Temp Bypass)	**EA**	**2.0000**	**60,442.28**
15 04 Phase 2 Internaly Braced Cofferdam	**LS**	**1.0000**	**5,199,433.00**
			48.4614
01 Sheet Piling PZ-35	**SF**	**60,800.0000**	**2,946,454.39**
			5.1201
02 Strut, Wales & Bracing	**LB**	**338,802.0000**	**1,734,692.88**
			200.7697
03 Tremie Slab	**CY**	**1,156.0000**	**232,089.82**
04 Dewatering System	**LS**	**1.0000**	**286,195.90**
15 05 Phase 3 Internaly Braced Cofferdam	**LS**	**1.0000**	**4,003,368.77**
			48.4614
01 Sheet Piling PZ-35	**SF**	**48,000.0000**	**2,326,148.20**
			5.0567
02 Strut, Wales & Bracing	**LB**	**243,322.0000**	**1,230,408.87**
			200.7697
03 Tremie Slab	**CY**	**800.0000**	**160,615.80**
04 Dewatering System	**LS**	**1.0000**	**286,195.90**

Description	UOM	Quantity	ProjectCost
			3,777,062.0294
15 06 Civil	**EA**	**1.0000**	**3,777,062.03**
			23.5198
01 Granular Fill	**CY**	**11,629.0000**	**273,512.05**
			40.7770
02 Embankment	**CY**	**24,822.0000**	**1,012,167.17**
			12.0399
03 Separator Geotextile	**SY**	**16,165.0000**	**194,624.46**
			43.3912
04 Bedding	**CY**	**5,389.0000**	**233,834.92**
			81.4000
05 36" Riprap	**TON**	**24,247.0000**	**1,973,705.22**
			2,008.3923
06 Fertilizing and Seeding	**ACR**	**5.0000**	**10,041.96**
			98.9703
07 9" Unreinforced Slope Paving	**SY**	**800.0000**	**79,176.24**
			30,050,135.1954
15 07 Foundation	**EA**	**1.0000**	**30,050,135.20**
			6,540,565.6796
U-Frame Structure	**EA**	**1.0000**	**6,540,565.68**
			15,487,857.6422
Tainter Gate	**EA**	**1.0000**	**15,487,857.64**
			8,021,711.8736
Tie-in Walls	**EA**	**1.0000**	**8,021,711.87**
15 08 Structure Concrete	**LS**	**1.0000**	**30,897,660.17**
U-Frame Structure	**LS**	**1.0000**	**6,531,399.43**
Tainter Gate	**LS**	**1.0000**	**22,184,844.37**
Tie-in Walls	**LS**	**1.0000**	**2,181,416.38**
15 09 Structural Steel	**LS**	**1.0000**	**11,175,409.54**
			7.5510
01 Tainter Gate	**LB**	**1,480,000.0000**	**11,175,409.54**
15 10 Mechanical	**LS**	**1.0000**	**2,621,000.10**
01 Tainter Gate Machinery	**LS**	**1.0000**	**2,621,000.10**
15 11 Electrical	**LS**	**1.0000**	**2,469,788.55**

Description	UOM	Quantity	ProjectCost
			1,213.2413
15 12 Timber Wall Guides	**LF**	**312.0000**	**378,531.28**
			29,105.3674
15 13 Timber Pile Clusters (7 Pile)	**EA**	**3.0000**	**87,316.10**
			15,297,165.8973
15 14 Ground Improvement	**EA**	**1.0000**	**15,297,165.90**

Table 10

ARCF GRR
Costs for Alternative 4

Auburn Dam Cost Update

Item		Cost, $1,000s
Auburn Dam cost 1995		948,700
CCI 1994	422.71	
CCI 2014	767.89	
CCI	1.8166	
Auburn Dam cost 2014		1,723,397
Note, will round up to nearest hundred million dollars		1,800,000

Notes
CCI information from EM 1110-2-1304.
Auburn Dam cost from the American River Watershed, Supplemental Information Report, 1996.

Alternative 4 Total Cost Estimate

Item	Cost, $1,000s
Auburn Dam	1,800,000
Levee Improvement work from Alternative 1	1,426,055
Total	3,226,055

Table 11

ARCF GRR
Costs for Alternative 5

Item	Cost, $1,000s
Alternative 2 Levee Improvement and Sacramento Bypass Widening Construction	1,567,746
I Street Diversion Structure	183,000
Yolo Bypass Mitigation Work	1,131,000
Auburn Dam	1,800,000
Total	4,681,746

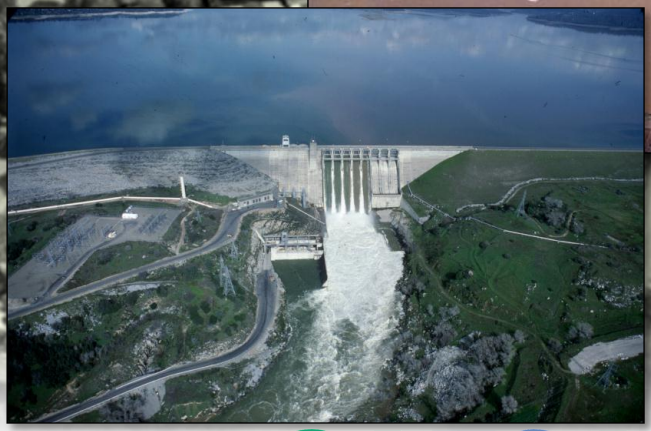
Table 12

ARCF GRR
Table 3-14 Backup

	Alternative						
	0.5 - Fix levees	1 - Fix & raise levees	2 - Fix levees and widen Sac Bypass	3 - I St Diversion	4 - Auburn Dam	5 - Maximum	6 - Non Structural
First Cost	1,262,915	1,426,055	1,567,746	2,122,000	3,226,055	4,681,746	N/A
Annual Costs	71,213	80,412	88,401	119,654	181,909	263,992	N/A
Annual Benefits	384,047	433,581	430,798	428,000	451,600	451,600	N/A
Net Benefits	312,834	353,169	342,397	308,346	269,691	187,608	N/A
B/C	5.4	5.4	4.9	3.6	2.5	1.7	N/A

American River Watershed

Common Features
General Reevaluation Report



Appendix B
Review Documentation

October 2015

SAFCA
Sacramento Area Flood Control Agency

CENTRAL VALLEY FLOOD PROTECTION BOARD
PUBLIC SAFETY
WITH FLOOD PROTECTION
STATE OF CALIFORNIA

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:

Sacramento Weir during operation

Sacramento River facing south near the Pocket and Little Pocket neighborhoods

High flows on the American River at the Highway 160 overcrossing

Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Appendix B

Review Documentation

U.S. Army Corps of Engineers
Sacramento District

October 2015

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AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

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1 District Quality Control (DQC)

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4. Real Estate
5. Economics

2 – Agency Technical Review (ATR)

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2. Completion of Agency Technical Review
3. Certification of Agency Technical Review

3 – Independent External Peer Review (IEPR)

1. PCX Memo transmitting the Final Comment Response Record
2. Final Comment Response Record
3. Draft Agency Response to IEPR

DISTRICT QUALITY CONTROL CERTIFICATION
AMERICAN RIVER COMMON FEATURES
GENERAL REEVALUATION REPORT, SACRAMENTO COUNTY, CALIFORNIA

COMPLETION OF QUALITY CONTROL ACTIVITIES

The District has completed review of the American River Common Features General Reevaluation Study. Products reviewed include the final report, report synopsis, slide presentation, risk register, decision log and decision management plan. Certification is hereby given that all quality control activities defined in the Project Review Plan appropriate to the level of risk and complexity inherent in the product have been completed. Documentation of the quality control process is enclosed.

GENERAL FINDINGS

Compliance with clearly established principles and procedures, utilizing clearly justified and valid assumptions, has been verified. This includes assumptions, methods, procedures and materials used in analyses; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets the sponsor's needs consistent with law and existing Corps policy. Cost data in the review copy of the document was DQC'd concurrent with ATR; however the District has yet to receive the certified final costs. Any changes resulting from the final cost certification will be reviewed prior to the Civil Works Review Board.

Based on documented policy concerns received during concurrent review, the DQC review included a consistency review between this project's document and the West Sacramento General Reevaluation Report to ensure a consistent response to ATR and policy comments, where applicable. DQC comments were provided based on this additional consistency review.

All appropriate DQC comments have been incorporated into this project.
The undersigned recommends certification of the quality control process for this product.

Jerry Fuentes
Quality Control Reviewer

Date 9/4/15

QUALITY CONTROL CERTIFICATION

As noted above, all issues and concerns resulting from technical review of the product have been resolved. The project is recommended to proceed to policy review by SPD.

Nick Applegate

9/14/15

for Mark E. Cowan
Chief, Water Resources Branch

Date

American River Common Features Draft Final Report
DQC Comments
Reviewer: Jerry Fuentes, RTS

19 August 2015

Comment	Response	Backcheck
Page 1-1, Section 1.2: Citation of Section 130 of EWDAA of 2004 is incorrect. Should be EWDAA of 2008. Also note that this need to be added to Section 2 of the PACR.	Concur. Text corrected and text added to Section 2 of PACR.	Response accepted. Comment closed.
Page 1-13, 2nd complete paragraph: Do we consider 1/3 to 1/5 ACE "high?"	Concur, term "high" removed from sentence.	Response accepted. Comment closed.
Page 1-16: This discussion is less history and more problem statement.	Concur. Wanted to emphasize points-problems as a result of the way the levee was constructed.	Response accepted. Comment closed.
Page 1-18, Added text in 2nd paragraph under Upstream Dams: Make sure this text is also added to W. Sac.	Concur	Response accepted. Comment closed.
Page 1-19, 1st paragraph: see second comment	Concur. But critical to overall storytelling.	Response accepted. Comment closed.
Page 1-23, Table 1-2: 2nd footnote: This information is repeated in text. Delete	Concur. Footnote deleted.	Response accepted. Comment closed.
Page 1-24, Section 1.5 Watershed Planning: Make sure this is consistent with W. Sac.	Concur.	Response accepted. Comment closed.
Page 1-27, Sacramento River Bank Protection Project: Update to note current GRR activities.	Concur. Language added.	Response accepted. Comment closed.
Page 1-28, CVFPP: Update with current information and note that the plan identifies a preferred alternative - SSIA.	Concur. Language added from CVFPP document.	Response accepted. Comment closed.
Page 2-5, General description: This discussion should include discussion of American River contribution as well.	Concur. Language added.	Response accepted. Comment closed.
Page 2-16, Seismic Vulnerability: Rewrite to match tone of report (sounds like cut and paste).	Concur. Paragraph rewritten.	Response accepted. Comment closed.
Page 2-36, Future Without-Project Conditions, 2nd paragraph: Don't feel comfortable with statement in final sentence. Should say that improvements would only be made as part of this project and locals are assuming authorization.	Concur. Statement removed.	Response accepted. Comment closed.
Page 2-38, next to last sentence: Suggest adding "without the LPP" to the end of the sentence.	Concur. Sentence modified to clarify that erosion protection is needed with or without the JFP.	Response accepted. Comment closed.
Page 2-39, Section 2.8.4: Are we assuming, herefore that it is in place for the without-project condition.	Concur. Sentence modified.	Response accepted. Comment closed.
Page 3-1, 1st paragraph: completeness is not a screening metric for measures.	Concur. Deleted.	Response accepted. Comment closed.
Page 3-17, Section 3.9, Table 3-3: Combined objectives should also have	Concur. Modified	Response accepted. Comment closed.

check marks for each shown.		
Page 3-20, Table 3-5: Make sure that if a measure was dropped because it did not preclude levee improvements, it would not be used in an alternative that addressed "worst second situation"	Concur.	Response accepted. Comment closed.
Page 3-25, Table 3-6: How did upstream storage and Max Plan get carried forward?	Concur. Both are not acceptable do to inclusion of the Auburn Dam.	Response accepted. Comment closed.
Page 3-26, Section 3.13.2, Why are we focused on the 1/200 ACE again?	Concur. statement is for comparison purposes only.	Response accepted. Comment closed.
Page 3-26, Section 3.13.2, second paragraph, first sentence: specify what concerns you mean.	Concur.	Response accepted. Comment closed.
Page 3-27, Section 3.13.3, first sentence: This implies that we are optimizing. These should be formulated as a common performance level. Same comment for Alternative 3.	Concur. Deleted reference to increments.	Response accepted. Comment closed.
Page 3-30, Section 3.13.5, 1st paragraph, added text: This is evaluation language, should focus only on description here.	Concur. Moved to evaluation.	Response accepted. Comment closed.
Page 3-31, Section 3.13.6: This description need a better rationale for including this plan since it does not fit into our formulation strategy.	Concur. Formulation strategy expanded to include a strategy to establish an out boundary for costs and benefits.	Response accepted. Comment closed.
Page 3-43, Table 3-16: Totals are incorrect.	Concur. Updated.	Response accepted. Comment closed.
Page 3-47, Table 3-17: Totals are incorrect.	Concur. Updated.	Response accepted. Comment closed.
Page 3-49, Table 3-18, Metrics should be renumbered.	Concur.	Response accepted. Comment closed.
Page 4-1, Chapter name: This is now that Selected Plan.	Concur.	Response accepted. Comment closed.
Page 4-1, Section 4.1, Bullet 4: Include length of new levee.	Concur. About two miles.	Response accepted. Comment closed.
Page 4-5, Launchable rock trench, Citation to figure 4-8 is not cross section graphic.	Concur. Changed to figure 4-9.	Response accepted. Comment closed.
Page 4-14, Magpie Creek Diversion Canal, 4th paragraph: No rationale provided for sizing.	Concur. Deleted.	Response accepted. Comment closed.
Page 4-14, Magpie Creek Diversion Canal, 4th paragraph: Provide additional information regarding when the takings analysis will be completed.	Concur. Coordination with RE is underway to determine schedule.	Response accepted. Comment closed.
Page 4-15, Figure 4-19: Graphic has letter designations but nothing in legend to explain them.	Concur. Will add to legend.	Response accepted. Comment closed.
Page 4-16, Section 4.1.4: Need to include length of new levee.	Concur. Added to text.	Response accepted. Comment closed.
Page 4-21, 1st paragraph: Clarify if there are any general fish and wildlife mitigation.	Concur. Clarification added.	Response accepted. Comment closed.
Page 4-26, Section 4.5.3: Are there any risk	Concur. Yes, will add to RR.	Response accepted.

register items for implementation?		Comment closed.
Page 4-40, Section 4.10: Summary does not address all significant effects beyond ESA.	Concur. Other significant effects added to summary.	Response accepted. Comment closed.
age 4-44, Item #3: Update to eliminate mention of the draft.	Concur.	Response accepted. Comment closed.
Page 4-47, Item #7: Update to eliminate mention of the draft.	Concur.	Response accepted. Comment closed.
Page 4-51, Table 4-11: Cost for levees is roughly $10 K less than W. Sac per mile.	Concur. In depth comparison is being prepared to address.	Response accepted. Comment closed.
Page 4-51, Table 4-11: Cost for bank stabilization is roughly 2x per mile in W. Sac.	Concur. In depth comparison is being prepared to address.	Response accepted. Comment closed.
Page 4-53, Table 4-12: Table is consistent with Table 4-11.	Concur. These are NED costs. Need to compare TSP costs to table 4-11.	Response accepted. Comment closed.
Page 5-5, Table 5-3: See comments on cost differences between W. Sac and yours.	Concur.	Response accepted. Comment closed.
Page 7-1, Recommendations: Costs are inconsistent with Ch. 5.	Concur. Costs have been revised and are now consistent.	Response accepted. Comment closed.
Page 7-3, Item n: Please ensure that the recommended rewrite of this item is also accomplished in W. Sac.	Concur.	Response accepted. Comment closed.

DATE: 13 August 2015

TO: Anne Baker, Environmental Manager, ARCF

FROM: Tanis Toland, Environmental DQC

SUBJECT: ARCF Draft Final EIS/EIR - DQC Backcheck

All of my DQC comments on the draft Final EIS/EIR for the American River Comment Features GRR are closed. Documentation of this review accompanies this memo.

Tanis Toland
13 August 2015

Main document changes and comments

Page 3: Comment [T1] **Tanis Toland** **8/13/2015 4:54:00 PM**

Also DWR?

RESPONSE: SAFCA is our only formal cooperating agency. DWR staff represent the CVFPB for the project, but DWR is not considered a sponsor or cooperating agency.

BACKCHECK: CLOSED

Page 1: Comment [T2] **Tanis Toland** **8/13/2015 4:54:00 PM**

Header needs to refer to the Final EIS/EIR and to the correct date. Note that, under NEPA, we clearly distinguish between the Draft and Final EIS's. Both are distinct documents and are part of the Administrative Record and both are published and widely circulated. It is important for tracking purposes throughout the project life that the distinction be clear, even where chapter or an appendix has been detached from the published final EIS.

RESPONSE: Concur. Change made throughout.

BACKCHECK: CLOSED

Page 14: Comment [T3] **Tanis Toland** **8/13/2015 4:53:00 PM**

Effects to cultural resources and resources significant to Native American tribes is identified in the Areas of Controversy and Unresolved Issues section. Is there specific information that should be included in this summary table?

RESPONSE: The table references potential adverse effects to historic properties by either of the alternatives and mitigation through implementation of agreement documents, such as the programmatic agreement. There is not specific information to include in the table beyond this since specific effects to historic properties will be later determined through execution of the programmatic agreement.

BACKCHECK: CLOSED

Page i: Comment [T4] **Tanis Toland** **8/13/2015 4:53:00 PM**

Need to identify the Environmentally Preferable Alternative in the TOC and within the body of the document.

RESPONSE: Sections ES-10 and 2.4 have been updated to identify Alternative 2 as the Environmentally Preferred Alternative.

BACKCHECK: OPEN – Correct language is "environmentally preferable alternative." See CEQ Regulations, Section 1505.2 and CEQ 40 Questions # 6a &6b. A quick fix would be to explain that, in this document, "environmentally preferred alternative" is the same as the NEPA "environmentally preferable alternative." Perhaps this choice was made to better communicate with the intended audience?

RESPONSE: Updated the sections referenced above to correct terminology.

BACKCHECK: CLOSED

Page iv: Inserted	Tanis Toland	8/13/2015 5:13:00 PM

112

Page viii: Comment [T5]	Tanis Toland	8/13/2015 4:52:00 PM

This is now the "Recommended Plan" and the NEPA "preferred alternative."

RESPONSE: TSP has been updated to Recommended Plan. Updated Sections ES - 10 and 2.4 to reflect NEPA Environmentally Preferred Alternative, CEQA Environmentally Superior Alternative, and LEDPA.

BACKCHECK: CLOSED

Page 1: Comment [T6]	Tanis Toland	8/13/2015 4:52:00 PM

If you are using the largest footprint that would reasonably be expected, wouldn't the site-specific work be expected to result in reduced impacts? If you do not reasonably anticipate additional significant impacts during PED, why flag it here? We are required to consider our project actions throughout the project life to e

RESPONSE: The intent of evaluating the largest footprint was to capture the maximum impact, however, there is the potential for a change in significance during PED. Public and IEPR comments requested that we acknowledge the possibility of supplements, which is why this language is here.

BACKCHECK: CLOSED

Page 10: Comment [T7]	Tanis Toland	8/13/2015 4:51:00 PM

Do you mean "performance"?

RESPONSE: Performance is an appropriate term to use here as well, but this is the language used in the GRR by planning/economics to discuss this issue. For consistency purposes, no change has been made.

BACKCHECK: CLOSED

Page 15: Comment [T8]	Tanis Toland	8/13/2015 4:51:00 PM

Do you mean "could"? NEPA requires discussion of all potential mitigation measures to reduce impacts but does not require that they be included in the project. It, therefore, becomes important to distinguish between those mitigation measures that could reduce impacts and those mitigation measures that are proposed to be implemented.

RESPONSE: Concur, change has been made.

BACKCHECK: CLOSED

Page 15: Comment [T9]	Tanis Toland	8/13/2015 4:50:00 PM

Do you mean "late 2015"?

RESPONSE: Concur, change has been made.

BACKCHECK: CLOSED

Page 15: Comment [T10]	Tanis Toland	8/13/2015 4:50:00 PM

Could you beef this up a bit so that it is very clear to the reader who will use this document for what purposes. The CEQA description seems pretty robust but you may wish to add some additional information to the NEPA description. Who will be making what decisions? Corps will be use the EIS as a basis for signing a ROD. The EIS and ROD, together with the GRR support a Chief's report, which is the Corps recommendation on a project.....which then goes to Congress.

RESPONSE: Section has been updated accordingly.

BACKCHECK: CLOSED

Page 56: Comment [T11]	Tanis Toland	8/13/2015 4:49:00 PM

Can you provide a clear overall significance determination for each alternative?

RESPONSE: Reviewed Chapter 3 and ensured that the determinations were there for each river/alternative/resource.

BACKCHECK: CLOSED; however, the overall significance determination for each alternative under each resource category is somewhat obscured by the by river. Table ES-3 does provide an overall description of significance for each alternative under each resource category.

Page 60: Comment [T12]	Tanis Toland	8/13/2015 4:48:00 PM

Needs content.

RESPONSE: Section updated.

BACKCHECK: CLOSED

Page 61: Comment [T13]	Tanis Toland	8/13/2015 4:48:00 PM

This seems reasonable. It is not consistent with some of the other No Action descriptions (which assume full compliance with the Veg ETL through veg free zones). You may wish to bring the others into alignment with this statement.

RESPONSE: Concur. This language has been consistently added to all No Action sections.

BACKCHECK: CLOSED

Page 62: Comment [T14]	Tanis Toland	8/13/2015 4:48:00 PM

Under NEPA, mitigation includes (in order of how each should be considered in project planning): avoiding, minimizing, rectifying, reducing and compensating.

RESPONSE: Concur. No change has been made.

BACKCHECK: OPEN. Avoidance and minimization are types of mitigation. This phrase (which is used in this title and elsewhere in the text) doesn't make sense. Do you mean "avoidance, minimization, and COMPENSATORY mitigation measures"? Two options I see for handling this: (1) add "compensatory" here and wherever this phrase occurs in the document, or (2) include an explanation in Chapter 1.8 that explains what this phrase means and the relationship to NEPA mitigation language and concepts.

RESPONSE: Changing these headings back to Mitigation Measures.

BACKCHECK: CLOSED

Page 70: Comment [T15] **Tanis Toland** **8/13/2015 4:47:00 PM**

Is the project description incomplete? How can you determine costs and impacts with an incomplete project description? Can you make some assumptions about how many miles of each measure would par t of the alternative?

RESPONSE: These two measures have been developed based on locations where each measure could potentially be implemented. In some cases, like the north bank of the American River, we evaluated impacts based on both measures being implemented – essentially doubling the impacts so that either measure's impacts are covered. However, given the level of uncertainty associated with the time frame of authorization and appropriations, vegetation is likely going to significantly change prior to project implementation, which is why this evaluation needs to occur prior to construction.

BACKCHECK: CLOSED

Page 76: Comment [T16] **Tanis Toland** **8/13/2015 4:46:00 PM**

What vegetation is planned for the bypass? How will it be managed? How will this affect water surface elevation?

RESPONSE: See the vegetation and wildlife analysis below for this discussion. The analysis here (in Land Use) is focused on the agricultural impacts to the Bypass.

BACKCHECK: CLOSED

Page 102: Comment [T17] **Tanis Toland** **8/13/2015 4:46:00 PM**

Can you be more specific? Will this be native grasses and forbs or something else?

RESPONSE: Added that the revegetation in the Sacramento Bypass would be native grasses and trees. Since this is the water quality section, the native grasses is the key issue for this resource to prevent additional erosion during flood flows. This was also previously established in the list of mitigation measures below.

BACKCHECK: CLOSED

Page 112: Comment [T18] **Tanis Toland** **8/13/2015 4:45:00 PM**

Recommend deleting this sentence. It is not necessary since any changed circumstances that occurs during the project life requires review to determine whether a new NEPA document is required or whether there is a need to reinitiate consultation under ESA, etc. If you want to address all of these kinds of possibilities you could include a paragraph at the beginning of the chapter that describes how NEPA treats uncertainty and changed conditions.

RESPONSE: Public/resource agencies/ATR/IEPR all requested that we include this statement. As a result, no change has been made.

BACKCHECK: CLOSED

Page 113: Comment [T19] **Tanis Toland** **8/13/2015 4:45:00 PM**

I am not sure how the entire Parkway would be lost. Do you mean that the Parkway would be severely damaged with high value habitat being lost for many years while natural or managed succession takes place?.

RESPONSE: See the American River Erosion Susceptibility Section of the H&H Section above. A key assumption of this project is that the American River erosion risk is significant enough that if we do nothing, it is possible to lose the berms of the parkway in a major flood event. In the case of the No Action, we assume full berm loss causing an eventual levee break. This erosion is part of the existing condition, which is why the project is necessary.

BACKCHECK: CLOSED

Page 113: Comment [T20] **Tanis Toland** **8/13/2015 4:44:00 PM**

Can't the sponsors use this approach now on both the landside and the waterside of the levees? Would the levee improvements make approval of a SWIF or a variance possible in the action alternative circumstance and unacceptable in the No Action alternative.

RESPONSE: Concur that the sponsors could apply the SWIF to both. However, under this study the Corps proposed to apply for a variance prior to the sponsor issuing a LOI to implement a SWIF. Therefore, the assumption under this project is that the variance is a Federal action by the Corps (and thus not occurring under the No Action) and the SWIF is the non-Federal Action (could occur with or without the project).

BACKCHECK: CLOSED

Page 187: Comment [T21] **Tanis Toland** **8/13/2015 4:43:00 PM**

Are there any applicable state laws or local ordinances?

RESPONSE: CEQA has been referenced below.

BACKCHECK: CLOSED

Page 200: Comment [T22] **Tanis Toland** **8/13/2015 4:25:00 PM**

Monument?

RESPONSE: Concur. Change has been made

BACKCHECK: CLOSED

Page 206: Comment [T23] **Tanis Toland** **8/13/2015 4:26:00 PM**

Southport 408 received a comment on the affect of utility relocations on cultural resources. You may wish to explicitly address this for each of the alternatives.

RESPONSE: For all activities for the project (including utility relocations) there will be inventory, eligibility determinations, and evaluation of effects to potential historic properties. This document does not have site specific information in order to complete an analysis on specific utility relocations.

BACKCHECK: CLOSED

Page 212: Comment [T24] **Tanis Toland** **8/13/2015 4:27:00 PM**

It is not clear what commitment is being made here. Are there historic properties that the project, as currently designed, would adversely affect? Is there an expectation that the project be redesigned during feasibility to avoid impacts on historic properties or is the expectation that the project would or could be redesigned during PED? If the latter, this raises concerns about whether the project has been appropriately identified, evaluated, and costs fully disclosed. Would it be appropriate to refer instead to "design refinements" during PED that may reduce or avoid impacts?

RESPONSE: There are likely historic properties that the project will adversely affect but those specific determinations by historic property have not been made. They will be made through the execution of the programmatic agreement during PED. Redesign during feasibility to avoid historic properties is not expected, but refinement of designs should be considered during PED. The costs for cultural resources were developed with consideration for significant efforts to identify and evaluate cultural resources during PED. Instead of "redesign," changed the references in this paragraph to "design refinements" in order to clarify the level of activity that may occur in PED.

BACKCHECK: CLOSED

Page 252: Inserted	**Tanis Toland**	**8/13/2015 5:13:00 PM**

Table

Page 252: Formatted	**Tanis Toland**	**8/13/2015 5:13:00 PM**

Font: Calibri, Not Bold

Page 331: Comment [T25]	**Tanis Toland**	**8/13/2015 4:42:00 PM**

Need to update.

RESPONSE: Updated.

BACKCHECK: CLOSED

Page 348: Comment [T26]	**Tanis Toland**	**8/13/2015 4:41:00 PM**

Who will request the 401 WQ Cert? When will this occur?

RESPONSE: Concur, this information has been added.

BACKCHECK: CLOSED

Page 349: Comment [T27]	**Tanis Toland**	**8/13/2015 4:41:00 PM**

Did you identify the LEDPA? Is it the preferred alternative/Recommended Plan? Include this information here.

RESPONSE: Concur. Added.

BACKCHECK: CLOSED

Page 350: Comment [T28] **Tanis Toland** **8/13/2015 4:40:00 PM**

Under ESA effect determinations are made for both listed species and designated critical habitat, using one of the following:
No effect
May affect, not likely to adversely affect
May affect, likely to adversely affect.
Please revise the text to specify the correct determination and address whether designated critical habitat is present in the project area and, if present, what your determination is.

RESPONSE: Section revised.

BACKCHECK: CLOSED

Page 350: Comment [T29] **Tanis Toland** **8/13/2015 4:40:00 PM**

Typically we would say something like, "In a letter, dated XXX, USACE requested to initiate Section 7 consultation."

RESPONSE: Concur. Change made as requested.

BACKCHECK: CLOSED

Page 350: Comment [T30] **Tanis Toland** **8/13/2015 4:39:00 PM**

Please include the USFWS' recommendations in this section together with the USACE response to each of those recommendations. This comment was also provided on the draft EIS/EIR (DQC Comment #12).

RESPONSE: Concur. The recommendations and responses have been added to this document as Section 4.7.

BACKCHECK: CLOSED

Page 350: Comment [T31] **Tanis Toland** **8/13/2015 4:39:00 PM**

EFH has not been designated for steelhead.

RESPONSE: Concur.

BACKCHECK: CLOSED

Page 350: Comment [T32] **Tanis Toland** **8/13/2015 4:38:00 PM**

NMFS' EFH recommendations should be included in the Final EIS.

RESPONSE: Concur. Will be added once received.

BACKCHECK: CLOSED

Page 351: Comment [T33] **Tanis Toland** **8/13/2015 5:05:00 PM**

Consider including EO 13112, Invasive Species.

RESPONSE: Added below.

BACKCHECK: CLOSED

Page 353: Comment [T34] **Tanis Toland** **8/13/2015 4:37:00 PM**

Are there any NRCS conservation easements on this land or on any other lands being used for this project?

RESPONSE: The draft EIS/EIR was provided to NRCS for review and no comments were received. Technical research has not resulted in any NRCS conservation easements found within the project area.

BACKCHECK: CLOSED

Page 353: Comment [T35] **Tanis Toland** **8/13/2015 4:37:00 PM**

Was For DA 1006 completed, provided to NRCS, and returned. Is this document included in the Appendix (doesn't appear to be).

RESPONSE: NRCS form DA 1006 will be included as an appendix to the final EIS/EIR.

BACKCHECK: CLOSED

Page 353: Comment [T36] **Tanis Toland** **8/13/2015 4:36:00 PM**

What is the relationship of this Act to the proposed project?

RESPONSE: The relationship is simply related to the level of protection in the study area. The NFIP is not a regulatory function over the project, just a relationship. Added the final sentence to the section.

BACKCHECK: CLOSED with the following caveat: Please check with the planner regarding this statement. USACE no longer supports the concept of "x-year level of protection." Perhaps an acception has been made in this case

BACKCHECK: Added because the GRR does identify the level of protection for the project. Specifically, Table 3-19 of the GRR indicates that Alternative 2 would bring the American River South Basin to a 1 in 147 level of protection, and the American River North Basin to a 1 in 256 level of protection. Will update this discussion to be consistent with those numbers, rather than general.'

BACKCHECK: CLOSED

Page 357: Comment [T37] **Tanis Toland** **8/13/2015 4:35:00 PM**

If you coordinated with the National Park Service, regarding this Act, recommend including this information here.

RESPONSE: Concur. Language has been added below.

BACKCHECK: CLOSED

Page 357: Comment [T38] **Tanis Toland** **8/13/2015 4:34:00 PM**

Please clarify, would the extraordinary fishery value improve over the baseline or No Action conditions or would the adverse project impacts to fisheries be reduced over time?

RESPONSE: There would be an initial direct effect during construction, but SAM results show that the long-term effects are beneficial/improvement over baseline. Section has been updated accordingly.

BACKCHECK: CLOSED

Page 362: Comment [T39] **Tanis Toland** **8/13/2015 4:34:00 PM**

Recommend specifying the number of meetings and the dates they were held.

RESPONSE: Concur. Dates and locations have been added.

BACKCHECK: CLOSED

Page 362: Comment [T40] **Tanis Toland** **8/13/2015 4:34:00 PM**

Discuss how the comments were addressed and helped to frame the scale of the analysis for the EIS.

RESPONSE: Concur, language was added following Table 55.

BACKCHECK: CLOSED

Page 363: Comment [T41] **Tanis Toland** **8/13/2015 4:33:00 PM**

Please confirm that these were DVDs and not actually CDs?

RESPONSE: They were DVDs.

BACKCHECK: CLOSED

Page 364: Comment [T42] **Tanis Toland** **8/13/2015 4:33:00 PM**

And comment cards?

RESPONSE: concur

BACKCHECK: CLOSED

Page 364: Comment [T43] **Tanis Toland** **8/13/2015 4:32:00 PM**

Can you provide some context? How many Federal, state, local agencies, NGOs, businesses, individuals provided substantive comments on the draft EIS?

RESPONSE: 137 people, to include the list above, attended the meetings. Further detail such as this will be included in the Public Response Appendix (Appendix F). This section is a brief summary and more detail will be available there.

BACKCHECK: CLOSED

Page 364: Comment [T44] **Tanis Toland** **8/13/2015 4:32:00 PM**

This is confusing. Are the comments summarized here the most significant comments? The comments raised by the greatest number of commenters? Reviewers and decision makers are most interested in being alerted to key substantive comments and how they were addressed in alternatives development and evaluation between the draft and the final EIS.

RESPONSE: Added, "The most significant comments"...focused on." Additionally indicated that the full array of comments are included in the appendix.

BACKCHECK: CLOSED

Page 364: Comment [T45] **Tanis Toland** **8/13/2015 4:32:00 PM**

Under NEPA, all interested parties are noticed regarding the availability off the FEIS and those who have submitted substantive comments on the Draft EIS must be provided with a copy of the Final EIS. This can be a CD. See 40 CFR Parts 1500-1508 (1502.19) and ER 1105-2-100, Appendix H, Amendment #1

RESPONSE: Concur. Added language indicating that the distribution would include commenters.

BACKCHECK: CLOSED

Page 364: Comment [T46] **Tanis Toland** **8/13/2015 4:31:00 PM**

Will Congress be taking one action or two separate actions? Be clear.

RESPONSE: Added "following authorization".

BACKCHECK: CLOSED with the following caveat: The modification didn't quite address my original comment. I proposed a revision within the text. "...project construciton is also contingent on congressional authorization OF THE PROJECT and SUBSEQUENT appropriat of funds TO DESIGN AND CONSTRUCT THE PROJECT.".

RESPONSE: Change accepted.

BACKCHECK: CLOSED

Page 365: Comment [T47] **Tanis Toland** **8/13/2015 4:30:00 PM**

This section needs to be beefed up so that it tells a useful story about coordination and consultation with other Federal, state and local agencies. Language included gives the impression that coordination with the state and federal agencies took place early on and leaves a question about whether coordination has continued throughout the project planning and EIS/EIR process. Need to distinguish between general coordination and required consultation.

RESPONSE: Concur, this section was updated as requested.

BACKCHECK: CLOSED

Page 365: Comment [T48] **Tanis Toland** **8/13/2015 4:30:00 PM**

Recommend that you specify, as appropriate, consultation with USFWS, NMFS and CDFW under FWCA, ESA and Magnuson-Stevens Fishery and Conservation Act. How about coordination or consultation with USEPA, RWQCB, or the air pollution control districts?

RESPONSE: Concur, updated as recommended.

BACKCHECK: CLOSED

Page 366: Comment [T49] **Tanis Toland** **8/13/2015 4:29:00 PM**

SJAFCA is identified as a Cooperating Agency. Is DWR also a Cooperating Agency?

RESPONSE: See response to cover page. No, DWR is not a coordinating agency.

BACKCHECK: CLOSED

Page 366: Comment [T50] **Tanis Toland** **8/13/2015 4:28:00 PM**

See comment T11 , above. Also, did this list also receive copies or notice of the release of the Draft EIS/EIR? If so, you may wish to make this clear.

RESPONSE: These individuals all received copies of the document. We typically send DVD copies of the document to all of the agencies and individuals listed here, and letters to residents.

BACKCHECK: CLOSED

Page 368: Comment [T51] **Tanis Toland** **8/13/2015 4:29:00 PM**

What about Sacramento Municipal Utility District?

RESPONSE: Added.

BACKCHECK: CLOSED

Page 384: Comment [T52]	Tanis Toland	8/13/2015 10:57:00 AM

Include the content providers and key reviewers from the CEQA Lead Agency and the NEPA Cooperating Agencies.

Response: Concur, added below.

BACKCHECK: CLOSED

Header and footer changes

Text Box changes

Header and footer text box changes

Footnote changes

Endnote changes

Main document changes and comments

Page 1: Comment [T1] **Tanis Toland** **8/28/2015 9:11:00 AM**

Need to write NEMDC out since this is the first time it appears in the document.

RESPONSE (VH):Concur. The change has been made as requested.

BACKCHECK (TT): CLOSED

Page 4: Comment [T2] **Tanis Toland** **8/28/2015 9:11:00 AM**

Need to define "East Side Tributaries" since this is the first time it appears in the document.

RESPONSE (VH): All areas of the East Side Tributaries have been defined.

BACKCHECK (TT): CLOSED

Page 7: Comment [T3] **Tanis Toland** **8/28/2015 9:12:00 AM**

Would the existing weir be replaced or modernized? This description seems to indicate that structure of the existing weir would not be altered by this project (Alternative 2. Is this correct?

RESPONSE (AB): Clarified the description to reflect that the extension of the Sacramento Weir would be a new structure. The existing weir is not proposed for alteration.

BACKCHECK (TT): CLOSED

Page 19: Comment [T4] **Tanis Toland** **8/28/2015 9:12:00 AM**

Comment carried in from fist DQC: How thick would the rock berm be? How thick would the silty/sandy layer be? Once this material is washed away, would it be replaced?

RESPONSE (VH): Included rock berm thickness.

BACKCHECK (TT): CLOSED

Page 20: Comment [T5]	Tanis Toland	8/28/2015 9:12:00 AM

Comment carried in from first DQC: What about the riprap, would it migrate, too?

RESPONSE (VH): Addressed possible migration.

BACKCHECK (TT): CLOSED

Page 23: Comment [T6]	Tanis Toland	8/28/2015 9:13:00 AM

Comment carried in from first DQC: What would the increase in water surface elevation be? At one time, an increase of half a foot was considered unacceptable.

RESPONSE (AB): Section has been updated to reflect that the increase in water surface elevation would be 0.10-foot during a 200-year event. Additional edits were madeto reflect that this would only be during large flood events, as the new weir would not be operated until flows from Folsom Dam exceed 115,000 cfs. The existing weir would be operated consistent with current conditions.

BACKCHECK (TT): CLOSED

Page 24: Comment [T7]	Tanis Toland	8/28/2015 9:14:00 AM

Comment carried in from first DQC: Has this been modeled? If freshwater flows leave the river and route to the Delta down the Bypass system, it would seem like this could affect salinity gradients as well as turbidity.

RESPONSE (AB): This has not been modeled, however changes could only occur during a large flood event, when there is already a huge amount of water in the system pushing salinity back down into the Delta/Bay system. The section was revised to more clearly portray the condition.

BACKCHECK (TT): CLOSED

Page 34: Comment [T8]	Tanis Toland	8/28/2015 9:14:00 AM

Mitigation must be evaluated consistent with ER 1105-2-100 (see Appendix C).

RESPONSE (AB): Updated this write up for consistency with the Biological Opinion.

BACKCHECK (TT): CLOSED

Page 37: Comment [T9]	Tanis Toland	8/28/2015 9:14:00 AM

What effect would the cutoff walls have on groundwater and other subsurface flows?

RESPONSE (VH): Concur. Included that there is minimal risk due to a non-permeable layer of soil between the groundwater table and the cutoff wall.

BACKCHECK (TT): CLOSED

Page 38: Comment [T10]	Tanis Toland	8/28/2015 9:15:00 AM

To improve clarity, please be more specific where appropriate throughout the document. In this case, the referenced vegetation s trees and shrubs?

RESPONSE (VH): Added the types of vegetation that would be permitted on site.

BACKCHECK (TT): CLOSED

Page 38: Comment [T11]	Tanis Toland	8/28/2015 9:15:00 AM

Type of vegetation?

RESPONSE (VH): Added the types of vegetation that would be permitted on site.

BACKCHECK (TT): CLOSED

Page 42: Comment [T12]	Tanis Toland	8/28/2015 9:15:00 AM

Temporarily during construction or permanently?

RESPONSE (VH): Added temporarily. Also: Once construction is complete the recreation facilities would be returned to the pre-construction conditions and long term effects would be less than significant.

BACKCHECK (TT): CLOSED

Page 44: Comment [T13]	Tanis Toland	8/28/2015 9:15:00 AM

Can you place this in context with other similar work in the Sacramento Valley/Central Valley? There are X LF/Miles of levee system. This project would place linear feet/miles linear feet of riprap. Riprap placed by other projects includes: X LF/miles of existing riprap, LF/miles of riprap currently being placed, LF/miles of riprap planned?

RESPONSE (AB): Updated to include a summary of cumulative Corps actions in the area.

BACKCHECK (TT): CLOSED

Page 44: Comment [T14]	Tanis Toland	8/28/2015 9:16:00 AM

Are these areas under an HCP or is one in development? In some cases, for example a SWIF, ESA compliance would be accomplished by the Corps under Section 7.

RESPONSE (AB): This language was from the BA and was specifically referring to non-Federal actions, as required in the ESA consultation handbook. The language has been updated to include Federal and non-Federal actions for the purposes of the 404(b)(1)

BACKCHECK (TT): CLOSED

Page 45: Comment [T15]	Tanis Toland	8/28/2015 9:16:00 AM

Do mean "placed" or "migrate"?

RESPONSE (VH):Changed to "placed".

BACKCHECK (TT): CLOSED

Page 45: Comment [T16]	Tanis Toland	8/28/2015 9:16:00 AM

Above ordinary high water?

RESPONSE (VH): Added no-in water work would occur. (AB): Also added that this measure is only implementable on the American River.

BACKCHECK (TT): CLOSED

Page 47: Comment [T17]	Tanis Toland	8/28/2015 9:17:00 AM

Need to identify the LEDPA. Which alternative is the LEDPA?

RESPONSE (VH): Concur. Identified the LEDPA. (AB): Also added explanation for why it is the LEDPA.

BACKCHECK (TT): CLOSED

Header and footer changes

Text Box changes

Header and footer text box changes

Footnote changes

Endnote changes

Comments and Responses for the
Habitat Mitigation and Monitoring Plan
American River Common Features General Reevaluation Report

*Note: all in-line changes were accepted in the document. All other comments are addressed below.

Number	Location	Comment	Response	Toland Backcheck (9/14/15)
T1	Under Primary Purpose and Goals	Recommend clarifying in this introductory section that most of the compensatory mitigation is directly tied to compliance with the ESA and is intended to off-set effects on listed species.	Concur; added text: "Mitigation for habitat loss is a requirement to compensate for the loss of habitat due to a Federal action. Section 2036(a) of the Water Resources Development Act of 2007 states that project alternatives must support recommendations with a specific plan to mitigate fish and wildlife losses. Additionally, the Endangered Species Act states that the purpose of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts (40 CFR 230.93 (a)(1)."	Comment Closed
T2	On statement "The purpose of this mitigation and monitoring plan is to establish a framework for creation of mitigation sites and evaluating the success of these sites"	This MMP is proposed as a "framework for creation of mitigation sites and the success of these sites." This is inconsistent with the requirements of USACE implementing guidance for Section 2036(a) of WRDA of 2007 (31 August 2009), paragraph 1a, which specifies that: "…any report, submitted to Congress for authorization, shall not select a project alternative unless such report contains (1) a specific recommendation with a specific plan to mitigate fish and wildlife losses or (2) the Secretary determines that the	Although the draft MMP does not specifically call out the exact parameters of the survey protocols that will be established for the individual mitigation sites, it does describe the types and amounts of mitigation that would be required for habitat losses due to the project. Revised text: "This Habitat Mitigation and Monitoring Plan (HMMP) describes the types of habitats that will be impacted, the potential impacts caused by the project, and describes the types and amounts of mitigation that would be established in order to compensate for habitat losses. This plan also establishes a framework for the creation of mitigation sites and methods to evaluate the success of these sites in order to ensure that the goals and requirements of the project's required mitigation are accomplished."	Comment closed

		project will have negligible adverse impacts." At what point will a specific recommendation with a specific plan to mitigate fish and wildlife losses be completed?		
T3	On statement "Due to environmental, real estate, and hydraulic constraints within the study area, the majority of the levees would be fixed in place."	The placement of "environmental" first in this list infers that the environmental concerns are a primary driver for the fix in place option. If this is not the case, recommend reordering this list.	Concur; the text has been revised to "Due to hydraulic,, real estate, and environmental constraints within the study area, the majority of the levees would be fixed in place."	Comment closed
T4	On title "Description of Proposed Protective Measures"	Recommend using "Proposed Flood Risk Management Measures" to distinguish the content of this section from mitigation measures.	Concur; text has been revised to "Proposed Flood Risk Management Measures" as recommended. Table of Contents has been updated.	Comment closed
T5	Under Section 1.6, Potential Project Impacts, first sentence	Who would obtain the variance from whom? This is a USACE document and USACE makes veg variance decisions. Has HQUSACE agreed to grant a veg variance? Do you mean that initial engineering analyses indicate that all/part (what part) of the project would be likely to be determined during PED to be suitable for a veg variance?	The text has been revised to "A vegetation variance is being sought by the Sacramento District to comply with ETL 1110-2-583 on the waterside of the levee. The vegetation variance request requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained if the vegetation were to remain in place."	Comment closed
T6	On the heading of Table 2	I understand that these headings are being revised to increase clarity.	Added "Western Yellow-billed Cuckoo" to "Riparian" tab.	Comment closed
T7	1.7, Proposed Mitigation Measures	Need to discuss the mitigation objectives before discussing the mitigation measures that will address those objectives (see USACE implementation guidance for Section 2036(a) of WRDA 2007.	Concur. Text assed: "The preparation of mitigation plans, including objectives, plan design, determination of success criteria, and monitoring needs would be coordinated with Federal and State resource agencies to the greatest extent practicable. Mitigation objectives are specific actions to be taken to avoid and minimize adverse affects, such as Best Management Practices,	Comment closed

			compliance with Federal and State regulatory laws, and environmental commitments. Mitigation objectives include the identification of specific amounts of mitigation required to compensate for remaining unavoidable losses."	
T8	Section 1.7 on the phrase "requirements specified in the BOs."	If these are terms and conditions, state this.	Text revised to "requirements, terms and conditions specified"	Comment closed
T9	Under Section 1.7, Proposed Mitigation Measures" first bullet, on "the Corps will obtain an ETL approved vegetation variance"	See previous comment on this subject. Could you say something like: "The Corps anticipates that the project will be found suitable for a variance to the XXX ETL [need the correct number].	Concur; text revised to "A vegetation variance is being sought by the Sacramento District to comply with ETL 1110-2-583 in order to exempting the Sacramento River and East Side Tributaries from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase."	Comment closed
T10	Section 1.7 on phrase "The mitigation acreages for ARCF GRR were calculated…"	Specify the acreages of what and/ or refer to the appropriate table.	Concur; text added to describe Table 3: "Table 3 describes the types and amounts of habitat that would be potentially impacted by the project, the duration of the impacts, the amount of mitigation in total acreage according to the requirements provided by USFWS and NMFS, and projected costs as estimated according to existing mitigation prices." Additionally, information in Table 3 has been changed from mitigation ratios to total acreage required according to projected impacts.	Comment closed
T11	Under Section 1.8, Location of Mitigation and Compensation Sites, first paragraph	Can you add any specificity? For example, about how much (or what percent-sh) of the project length (ideally by waterway) would be restored to pre-construction conditions?	The only specificity we really have at this design phase is the area associated with on-site restoration. Revised text: "Sites compatible with on-site mitigation such as the 30 acres of upland GGS habitat and 82, 325 linear feet of SRA habitat would be restored in place."	Comment closed
T12	Under Section 1.8, Location of Mitigation and Compensation Sites, third paragraph	You may also wish to include similar language in the first paragraph of the document.	Concur; the language "This mitigation and monitoring plan will accompany the final EIS/EIR, and will be updated throughout the design phase as detailed design efforts allow for finalizing the mitigation plans" has been added after the phrase "This HMMP is a living document and will be modified as part of an adaptive management strategy to allow for the accomplishment of the goals and requirements in a	Comment closed

			constantly changing environment" in the second paragraph of the introduction.	
T13	Section 1.9, Compensation Timing on phrase "The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] § 2283)."	ER 1105-2-100, Appendix C, page C-19 provides guidance on the timing of mitigation.	Concur; language added: "Additionally, ER 1105-2-100, Appendix C states that authorized ecological resource mitigation activities and features should occur before construction of the project, concurrent with the acquisition of lands, or concurrent with the physical construction of the project."	Comment closed
T14	Section 2.0, fourth paragraph, on phrase "project objectives"	Do you mean "mitigation objectives"?	Concur; text has been changed to "mitigation objectives."	Comment closed

QUALITY CONTROL CERTIFICATE FOR CIVIL DESIGN PRODUCTS

PROJECT NAME: American River Common Features GRR

PROJECT MANAGER: Dan Tibbitts

ORGANIZATION: Civil Design Section A

TECHNICAL PRODUCTS: The edited engineering summary appendix for the Feasibility Report Milestone (FRM). This review is for edits made as a result of the concurrent review period and refinements to the plan and document.

PREPARER – I have prepared the above products in accordance with the Quality Management Plan. I have incorporated or resolved all review issues in accordance with the Quality Management Plan.

Preparer: _____ Date: 8/17/15
James Elsberry, P.E.

REVIEWERS – I have reviewed the product noted above and find it to be in accordance with the Quality Management Plan meeting project requirements, standards of the profession and Corps of Engineers policies and standards. All comments have been back-checked and closed out to my satisfaction.

QC Reviewer: _____ Date: 8/17/15
Mark Boedtker, P.E.

RESOURCE PROVIDER – I have reviewed and resolved all critical and technical issues. I agree that all project requirements and standards of the profession and Corps of Engineers policies and standards have been met.

Section Chief: _____ Date: 9.9.15
Peter Valentine, PE
Chief, Civil Design Section A

PROJECT: American River Common Features GRR
P2#: 149827
PM: Dan Tibbitts
REVIEW: Engineering Appendix for FRM

DESIGNER: James Elsberry, P.E.
REVIEWER: Mark Boedtker, P.E.
PERIOD OF REVIEW: 8/10/2015 - 8/14/2015

#	TYPE	REFERENCE	NOTES
1	Comment 08/10/2015	Table of Contents, List of Figures	There is no Figure 1 listed. Based on what was deleted prior, it appears it should be "Figure 1 - Study Area Map".
	Response 08/16/2015		Yes that is a good catch. The list of figures has been updated to include "Figure 1 - Study Area Map". Thank you.
	Backcheck 08/17/2015		Comment closed.
2	Comment 08/10/2015	Paragraph 1.3	Change Figure 1-1 to Figure 1.
	Response 08/16/2015		"Figure 1-1" reference has been changed to "Figure 1" and cross link to the figure has been incorporated. Thank you.
	Backcheck 08/17/2015		Comment closed.
3	Comment 08/10/2015	Figure 13	Delete "SEE PLANS" in the figure.
	Response 08/16/2015		Another good catch. The figure was revised with the "see plans" annotations removed. Thank you.
	Backcheck 08/17/2015		Comment closed.

WATER MANAGEMENT SECTION
CERTIFICATION FOR AGENCY TECHNICAL REVIEW

American River Common Features Project General Reevaluation Report
Placer, Sacramento, Sutter Counties, California
Synthetic Hydrology Technical Documentation, Sacramento District
September 2008, Revised January 2009

GENERAL FINDINGS

Compliance with clearly established policy, principles, and procedures, utilizing clearly justified and valid assumptions, has been verified for the subject project. This includes assumptions; methods, procedures and materials used in the analyses; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets the customers' needs consistent with law and existing Corps criteria and policy.

I certify that an agency technical review of the project indicated above has been completed and all technical issues have been identified and resolved. I recommend certification that the quality control process has been completed.

In accordance with CESPD R 11 10-1-8, South Pacific Division Quality Management Plan, May 2000, this letter certifies that the without-project hydrology is appropriate as the basis for use in the hydraulic analysis for the American River Common Features Project General Reevaluation.

Laurine L. White — 26 Jan 2009
Laurine L. White
Hydrologist, SPK
Date

James Chieh — 1-26-2009
James Chieh
Independent Technical Reviewer
Date

John M High IV — 1-26-2009
John M. High
Chief, Water Management Section, SPK
Date

HYDROLOGY SECTION
CERTIFICATION FOR AGENCY TECHNICAL REVIEW

American River Common Features Project General Reevaluation Report
Appendix B, Dry and Arcade Creeks Flow Frequency Curves
And Synthetic 8-Flood Series Hydrographs
Upstream of Steelhead Creek, Sacramento District
November 2009, Revised January 2010

GENERAL FINDINGS

Compliance with clearly established policy, principles, and procedures, utilizing clearly justified and valid assumptions, has been verified for the subject project. This includes assumptions; methods, procedures and materials used in the analyses; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets the customers' needs consistent with law and existing Corps criteria and policy.

I certify that an agency technical review of the project indicated above has been completed and all technical issues have been identified and resolved. I recommend certification that the quality control process has been completed.

In accordance with CESPD R 11 10-1-8, South Pacific Division Quality Management Plan, May 2000, this letter certifies that the without-project hydrology is appropriate as the basis for use in the hydraulic analysis for the American River Common Features Project General Reevaluation.

Laurine L. White — 19 January 2010
Laurine L. White
Hydrologist, SPK
Date

James Chieh — 20 January 2010
James Chieh
Independent Technical Reviewer
Date

John M. High — 19 JANUARY 2010
John M. High
Chief, Hydrology Section, SPK
Date

QUALITY CONTROL CERTIFICATE

Hydraulic Design/Analysis Section, Engineering Division

PROJECT NAME: AMERICAN RIVER COMMON FEATURES (ARCF) GENERAL RE-EVALUATION STUDY
PRODUCT: HYDRAULIC APPENDIX TO SUPPORT FINAL ARRAY OF ALTERNATIVE FOR ACRF STUDY
Actual Completion Date: 9-Sep-15

PROJECT MANAGER: DAN TIBBITTS

Background: [Include project description, technical products, and review methodology]

Additional District Quality Control was performed for the American River Common Features General Re-evaluation Study on the updated portions of the Hydraulic appendix to support the final array of alternatives for the feasibility study. The DQC Certificate from August 13, 2013 still applies as this is an update to that review, not a replacement.

The purpose of this document is to present the summary of hydraulic analyses conducted to support the American River Common Features General Re-evaluation Report (ARCF GRR) Study. This is an executive report of what has been traditionally know as a hydraulic appendix. A collection of technical memorandums (see table below) containing the detailed information typically found in a full version of the hydraulic appendix have been assembled as an office report for reference here at the District. This executive report has been prepared to meet the intention of the new Planning Modernization that USACE has undertaken.

The ARCF study area includes generally the entire Sacramento metropolitan region. The project area being considered for flood damage reduction can be divided up into three basins – Natomas, American River North, and American River South.

Both Flo2D and HECRAS models were used for this effort.

Models and Technical Memorandums Supporting the ARCF Hydraulic Appendix
Hydraulic Models
HECRAS 1-D Hydraulic Model
FLO2D 2-D Hydraulic Model
Technical Memorandums
Sacramento Basin HEC-RAS Phase I Model Development
Sacramento Basin HEC-RAS Phase II Model Development
Sutter Basin HEC-RAS Model Conversion
Datum Conversion
Downstream Boundary Conditions
Gages
Hydrologic Inputs (.dss files)
Highwater Marks
FDA Inputs
FLO-2D Floodplain Mapping Documentation
Levee Breach Sensitivity
Climate Change
Systems Risk and Uncertainty
Interior Drainage
Upstream Alternative Analysis
Calibration

HYDRAULIC LEAD

I have ensured that the above products were prepared in accordance with standard quality control practices. I have also incorporated or resolved all issues identified during District Quality Control (DQC) review.

Title: Jesse Schlunegger		9-11-2015
Print name	Signature	Date

REVIEWERS

I have reviewed the products noted above and find them to be in accordance with project requirements, standards of the profession, and USACE policies and standards.

DQC Reviewer: Peter Blodgett	Title: Regional Technical Specialist, Senior Hydraulic Engineer	
	BLODGETT.PETER.JAMES.1366852340	
Print name	Signature	Date

RESOURCE PROVIDER

I have reviewed and resolved all critical and technical issues. I agree that all project requirements, standards of the profession, and USACE policies and standards have been met.

Section Chief: Jesse Schlunegger		9-11-2015
Print name	Signature	Date

American River Watershed Common Features General Re-evaluation Report Study

SPK HYDRAULIC ANALYSIS SECTION
DISTRICT QUALITY CONTROL REVIEW

HYDRAULIC APPENDIX
DATED FEBRUARY 25, 2013
UPDATED DQC AUGUST 10, 2015

Reviewer: Peter Blodgett, P.E. SPK Hydraulic Analysis Section
Review Date: 12 August 2015
Response Date: xx August 2015
Backcheck Date: xx August 2015

The following describes SPK District Quality Control (DQC) performed for the report noted above.

Responder Comments
Blue – Comment is ready for Backcheck
Dark Blue – 2nd Response to Comment.
Red – Comment needs Discussion or more work to resolve

No.	Date	Notes
1.	Comment	Plate 4 and 5. "ARCF Study Area" should be "project area". The text in the report differentiates between study area and project area and this map is not consistent with that.
	Response	Plates were updated.
	Back-check	Comment addressed and closed.
2.	Comment	Plate 9 and 10. We should avoid the use of the term "repair" because OMRRR is a sponsor responsibility. Need clarification, are these locations of proposed improvements or existing features.
	Response	Plates were updated.
	Back-check	Comment addressed and closed.
3.	Comment	General: Recommend removing all use of recurrence interval from document. Document should use ACE.
	Response	Concur, Recurrence interval has been replaced with ACE.
	Back-check	Report still contains recurrence intervals throughout. However, this is primarily a terminology comment and does not impact the selected plan. Comment closed.
4.	Comment	Section 6.6. This section indicates the stages are based on upstream failures. Is this correct? If so, how was the upstream

		failure scenario determined?
	Response	The stages were not based on upstream failures. The text has been updated. This paragraph was trying to highlight some of the assumptions used for the study.
	Back-check	Comment addressed and closed.
5.	Comment	Figure 6-1. X and Y axis need labels. The x axis appears to be log. However, it should be probability.
	Response	Based on additional comments, this entire section has been removed including this graphic.
	Back-check	Comment addressed and closed.
6.	Comment	Section 7.2. Levee Superiority Suggest including Sanke Gap as a levee superiority reach.
	Response	This section has been rewritten, including bringing in the Sankey Gap as part of the superiority discussion.
	Back-check	Comment addressed and closed.
7.	Comment	Section 7.3. Climate Change.This wording needs to be rephrased. A project would be constructed and maintained to a design flow rate. We should not imply the design is based on maintaining a design frequency. In addition, it appears the LPP is designed to meet the ULOP requirements which are tied to a finding over the ULOP finding period. Was this climate change amount included in the design height of the LPP?
	Response	Text has been updated to reflect this concern. An added increase in height was not included in the Top of Levee Design Height. Much of the top of levee was based on 160,000 cfs coming out of the American regardless of the frequency.
	Back-check	Comment addressed and closed.
8.	Comment	Profile Plates. Text indicates profiles are based on infinite levee height in model. This assumption should probably be included on the profile plates.
	Response	The n-year profiles, Plates 12-24 are for the without project condition and do not include infinitely tall levees in the project area. Plates 31 – 56 show the existing top of levee but include the with-project Alt 1 and Alt 2 water surface profiles that have the project levees raised 20’ to account for any levee raise.
	Back-check	Comment addressed and closed.
9.	Comment	Plate 68. Index point title is wrong. This should be ARN E.
	Response	Concur. Plate Updated.
	Back-check	Comment addressed and closed.

10.	Comment	Plate 70 through 72. - All plates should not use return period. - On Plate 70. Page number is wrong. This should be Plate 70 but text says 72. On Plate 72 text says Plate 70. - The title of these plates says existing conditions but should say future without project conditions. - There term "advertised flow" is not standard terminology. Is this the "design flow" as described in the OMRRR manual? - Check location for flow comparison for yolo Bypass upsteam of Sac bypass. The arrow is shown above the sac bypass but I think this is flow below the sac bypass.
	Response	Return Period corrected to ACE, Plate numbers corrected, Title corrected. Advertised flow is from the DWR 1986 graphic which is supposed to represent the 1957 design flows that should match the O&M manual. The flow for the Yolo Bypass upstream was at RM 45 which is a half mile upstream of the Sacramento Bypass.
	Back-check	Comment addressed and closed.
11.	Comment	Erosion Protection. This section needs to more clearly describe the features that were included in the design and cost estimates.
	Response	Text has been updated .
	Back-check	Comment addressed and closed.

DISTRICT QUALITY CONTROL CERTIFICATE
for GEOTECHNICAL PRODUCTS

PROJECT AND DOCUMENT INFORMATION

Project Name: ARCF GRR

Document: Geotechnical Appendix and Office Report

Project Manager: Dan Tibbitts

Document Completion Date: January, 2013 Document Author: Michael Kynett, P.E.

Reviewer: Anthony Deus, P.E. Senior Reviewer: Mary Perlea, P.E.

The above reviewer will perform the Quality Control Review in accordance with SOP EDG-02: "Technical Product Review Policy and Procedures" developed for the Engineering Quality System. The senior reviewer will provide a review of major assumptions, analytical approaches, significant calculations, recommendations and conclusions.

REVIEW CERTIFICATION

PREPARER – I have discussed the above document and review requirements with the DQC Reviewer(s) and believe that this review is completed and that the document will meet the requirements of the project.

Preparer's Signature: _____ Date: 12 Feb 2013

REVIEWER – I have reviewed the assigned Item(s)/Section(s) noted for the above document and believe them to be in accordance with the project requirements, standards of the profession, and Corps of Engineers policies and standards.

Reviewer's Signature: _____ Date: 12 Feb 2013

SENIOR REVIEWER – I have reviewed and resolved all critical and technical issues. I agree that the item(s)/Section(s) noted for the above document are in accordance with project requirements, standards of the profession, and Corps of Engineers policies and standards.

Senior Reviewer's Signature: _____ Date: 12 Feb 2013

No.	Page No.	Comment	Response
1	xii	Is part of the Yolo Bypass included only because you have that weir structure on the Sacramento River? Otherwise why do you include Yolo Bypass?	The Yolo Bypass is included because it is a critical component to both the Sacramento Bypass Weir expansion and the I Street Diversion Structure. The study has expanded to look at features outside of the existing flood protection system that may benefit the study area.
2	Xiii	What about the windows? Do you want to discuss them here?	Windows are a component to the WRDA 96/99 project, the with project assumption is that the WRDA 96/99 project is completed. A discussion of the windows sites is a detail associated with the WRDA 96/99 project and not relevant to the ARCF GRR.
3	Xiii	No blanket?	The geology of the MCDC area is not riverine (riverbank formation) but modesto formation associated with the foothills. The subsurface conditions consist of low permeability dense/stiff silty sand and sandy silt. Essentially there are not the typical blanket/aquifer layers associated with riverine geology.
4	xv	I am not sure we want to show what has been constructed as part of NLIP. NLIP is approved for credit after the Natomas NPACR is authorized, we consider the NLIP improvements as non-existent and have them included as preferred plan in our proposal, so I would not say anything regarding the already improvements in place recently done by NLIP. However you can mention that there is additional information available from NLIP studies only.	Correct, the references to NLIP and constructed features associated with NLIP have been removed from the report text. Reference to the implementation of the NPACR as part of the without project conditions for the ARCF GRR remain.
5	xv	Delete this completely, we disregard the NLIP construction at this stage. However you may indicate the levee improvement such as cut-off wall and others was included in NPACR, and the Chiefs report approved,	See response to previous comment.

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		but do not say constructed.	
6	Xvi	Are you sure that this is for 200 year flood? The levees are designed for 200 year +3 feet of freeboard, so if 1 foot is lost than the freeboard is only 2 feet.	The seismic criteria came directly from Vlad's draft ETL on seismic analyses of levees, I can only present the criteria as it has been written in the draft ETL.
7	xvi	I would not write this, it is less stringent than the SOP which we actually apply being in the SPK	Agreed that it is less stringent, but in this section of the report I am presenting the various criteria associated with the federal levee section from the national to local level.
8	Xvii	Actually there is a typical cross section that is 1V:3H waterside, 1V:2H landside and 20 feet wide crest. Exceptions may be at ramps, pump stations and other encroachments where the levee varies from the typical cross section, but you cannot say there is no typical cross section,.	There might be some confusion here, the text does not say that there is no typical levee section of the existing levee but that there is variability in the levee section and the critical section was chosen. Further, the typical existing levee section varies for each channel.
9	Xvii	Say something regarding the Datum used (NAVD88) also regarding the horizontal datum.	Reference to datum has been included.
10	Xvii	Do you really need to show all these details on HH? These may confuse only the reviewers. What if you simply said the data was obtained from HH studies, list the years and this is all.	I believe it is warranted, the H&H changed so many times that it was confusing for us to track what version we used on what analyses and it is important to document the process and why.
11	xvii	Usually we extended the model to the centerline of the river, this is a requirements we always used, and was also imposed to the URS models for ULE. The models used bathymetric information from ULE survey	Correct, this is what we did as well. The text has been updated.
12	xviii	Did we not use wedge analyses when a thin clay layer would indicate that this would be appropriate?	No, for feasibility we used circular searches to find the critical failure surface. We acknowledge that a noncircular failure surface maybe critical in some locations but that would not have a significant

No.	Page No.	Comment	Response
			effect to the results and is a PED level refinement.
13	xviii	Seepage or combined berms were not analyzed at all? I believe we had some in Natomas at least.	Berms were not analyzed, berms were screened prior to analyses using maximum sections for cost and real estate analyses. The berms in Natomas were analyzed under NPACR and only levee raise was analyzed in Natomas under the ARCF GRR.
14	xix	Was this included in the acronyms?	Yes.
15	xix	Was this included in the acronyms?	Yes.
16	xx	I suggest spelling it out, you do not write the report in acronyms only.	Text revised.
17	xx	I suggest spelling it out, you do not write the report in acronyms only.	Text revised.
18	xx	Again, I am not sure we want to include NLIP improvements since the ANLIP is not yet credited and the "without project" conditions assumes NLIP not being constructed,	Text revised as per previous comment.
19	xx	What about tributaries such as Arcade Creek, NEMDC, Dry Creek?	Correct, deficiencies remain on those channels. The point I was making was that the majority of deficiencies and the most serious ones remain on the Sacramento River.
20	xx	There are no other deficiencies here? I was sure we have some seepage and slope stability issues also besides freeboard. Am also , generally, may we ask in the official report for 3 feet of freeboard or we need to talk the new language?	Yes, there are other deficiencies remaining. This sentence is just pointing out that there are overtopping deficiencies in addition to geotechnical deficiencies such as seepage, slope stability, and erosion. The text has been updated to be more clear.
21	xxi	Rephrase it, the sentence does not sound right.	Sentence does appear to convey the message of where deficiencies remain in ARN.
22	Xii	It is not clear if these were proposed and constructed already or are not constructed but there is no need for any improvement. I	This paragraph does appear to convey that I have evaluated the recommendations from previous studies as geotechnical acceptable for inclusion in

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		would rather say these were constructed not were proposed.	the ARCF GRR. Some text was revised.
23	xii	Was it not discussed to lower the weir also?	Yes, but it was screened early. This would be covered by H&H.
24	xxiii	Considerations or constrains? I believe there are constrains since it is not recommended.	The considerations were design level recommendations that would need to be implemented during further study if the alternative were recommended as the tsp. They are not constraints that eliminated the alternative as viable.
25	xiii	I suggest spelling out the first time, particularly in the Executive summary –	Text revised.
26	xiii	This entire paragraph is somehow confused. I do not understand why the additional 60,000 cfs discharged in the Yolo Bypass would increase the capacity in the Deep Water Sheep Chanel. Actually what you probable want to say is that the additional discharge in the Yolo Bypass would require additional work on the levees on both sides of the bypass by relocation, setback, raising and improvements such as seepage and slope stability mitigations to preserve the 6 feet of freeboard as required for a Bypass levee and to improve seepage and stability for a higher water elevation. The water will flow through the Bypass not through the DWSC, so practically it has no impact on the DWSC.	At this point the measures used to mitigate for hydraulic impacts associated with the alternative have not been fully defined by planning, civil, and pm. I have chosen to present the list of possible measures and the geotechnical components so that the PDT can choose which ones they need in the future without revisions to the geotech report. The paragraph referenced presents a summary of the requirements to mitigate hydraulic impacts through improvements to the affected levees in the bypass. The previous paragraph grave recommendations for the geotechnical components to increased capacity in the bypass.
27	xxv	There is no discussion on the borrow material below, it is in the main report only, but not in the executive summary.	Correct, it seemed appropriate to only discuss the needs and how we would obtain the material in the summary. Not the material requirements.
28	8	Do you have all these reports in the references?	Yes.

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29	9	Were the improvements only on American River or included some on Sacramento River also? (i.e. improvement on Sac River for the Pump Station 1.	Yes there were some Sacramento River improvements which were discussed with the other Sacramento river improvements.
30	35	Fix the table to fit on the page width (change fonts eventually) (on all tables eventually)	Table formatting revised.
31	38	Don't forget, NLIP has not been constructed , it is not without project conditions. Rephrase it.	Text revised.
32	39	This is NLIP, not yet constructed,	Text revised.
33	51	You may want to discuss that analyses were performed to determine the levee would respect the seepage and stability requirements in case of a vegetation variance will be requested during the PED	Agreed, this is discussed in a separate section of the report.
34	51	This is not clear, you may need additional description. Anyway, I did not understand what you mean.	Text revised.
35	51	A planting berm cannot serve as access road for vehicular access!	Text revised.
36	51	Are the following paragraphs mitigation measures? I don't think so, these are analyzed alternatives. In this paragraph 8 you have mitigation measures only. You may have eventually a separate paragraph regarding studied alternatives.	As presented these are measures. The Sacramento Weir and Bypass widening is a measure to address overtopping of the Sacramento River and on its own is not an alternative. The I Street Diversion Structure is a measure to address seepage, stability, and erosion on the Sacramento River.
37	51	See the comment above. These are not mitigation measures but alternatives.	See previous response.
38	58	Did you not use an anisotropy 1 for poorly graded sands?	No, all the material parameter guidance at the beginning of our analyses provided a range between 4 and 10 for sands. Since then the ULE

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			study has recommended 1 for clean sands. We could not revise our parameters at that late date and maintain schedule. I have performed a sensitivity study of this and the difference is relatively small. The Kh is vastly more important than Kv for sands.
39	65	Check the numbers. This is after 11.4.5.	Text revised.
40	66	This segment does not meet criteria. You do not have with project analyses results	I believe the wrong results were presented here, the figure has been updated.
41	66	Stability does not meet criteria. You do not have any mitigation measure and with project analyses results?	I believe the wrong results were presented here, the figure has been updated.
42	68	You may indicate this is a new levee designed and constructed to meet recent requirements	I would prefer not to state that. The report presents the construction history of the segment in a previous section. It may not be totally accurate to say that it was designed and constructed to modern guidance as it probably wouldn't meet SOP-003 requirements of the requirements of a 408 review conducted today.
43	68	No with project for stability analysis?	No, the levee meets seepage and stability criteria for top of levee and design water surface elevations.
44	72	It looks like with project barely meets criteria. I suggest to add a table showing the gradients and FS with and without project as a summary.	Correct, this is discussed in text. I would prefer not to add a table.
45	85	May you please check the sentence, it does not sound right	That should have been a report reference, the text has been revised.
46	89	You need to discuss the white paper accepted by the HQ and explain the reasons for non-compliance: the fact that we do not do any work on the landside slope and levee so we do not cut trees there. You cannot	Correct, the text was revised. However, the white paper never went anywhere, I referenced meetings held with HQ that were documented with meeting minutes instead.

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		just say not compliant with no explanation why.	
47	89	Actually the construction on the Sac River is from the landside toe to the river but not on the landside entire 15 feet from the toe. I suggest to indicate a 10 foot wide access road will be constructed along the landside toe , the remaining 5 feet for vegetation free zone will be the responsibility of the Sponsor. Leave it there, do not say when and how. Show it also like that on the drawing. Also trace a horizontal line from the landside toe to show the corresponding toe of the levee on the waterside slope, to show that trees are above the toe	As per our conversation, the 15 feet vegetation free zone would be acquired for the project. The exact details of how the vfz versus the access road were not important for geotech. We decided to simply state for the VVR that a 15 foot vegetation free zone would be acquired as part of the project.
48	92	We need to discuss the stability, I am not sure I agree with it. You need to remove a piece of the levee supposed to be gone due to the tree fall and have a steeper slope, than do a stability analysis for rapid drawdown and one for intermediate river level. I do not really agree or understand what you did so far. Seepage analysis and slope stability of the landside slope is not needed since you have a cut-off wall.	It appears that figure 14-3 was obscured for some reason in the document. As shown in that figure and described in text, the analyses did remove the tree fall scour as described in your comment. Landside seepage and stability was performed to confirm that the tree fall scour did not adversely affect the performance of the seepage and stability improvements.
49	92	I think you need a paragraph regarding the O&M corridor for inspection and maintenance, also show the sketch from Sarah. You can relate these two together if you want but need to discuss it for all areas, including American River.	The O&M corridor will be covered in the planning report as per our meeting with April and Virginia. The O&M corridor is not a geotechnical component and is unrelated to the ability to obtain a vegetation variance.
50	93	NLIP is not yet considered as without project conditions.	Text revised.

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51	93	Say something on the O&M corridor	See previous comment.
52	94	Check numbering	Text revised.
53	96	Is it geotextile or Tensar for reinforcement? Need to specify.	Andy Johnson has design/construction experience in New Orleans with geotextile reinforcement and performed this analysis for us. Geotextile was his preference.
54	96	Fig. 15-4 shows a levee with a cut-off wall, I do not see the cross section with the geoptextile or tensar. May you check again please? Also this figure needs wore work. What is the benching width below the dashed line. We need to discuss it a little.	Correct, the wrong figure was included. An updated figure has been included.
55	99	Use SB for traditional open trench method	I am not recommending one over the other, that is PED. WRDA 96/99 used SCB, it is possible we would again.
56	100	The minimum 1:2 slope is not only for stability but for O&M also (walkable, wowing). You need to indicate a special ground cover is recommended that will not require mowing, if the slope is steeper than 1:2/	That is an O&M/Planning issue. Geotechnical, the geotextile allows for maintaining the existing footprint and slope.
57	100	Do you really need to relocate or replace the open ditch with culverts if you have a cut-off wall?	Yes.
58	101	I do not recall any floodwall for levee raise. You need to show a cross section with the adjacent levee that will be raised to 200 year level of protection also.	Raises were not included in the NPACR, the ARCF GRR did a comparison between an embankment raise and a floodwall raise.
59	103	This is also an improvement in place, so is a continuation of the Par. 15.	The Magpie Creek area does include levees but also several other features. The previous section included solely recommendations for levees within the existing flood control system. The Magpie Creek levees and additional features are

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			not part of the existing system and therefore have been included in a separate section.
60	105	Consider this as Alternatives for increasing the level of protection but not for levee improvements. Suggest to consider it as a separate paragraph.	Again, this is a separate measure associated with levees outside the existing system and is therefore a separate section.
61	106	Should be Part 17	Again, this is a separate measure associated with levees outside the existing system and is therefore a separate section.
62	111	Was this coordinated with Vlad? Why is it different than the entire CF GRR study? It has to be the same seismicity, it is within the basin anyway. Who made this paragraph?	The seismic characterization was done in accordance with Vlad's guidance. The analyses is not different that the entire ARCF GRR study performed by George Hu. The diversion structure was deemed by be a significant structure with critical seismic design considerations and therefore a location specific seismic characterization was performed.
63	124	Indicate there is no improvement for this reach, therefore the same curve is with and without project conditions	Text revised.
64	125	Where is the curve for with project conditions? Do you have any improvement here? It looks like it needs improvement for seepage	No with project analyses was performed. First, this section was not utilized for economic analyses. Secondly, the deterministic analyses met criteria. The BTA was very sensitive to the input parameters and slightly more conservative than the FEM analyses. Instead a judgment call was made to recommend cutoff wall extents and depth based on coordination with DWR/AMEC on the ULE results using information that was not available to us at the time of analyses.
65	127	Why is this the same curve as with project condition? It does not look there is a need for an improvement. You indicate that a cut-off wall is recommended, this means	I believe the wrong results were presented here, the figure has been updated.

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		seepage may be an issue.	
66	129	You need somehow to explain why you do not have any improvements for stability particularly that the Prf is above 15% (which requires mitigations. Actually you may indicate that the high Prf is for water at the crest of the levee, for 3 feet below (design level) it is 0.	Agreed, text revised.
67	133	No erosion protection on this reach? If so, add a reduced curve	Apparently there is, the curve has been revised.
68	136	What do you want to say here?	Text revised.
69	139	Check the two sets. The stability without project condition is flat 0 and with project condition you have a risk up to 10%	I believe the wrong results were presented here, the figure has been updated.
70	139	You need to explain the R&U analysis for the Natomas existing conditions was provided in the NPACR. What you have here is strictly the R&U considering the approved NPACR, only for the additional levee raise. Otherwise it is not clear	Text was already included that described this.
71	139	What about reaches A and B	The report was updated with all the Natomas Curves
72	139	Check the pages, it shows Page 137 of 134?	Formatting changed.
73	149	I am not sure we include anymore the list of approved quarries in the specifications, so I believe you do not have to add it in the report either. Actually you do not add this list in the geotechnical report for the design phase either.	True, for consistency I prefer to keep it in. We provided soil borrow locations so rock locations seem appropriate.
74		Consider the NLIP project not being constructed, not part of the “without	Agreed, comment incorporated.

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		project" conditions, but consider NPACR approved for improvements to the exiting level of protection. I tried to chase down all references to the already constructed NLIP but I may miss some of them.	
75		I would recommend calling the probabilistic analyses Risk Base Analysis. It is strange you have it at the end, however it is explicable because you have included the with project curves. Normally it should be following the deterministic analysis, this actually was the reason for improvements.	While the existing/rescinded USACE guidance (EM/ETL) do reference the analyses as "Risk Based" the comments I have received in past ATR reviews have been technically correct that it is not risk based. The geotechnical analyses we perform is technically correct as probabilistic analyses that is used in hazard analyses. Risk analyses is technically not performed.
76		R&U curves: I recommend reducing the horizontal scale for each segment within the top to toe levee height to make the figures more readable.	I understand the figures are a little hard to read but, the R&U spreadsheet I developed has code that auto creates the x and y axis based on a standard scale for all points regardless of the levee height. That way all of the slopes of the lines in the graphs are equal representations. Reformatting would be significant effort and would no longer provide a standard scale for relative comparison between index points.
77		You should discuss the LSAC rating also as part of the Risk Based Analysis. The HQ is interested to have the rating done before the feasibility report. Showing that you have it done and it is already categorized by LSOG it will help the HQ for a better understanding and for an approval with fewer comments. The geotechnical engineering of this report was actually included in the LSAC. You may just summarize it and indicate the rating for each system. Tony may help you a lot, he did a great job for the LSAC.	Agree, comment incorporated. A section has been added at the end of the R&U section.

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78		Include a paragraph on access road along the levee on the landside, it is completely missing. Add as an enclosure the memo we sent to the HQ asking for the American River landside slope, vegetation issue and ROW and discuss why we don't touch American River landside vegetation and access.	This is a planning consideration, not a geotechnical one.
79		Separate the geotechnical fix in place levee improvement as an analyzed alternative (with subchapter for each basin) and the other 2 (widening the Sac Bypass and diversion structure) present them as separate alternatives not as geotechnical mitigation.	HQ has not given approval of the final array of alternatives. Therefore the alternative descriptions may change. I have chosen to describe alternatives and their geotechnical components so that planning can arrange them as necessary and in accordance with my technical recommendations. The widened Sacramento Weir and Bypass are not geotechnical mitigation, they are hydraulic improvements for increased system performance. I provided the geotechnical measures associated with this feature. The Diversion structure is a measure that addresses seepage, stability, erosion, and overtopping and requires its own set of geotechnical recommendations not associated with the existing flood control system.

QUALITY CONTROL CERTIFICATE FOR COST ENGINEERING PRODUCTS

Project Name: AMERICAN RIVER COMMON FEATURES - GRR
Project Manager: Dan Tibbitts

Technical Products: GRR documents
Actual Completion Date: 9/9/2015

PREPARER – I have prepared the above the products in accordance with Quality Management Plan.

Preparer: date:

REVIEWERS – I have reviewed the product noted above and find it to be in accordance with the Quality Management Plan meeting project requirements, standards of the profession and Corps of Engineers policies and standards.

Lead QC Reviewer: date:

Preparer – I have incorporated or resolved all review issues in accordance with the Quality Management Plan.

Preparer: date:

Resource Providers – I have reviewed and resolved all critical and technical issues. I agree that all project requirements and standards of the profession and Corps of Engineers policies and standards have been met.

Section Chief: date:

Branch Chief: date:

ARCF-GRR

Feasibility Study

EXTERNAL REVIEW

Document Under Review: ARCF-GRR MII Feasibility Cost Estimate

Backcheck Document:

ATTN:

	ADMIN USE ONLY	REVIEWER				RESPONDENT								
	COMMENT ID (DO NOT Edit this Column)	REVIEWER CONTACT INFO	LOCATION IN REPORT/DWG	DATE OF ORIGINAL REVIEW COMMENT MM/DD/YY	ORIGINAL REVIEW COMMENT	RESPONDENT CONTACT INFO	DATE OF RESPONSE MM/DD/YY	RESPONSE	CONCUR	NON-CONCUR	FIO	CARRY FORWARD	CLOSED Y / N	DATE OF BACK CHECK MM/DD/YY
	Date of Document under review and Sub info if appropriate (e.g., "BCI - Dated June 8, 2012")													
1	1	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	Project Properties	5/21/2015	"General" tab - add phone number to contact information and possibly email address	Robert Vrchoticky (916) 557-7336, Robert.D.Vrchoticky@usace.army.mil	5/29/2015	Not enough characters can be input into the 'General' tab so notes have been added to the general 'Notes' tab, authored as POCs.	X				Y	6/19/2015
2	2	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	Project Properties	5/21/2015	"Labor" tab - Please add more specific info on the rates used. DB rates indicate when they were updated.		5/29/2015	Added additional wording to Note - 'Labor Rates are per General Decision Number - CA140009 12/19/2014 CA9 State - California Construction Types - Building, Heavy (Heavy and Dredging), Highway Counties - Multiple (including Sacramento County) '	X			X	Y	6/19/2015
3	3	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	Project Properties	5/21/2015	"Equipment" tab - current costbook being used. Prior to final ATR'd estimate, consider updating to most current fuel rates. Currently they look just a little high, however fuel is ver cycical and may be fine over the long run.		6/12/2015	Fuel Costs updated.	X				Y	6/19/2015
4	4	Joe Reynolds, (916) 557-7573,	Project Properties	5/21/2015	"Notes" tab - Scope is included.		5/29/2015	FIO			X		Y	6/19/2015
5	5	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	Contractors Tab	5/21/2015	All bonds are below 1%. Consider making at least 1%.		5/29/2015	Bond Table 'Class B' typically appear to be low per DQC reviewer's previous conversation with Bid Agent (1-1.2% is more typical). Increased to 1.2%.	X				Y	6/19/2015
6	6	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	Contractors Tab	5/21/2015	Profits generally 8.5% with a few at 10%. Consider getting Profits all up into the 10% range.		5/29/2015	Weights in Profit Weighted Guidelines increased to reflect profit around of just over 10%. Assumed relatively high values due to project size, complexity (confined area, utility crossings), construction duration (10 yr plus), and risk (e.g. unknown utilities).	X				Y	6/19/2015
7	7	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	Project Items Tab	5/22/2015	Zero Quantity Check: You may want to put a note describing the use of "NULL ITEM" - ARS-Reach G/ Levees / Jet Grouting / Random Fill => Zero quantity, please verify this to be the case for this item.		5/29/2015	NULL ITEM' was previously used as a 'dummy' in order to express task duration only (not cost). In this case all those items were part of omitted folders. Deleting the omitte folder removed all 'NULL ITEMs' Quantity in Reach G corrected.	X				Y	6/19/2015
8	8	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach A	5/22/2015	Appears that time at CHP scales along HWY 80 have not been accounted for in haul cycle times. There are scales on both East bound and West bound directions. Any time Teichert-Cool Cave is used as a supplier, this will be the case.		5/29/2015	Added 7 minutes as average wait time at the scales for all trips to-from Teichert Cool Cave.	X				Y	6/19/2015
9	9	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach A	5/22/2015	Several staging areas appear that they will requuire removal of existing elements to be able to gain access to them. Along with this, estimate is also missing the repair of staging areas. Highlighted areas on GE indicate that there are areas that will require repair of gates, fences, grass areas.		6/4/2015	Estblishment and repair of staging area is considered to be part of JOOH costs. Locations identified on Google Earth are not per any design (were a rough guess by the Cost Engineer. Civil Designers have only indicated that about 1 acr per levee mile was needed for staging.		X			Y	6/19/2015
10	10	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach A	5/22/2015	In this reach there are numerous asphalt ramps that are between the top and top of levee that may need to be repaired at completion of project.		5/29/2015	Added costs for resurfacing ramps that appear from Google Earth to be asphalt. Also added costs for regrading, compaction, adding AB to AB ramps.	X				Y	6/19/2015
11	11	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach A	5/22/2015	haul assumptions indicate to midpoint of reach, but do not address how the trucks would make there way onto the levee in one location and off the levee in another. What is missing is the time lost in the various subreaches.		6/4/2015	Checked sensitivity. Determined Haul Routes to Access Pts of subreaches for several reaches. Using the average (not rounded down to the nearest 5 MPH) in the calculations. This resulted in an average increase of 0.14% in the construction costs. This is not considered significant.		X			Y	6/19/2015

12	12	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach A	5/22/2015	Project will require bicycle/pedestrian detours. Estimate does not address this hidden cost.		6/4/2015	No design has been done for this at this stage. Establishment of bicycle/pedestrian detours. Added a percentage cost of 0.5% to cover temporary access ramps, bicycle/pedestrian detours, etc. Folder added under Relocations.	X				Y	6/19/2015
13	13	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach B	5/22/2015	See comments 8, 9, 10, 11, 12		6/4/2015	(8) Added 7 minutes as average wait time at the scales for all trips to-from Teichert Cool Cave. (9) Estblishment and repair of staging area is considered to be part of JOOH costs. Locations identified on Google Earth are not per any design (were a rough guess by the Cost Engineer. Civil Designers have only indicated that about 1 acr per levee mile was needed for staging. (10) No ramps that appear to be available from Google Earth appear to be asphalt. Restablishing any gravel ramps should be a minimal cost and is considered at this time to be covered under mob/demob costs. (11) Checked sensitivity. Determined Haul Routes to Access Pts of subreaches for several reaches. Using the average (not rounded down to the nearest 5 MPH) in the calculations. This resulted in an average increase of 0.14% in the construction costs. This is not considered significant. (12) No design has been done for this at this stage. Establishment of bicycle/pedestrian detours. Added a percentage cost of 0.5% to cover temporary access ramps, bicycle/pedestrian detours, etc. Folder added under Relocations.					Y	6/19/2015
14	14	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach C	5/22/2015	See comments 8, 9, 10, 11, 12		6/4/2015	(8) Added 7 minutes as average wait time at the scales for all trips to-from Teichert Cool Cave. (9) Estblishment and repair of staging area is considered to be part of JOOH costs. Locations identified on Google Earth are not per any design (were a rough guess by the Cost Engineer. Civil Designers have only indicated that about 1 acr per levee mile was needed for staging. (10) Added costs for resurfacing ramps that appear from Google Earth to be asphalt. (11) Checked sensitivity. Determined Haul Routes to Access Pts of subreaches for several reaches. Using the average (not rounded down to the nearest 5 MPH) in the calculations. This resulted in an average increase of 0.14% in the construction costs. This is not considered significant. (12) No design has been done for this at this stage. Establishment of bicycle/pedestrian detours. Added a percentage cost of 0.5% to cover temporary access ramps, bicycle/pedestrian detours, etc. Folder added under Relocations.					Y	6/19/2015
15	15	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach D (alt 1)	5/22/2015	See comments 8, 9, 10, 11, 12		6/4/2015	(8) Added 7 minutes as average wait time at the scales for all trips to-from Teichert Cool Cave. (9) Estblishment and repair of staging area is considered to be part of JOOH costs. Locations identified on Google Earth are not per any design (were a rough guess by the Cost Engineer. Civil Designers have only indicated that about 1 acr per levee mile was needed for staging. (10) Added costs for resurfacing ramps that appear from Google Earth to be asphalt. (11) Checked sensitivity. Determined Haul Routes to Access Pts of subreaches for several reaches. Using the average (not rounded down to the nearest 5 MPH) in the calculations. This resulted in an average increase of 0.14% in the construction costs. This is not considered significant. (12) No design has been done for this at this stage. Establishment of bicycle/pedestrian detours. Added a percentage cost of 0.5% to cover temporary access ramps, bicycle/pedestrian detours, etc. Folder added under Relocations.					Y	6/19/2015

16	16	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach D (alt 1)	5/22/2015	You may have to get creative on the access. On the south end, you may need to move K-rail out of the way and restore at the end of every day.		6/4/2015	At the access point cited (existing K-rail along the road, 20 ft sections), there is an area over 100 ft6 wide where bicycles access the levee. There are about 4 small (6"-12" dia) existing trees that either must be removed, or k-rail removed and re-set each day. There are also two sidewalk access paths. Assumption is that the trees will be removed and replanted and sidewalk will be removed and replaced.	X				Y	6/19/2015
17	17	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach D (alt 1)	5/22/2015	GE layer indicates that there are no seepage issues, but MII indicates installation of DSM, Excavator, and Jet grout in estimate. Also indicates degrade. Please verify quantities, and if needed and remove all related un-needed tasks. Looks as though nothing needed in Old Sac but possibly further south these tasks may be needed.		6/4/2015	Per the quantity takeoff provided by Civil Design, about cutoff wall is required south of about STA 125+00 (intersection of Front Street and Miller Park Circle) Jet grouting is required around two large RC Boxes. Note the shaded area from Google Earth relative to Seepage extends to about STA 96+00, but this is not correct. Civil has not provided an updated kmz file, QTO value and station is used. Quantities for cutoff walls and jet grouting remain unchanged.		X			Y	6/19/2015
18	18	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach D (alt 1)	5/22/2015	Bank stabilization is estiamated using water side placement. Consider using waterside placement for sand filter as well.		6/4/2015	The quarry that the stone protection is expected to come from for waterside placement is not a supplier of bedding sand for the riprap. Sand would have to be hauled from the source to someplace along the river where it would be loaded on barge and then transported via barge for placement at the various slope/erosion protection sites.		X			Y	6/19/2015
19	19	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.a	MII - ARS - Reach D (alt 1)	5/22/2015	This reach indicates slurry wall needed and stationing indicated along top of levee where there is a rail line present. Estimate does not indicate R&R of RR Track.		6/3/2015	RR Track R & R added.	X				Y	6/19/2015
20	20	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach D (alt 1)	5/22/2015	CL stationing appears to go into parking lot of hotel. There does not appear to be any tasks associated with removing & replacing asphalt, and any associated concrete repair.		6/4/2015	This appears to be in ARS E (~STA 239+00 to 247+00). This is not an area of Cutoff Wall placement, but WILL be part of the haul route. Haul Route surface repairs are included under Relocations.		X			Y	6/19/2015
21	21	Joe Reynolds, (916) 557-7573,	MII - ARS - Reach D (alt 1)	5/22/2015	Due to bike trail basically being the haul route, consider adding task to repair bike trail		6/4/2015	Similar to Cmt 12. Levee Access Asphalt Repairs have been added as part of relocations.	X				Y	6/19/2015
22	22	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach D (alt 1)	5/22/2015	Does haul route include getting on levee at one point and getting off at another?		6/4/2015	Similar to Cmt 11. Haul Routes were typically determined using the average distance from the upstream/downstream access points and the midpoint of the reach. Checked sensitivity of this using apparent access points for reaches ARSA,B,C,D. Determined Haul Routes to Access Pts of individual subreaches for these reaches. Using the average (not rounded down to the nearest 5 MPH) in the calculations. This resulted in an average increase of 0.14% in the construction costs. This is not considered significant.		X			Y	6/19/2015
23	23	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach D (alt 1)	5/22/2015	Slurry wall is down center of bike trail which is currently paved but no asphalt replacement included in estimate for repair of this path. Haul route repair description does not appear to cover this item.		6/4/2015	No quantities were provided for this in the Civil Design QTO but it is quite evide from Google Earth. Bike Trail is from ~STA 145+00 to 216+00 and appears to be about 20' wide. Quantities for removal of bike trail, replacement of AC portion of bike trail, and bike trail striping have been added as Relocations. Quantities for ABC below bike trail are included in ABC for levee.	X				Y	6/19/2015
24	24	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach E	5/22/2015	Slurry wall is down center of bike trail which is currently paved but no asphalt replacement included in estimate for repair of this path. Haul route repair description does not appear to cover this item.		6/4/2015	No quantities were provided for this in the Civil Design QTO but it is quite evide from Google Earth. Bike Trail is from ~STA 247+00 to 250+00 (20' w) and ~STA 317+00 to 343+00 (12' w). Quantities for removal of bike trail, replacement of AC portion of bike trail, and bike trail striping have been added as Relocations. Quantities for ABC below bike trail are included in ABC for levee.	X				Y	6/19/2015
25	25	Joe Reynolds, (916) 557-7573,	MII - ARS - Reach F	5/22/2015	ABC notes not clear that it includes the topping on the levee.		6/4/2015	Titles for ABC changed to reflect ABC at levee crest and levee maintenance road	X				Y	6/19/2015

26	26	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach G	5/22/2015	Appears headwall might need to be built out into middle of access road to business on south end of this improvement		6/4/2015	Response from Civil Designer (James Elsberry) - I would think that we would be able to dowel and bolster up this wall where it currently stands. There may need to be some fill brought in to tie-off the extra 1-2 foot of raise through the parking lot, or as comment #27 alludes to, the temporary floodwall system may be altered to add another board or two. We shouldn't need to extend the current length because it would be past the beach levee. If levees were to overtop just downstream, the ARS basin would be isolated. See comment attachment #26-27 (pdf of Google Earth snapshot with comments).		X			Y	6/19/2015
27	27	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARS - Reach G	5/22/2015	Appears existing deplyoable temporary emergency headwall will need to be modified to account for headwall raise. (In GE it appears that there is a concrete band in the existing asphalt that has removable plates to install temp posts.		6/12/2015	Response from Civil Designer (James Elsberry) - I would think that we would be able to dowel and bolster up this wall where it currently stands. There may need to be some fill brought in to tie-off the extra 1-2 foot of raise through the parking lot, or as comment #27 alludes to, the temporary floodwall system may be altered to add another board or two. We shouldn't need to extend the current length because it would be past the beach levee. If levees were to overtop just downstream, the ARS basin would be isolated. See comment attachment #26-27 (pdf of Google Earth snapshot with comments). NOTE from Cost Engineer - This appears to be a stoplog structure. Rough costs have been added assuming a 2 ft added height.	X				Y	6/19/2015
28	28	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.a		5/26/2015	Remove RR ties & track: is missing all removal from site (trucking & disposal). Keep in mind that the rail weighs about 35#/lf and will be cut in ~ 40' lengths		6/5/2015	Added removal costs, assumed 18 TN loads	X				Y	6/19/2015
29	29	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	There are several areas along this reach that will require special care during construction. Design branch needs to give you information or assumptions of scope for these areas. See me if you have questions as to where. These areas are readily visiable on Google Earth		6/5/2015	Response from Civil Designer (James Elsberry) -pump sta at LM 9.91: I would say that this area would be analyzed futher in PED to determine whether or not slope stability is even a problem here. The access ramp provides additional width to levee and serves as a stability berm (to a degree) and therefore geotextile may not need to be applied here. A fix type 3B was proposed here, however, it may be suitable for jetgrout depending on whether or not service of this utility can be interrupted. -It's unlikely that the freeport bridge area would require slope stability measures, it's a very wide levee here. If stability was still a concern it would likely be applied on the east side of hwy 160, where the embankment slopes gently down into the golf course. -marina wall: assume removal of keystone wall, placement of geotextile, and slope back from existing into parking lot. The real estate costs will handle the damages for taking and relocating some of their parking. See comment attachment #29 (pdf of Google Earth snapshot with comments). Note from Cost Estimator - quantities for geotextile and slope back are assumed to be covered by the quantities per the QTO as these were developed from cross-section templates. Costs have been added for removing keystone wall and parking lot paving. From above, assumes keystone wall IS NOT replaced.	X				Y	6/19/2015
30	30	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Levee Stripping, to Spoil: Does not appear to have dump fees included unless there is a reason not to include.		6/4/2015	Spoil site is assume to be the borrow site, but this is left up the contractor. Material should be similar to the degraded levee spoil.		X			Y	6/19/2015
31	31	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Levee Excavation, to Stockpile (Degradation of Levee): Consider reviewing this reach. Not all areas will allow this type of operation		6/5/2015	Turning on Terrain in Google Earth and taking measurements at what appears to be levee hinge points shows the typical top width of the leveee, even when RR present on 20 ft. This should be adquate to allow the levee degrade operation assumed.		X			Y	6/19/2015

32	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	Levee Excavation, to Spoil (Degradation of Levee)	5/22/2015	comment is the same as 31		6/5/2015	Turning on Terrain in Google Earth and taking measurements at what appears to be levee hinge points shows the typical top width of the leveee, even when RR present on 20 ft. This should be adquate to allow the levee degrade operation assumed.		X			Y	6/19/2015
33	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach A	5/22/2015	I'm assuming that Engineering gave you the quantity assumptions used in the estimate. From out conversations, it appears the same section used for American River is the same as that used for Sacramento River, they typically have little in the way of "fixes". See comment 35.		6/5/2015	Per the Civil Designer (James Elsberry) Yes, we did use the same 'bank' or 'no bank' section for both sides depending on the existing condition. The thought process here was that even if we made more cross section details for estimates, we still would be adapting the design to provide the same amount of launchable rock quantity (to address scour and erosion). In early estimates, we did have more cross sections and found that the quantities did not change significantly. Therfore, at the time we reduced the effort to a typical section since rock is the major cost driver for erosion protection fix, and the quantities would be designed very similarly.			X		Y	6/19/2015
34	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach B	5/22/2015	Fish monitoring included in "Fish & Wildlife mitigation", However there will be no inwater work in this reach. Is this item needed?		6/12/2015	Per the Environmental Planner (Anne Baker), The fish monitoring is for Green Sturgeon – critical habitat for Green Sturgeon goes to the Highway 160 Bridge on the American River, and all of the Sacramento River reaches. The monitoring would be mitigation efforts for effects we have on Green Sturgeon. The geographic extent of where we would be monitoring has not been determined yet – it is still being sorted out through our ESA consultation. But the likelihood is that we may have monitoring activities occurring anywhere that is critical habitat for green sturgeon in the study area. Additionally, we are assuming that we are having in water work on both rivers. It is only the reaches where we do launchable trench where there would be no in-water impacts. Removing the line item from Reaches B and C on the American River is reasonable, but make sure to maintain the same total for the fish monitoring effort, because that was based off of the efforts on SacBank. NOTE: Fish Monitoring removed from this reach. Per the requirement of the Environmental Planner, spread between other reaches on American River.	X				Y	6/19/2015
35	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Most if not all of the Fish and Wildlife Facilities work would be appropriate if the levee touched water, but the project levees in this reach do not normally touch unless the storm flows breach the normal river banks and actually get to the levees which are significantly away from the banks.		6/5/2015	Per the Civil Designer (James Elsberry) - We do have erosion protection work in Reach B, but not a lot (1000').		X			Y	6/19/2015
36	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach C	5/22/2015	See comment 35		6/5/2015	Fish and Wildlife Mitigation for Reach C is mitigation for vegetation removal, not fish monitoring.		X			Y	6/19/2015
37	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Hydroseed application time appears low. What does "Prep time" consist of? Does the .5 acr/hr include the double placement? Rough SWAG would hav been ~$4k/acre which includes mob/demob of crew/equip.		6/12/2015	Changed method of calculating these costs to using Cost Book assuming costs similar to seeding with field mix. This gave aunit costs of $4350/ACR.	X				Y	6/19/2015
38	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Levees and Floodwalls (Sta 39+50 to 52+00; cutoff wall): Estimate appears to be missing replacement of existing AC at top of existing levee.		6/5/2015	Levee is NOT topped with AC in this area (ABC only)		X			Y	6/19/2015
39	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Base rock placement looks short time wise. It is only 727 tn, but the thickness is thin, width is short and length is long. Consider 2 day min.		6/5/2015	Combined tonnage of ABC for the reach is actually 859+727=1586 TN. Total time for placement is 18 days calculated, 20 if productivity is factored in. Length is less than a mile combined. UC is almost $80/ton		X			Y	6/19/2015
40	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	CL stripe at (E) bike path		6/5/2015	Levee is NOT topped with AC in this area (ABC only)		X			Y	6/19/2015

41	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	It appears that levee improvements from station 49+50 to 65+00 may have been built already or are in final design stage. Please verify that this reach is needed in this project and can be removed from this project.		6/12/2015	Per Civil Designer (James Elsberry) The quantities under the feasibility folder <\\amethyst\civcad_2\AmerRiv\CommonFeaturesGRR\Civil\Feasibility Quantities\Alt 1\ARN> have accounted for the WRDA99 NEMDC North project. See comment attachment #41 for approximate clearances at the Arden Garden Connector Bridge in ARN Reach C. Suggest estimating the jet grout portion as 80' long x 80' deep = 6400SF. NOTE from Cost Engineer: Replaced 6400 SF of DSM Wall with Jet Grouting.	X				Y	6/19/2015
42	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach D	5/22/2015	Estimate missing removal of existing floodwall from ~sta. 68+00 to 110+00		6/12/2015	per Civil Designer (James Elsberry)Correct, originally we were just bolstering the existing wall along Arcade Creek because we did not have seepage improvements. However, the current geotech appendix has seepage/stability improvements for the whole length of Arcade reaches. Therefore, we cannot build the cutoff wall without the demo of existing floodwall and subsequent rebuild of a new larger floodwall. Reach F and G do not have existing floodwall. NOTE from Cost Engineer - Demo/Removal of existing concrete floodwall has been added to ARN, Reaches D and E	X				Y	6/19/2015
43	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Has additional time been added to production for crossing the major streets in this section? (Rio Linda Blvd, bike path, Norwood)		6/12/2015	Production Rate has been reduced for the crossings of major streets		X			Y	6/19/2015
44	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Repair of existing asphalt & concrete at the road crossings?		6/12/2015	Costs have been added for resurfacing AC and concrete at road crossings for Reaches ARSA, ARND and ARNE.	X				Y	6/19/2015
45	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	There are several storm drain closure valves along this reach. I do not see where the pipes are dealt with in any manner. Is there anything that needs to be done with these" (83+00 is in estimate, structures at 93+00, 102+50, 106+00 not in estimate)		6/12/2015	Excavation, removal and replacement of pipe added to estimate. Per the Relocation Inventory for Reach D, these stormdrains have existing positive closure structures. (Assumed Util Fix 3A, sans positive closure structure).	X				Y	6/19/2015
46	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach E	5/22/2015	From station 70+00 to 110+75 (~4075 lf), there appears to be a concrete flood wall. Estimate includes the construction of 4400 lf of floodwall. Is estimate appears to be missing the removal of this wall for the degrade of the new slurry wall.		6/12/2015	per Civil Designer (James Elsberry)Correct, originally we were just bolstering the existing wall along Arcade Creek because we did not have seepage improvements. However, the current geotech appendix has seepage/stability improvements for the whole length of Arcade reaches. Therefore, we cannot build the cutoff wall without the demo of existing floodwall and subsequent rebuild of a new larger floodwall. Reach F and G do not have existing floodwall. NOTE from Cost Engineer - Demo/Removal of existing concrete floodwall has been added to ARN, Reaches D and E	X				Y	6/19/2015
47	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Between stations 70+00 to 100+00, there appear to be several SD vaults with cooresponding outfalls shown on GE. Estimate does not indicate any relocations within these stations. Are these missing from the estimate/relocations list?		6/12/2015	Excavation, removal and replacement of pipe added to estimate. Per the Relocation Inventory for Reach D, these stormdrains have existing positive closure structures. (Assumed Util Fix 3A, sans positive closure structure).	X				Y	6/19/2015
48	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Please review fiber roll cost. $8/lf direct cost looks high. Maybe look at CalTrans for comparison		6/5/2015	Per CalTrans Historic Costs, this number shoud probably be more in the $4-$5/LF contract cost. Change made typically reflects $3.50/LF sub bid, $4.59/LF contract cost.	X				Y	6/19/2015
49	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Silt Fence Install: Consider adding riding trencher to help production of installation of fence.		6/5/2015	Per CalTrans Historic Costs, this number shoud probably be more in the $4-$4.50/LF contract cost. Adding trencher and bumping production to 120 LF/HR gives a contract cost of about $4.22/LF.	X				Y	6/19/2015
50	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach F	5/22/2015	Review this reach with engineer. More effort shold be done on the portion of wall that goes underneath I-80 bridge. Can excavator method or DSM physically be used or will jet grout be required?		6/5/2015	Discussed with Civil Designer, changed estimate to reflect jet grouting instead of DSM under bridge. Length of wall under I-80 would be ~145' at 80' depth = 116,000SF.	X				Y	6/19/2015

51	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		5/22/2015	Please review the haul costs associated with this reach. Access is limited due to RR and crossing points are beyond the reach limits		6/8/2015	Haul Costs revised to reflect longer access. Length of haul along levee increased to reflect 3.8 MI of levee.	X				Y	6/19/2015
52	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach G	5/22/2015	There is a power line at 25+50. How does this effect construction efforts?		6/8/2015	Power line will not affect construction efforts in this reach. Work is from Sta ~93+00 to 117+25	X				Y	6/19/2015
53	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach H	5/22/2015	No work, no comments		6/8/2015	FIO			X		Y	6/19/2015
54	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	MII - ARN - Reach I	5/22/2015	Box culverts mentioned in estimate, where is it being constructed?		6/8/2015	This quantity comes from the Magpie Creek CAP study quantities (basis for the work done in Reach I). The box culverts will actually be constructed in Reach G, where there is a bike trail that parallels Rose St and crosses the levee. There is a bike trail bridge over the Magpie Creek channel just North of the levee (between ARN-G Sta 90+00 to 95+00). The culverts will be built roughly adjacent to the bridge.			X		Y	6/19/2015
55	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	ARCF_GRR_SBW-Extend_Bridge (Alt2) MIIv4.2 141020	6/3/2015	Quantity of rail material is incorrect. 100 #'s is the correct weight per yrd (3 ft). Actual weight required is 33.3 #'s/lf = 106,560 #'s		6/8/2015	Weight revised to reflect 100 LB/YD (33.33 LB/LF) NOTE: # of ties revised to reflect 19.5" spacing	X				Y	6/19/2015
56	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil		6/3/2015	Verify quantities of tie plates, spikes. Quantities not making sense when comparing with Excel quantity sheet		6/8/2015	Revised quantities to reflect 2 tie plates per tie and 4 spikes per tie plate	X				Y	6/19/2015
57	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	TPCS form Alternate 1.	6/3/2015	Verify mid-points of construction. See spreadsheet that calculates midpoints. Keep in mind that the formulas are written to start at beginning of "Pre-construction" and end at the last task. Some of these are by construction season. Check not done on Alt2 but presume similar issue.		6/8/2015	Mid-points of construction will be verified from SS after final MII estimate completed.	X				Y	6/19/2015
58	Joe Reynolds, (916) 557-7573, Joe.L.Reynolds@usace.army.mil	TPCS form	6/3/2015	All numbers have not been reviewed and will be reviewed at a later time prior to Cost Cert. This will be an itterative process and will need to be looked at again.		6/8/2015	FIO			X		Y	6/19/2015
59	Cameron Sessions, (916) 557-7896, Cameron.L.Sessions@usace.army.mil	Total Project Schedule	6/1/2015	Default Calendar for design is 5 day per week which provides a conservative timeframe at this stage of development	Robert Vrchoticky (916) 557-7336, Robert.D.Vrchoticky@usace.army.mil	6/3/2015	FIO			X		Y	6/19/2015
60	Cameron Sessions, (916) 557-7896, Cameron.L.Sessions@usace.army.mil		6/1/2015	Plant Maintenance is an important feature of the schedule, but the roll up calendar does not break out this information in a clear manner. Construction is complete in Sept 2028; however, plant maintenance extends the overall duration out to Jan 2031. Consider grouping "Plant Maintenance" as a Maintenance group instead of including with construction in order to better convey the split in total time between construction and plant maintenance.		6/18/2015	Plantings 'Maintenance' (Establishment) has been split from Construction	X				y	6/19/2015
61	Cameron Sessions, (916) 557-7896, Cameron.L.Sessions@usace.army.mil		6/1/2015	Task 3 "Collect field explorations" does not have a predesessor activity, but has a start constraint assigned for October 2017. Please confirm this is the intended start of the activity and consider removing the constraint if possible.		6/18/2015	Constraint removed. Start Date entere into Project Information	X				y	6/19/2015
62	Cameron Sessions, (916) 557-7896, Cameron.L.Sessions@usace.army.mil		6/1/2015	Task 473 "Vault Foundation" does not have a predesessor activity		6/18/2015	Task has been given a predecessor activity	X				y	6/19/2015
63	Cameron Sessions, (916) 557-7896, Cameron.L.Sessions@usace.army.mil		6/1/2015	Task 709 "Levee Excavation" does not have a predesessor activity		6/18/2015	Task has been given a predecessor activity	X				y	6/19/2015
64	Cameron Sessions, (916) 557-7896, Cameron.L.Sessions@usace.army.mil		6/1/2015	There are 317 tasks without successor activities. Without proper assignments, it can be impossible to reflect a true critical path or understanding of the project		6/18/2015	All tasks have been given a successor activity	X				y	6/19/2015

65	Cameron Sessions, (916) 557-7896, Cameron.L.Sessions@usace.army.mil		6/1/2015	The level of detail regarding construction and utility relocations is very detailed and appears to be very thourough for this stage of design		6/3/2015	FIO			X		y	6/19/2015
66	Cameron Sessions, (916) 557-7896, Cameron.L.Sessions@usace.army.mil		6/1/2015	Durations: There are 225 activitys with a duration of 5hrs - at the feasibility stage it is not normally recommended to have durations of less than 1 day. No need to revise, but please note for future estimates/schedules.		6/3/2015	FIO			X		y	6/19/2015

REVIEWER
BACK CHECK COMMENT **(Needed Only If NOT Closing Comment)**
Item will need to be updated to latest labor rates before you/we finalize TPCS prior to certification. Okay for now.

USACE District Quality Control / Quality Assurance

Project: American River Watershed Common Features, General Re-Evaluation Report (ARCF GRR)
Submittal: Attachment E, Erosion Protection Report
Section: Hydraulic Design Section (CESPK-ED-HD)

Hydraulic Design Documentation and Products reviewed:

1. Document, American River Watershed Common Features, General Re-Evaluation Report, Erosion Protection Report, Draft Version, Dated January 23, 2014

File Location:
\\amethyst\civcad_2\AmerRiv\CommonFeaturesGRR\Hydraulics\Erosion\ErosionSummary_ForGRR\DQC_Review\Certification\

Limitations of Review:

The review is limited to the document which is a summary of existing documents, analysis, models, and data. The review does not include review of the referenced documents, analysis, models, or data. The review of these was conducted separately.

(1) Designers: We have prepared the above products in accordance with the Quality Control Plans meeting project requirements, standards of the profession and US Army Corps of Engineers policy, essential engineering guidelines and standards. All comments resulting from DQC review have been entered into DrChecks and resolved.

_____ 2/11/2014
Todd Rivas, P.E., Senior Hydraulic Engineer, CESPK-ED-HD Date

_____ 2/11/2014
Scott Stonestreet, P.E., Senior Hydraulic Engineer, CESPK-ED-HD Date

(2) DQC Reviewer: I have reviewed the above products and find them to be in accordance with the Quality Control Plans. This includes review of assumptions, methods, procedures, and material used in analyses, alternatives evaluated, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing US Army Corps of Engineers policy. All comments have been entered into DrChecks and resolved to my satisfaction.

_____ 2/11/2014
Ethan Thompson, P.E., Senior Hydraulic Engineer, CESPK-ED-HD Date

(3) QA Reviewer: I have performed Quality Assurance review of the above products and confirm that all critical and technical issues resulting from DQC/QA review have been addressed. All DQC comments and responses are loaded into DR Checks under Project ID: "*149827 GRR*", Project Name: "ARCF - General Reevaluation Report (GRR), TSP & Attachments, American River Common Features (ARCF)," Review Name: "*DQC Erosion Attachment*".

_____ 2/11/2014
Jesse Schlunegger, P.E., Acting Chief, Hydraulic Analysis Section, CESPK-ED-HA Date

_____ 2/11/2014
Greg Kukas, P.E., Chief, Hydrology and Hydraulic Branch, CESPK-ED-H Date

Comment Report: All Comments
Project: ARCF - General Reevaluation Report (GRR), TSP & Attachments, American River Common Features (ARCF), California (P2 #149827)
Review: DQC Erosion Attachment (23-29 Jan 2014)
Displaying 96 comments for the criteria specified in this report.

Id	Discipline	Section/Figure	Page Number	Line Number
5501895	Civil	n/a	Page 22	n/a

Comment Classification: **For Official Use Only (FOUO)**

Page 22, 3rd paragraph, second to last sentence, change "regarding" to "regrading".

Submitted By: Markus Boedtker ((916) 557-6637). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**
Thanks. Text has been changed to "re-grading".

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Markus Boedtker ((916) 557-6637) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5501899	Civil	n/a	Page 58	n/a

Comment Classification: **For Official Use Only (FOUO)**

Page 58, paragraph 6.2, it should be recommended that the most recent Sac Bank designs should be used as the template for the bank protection design, due to this being the most recently coordinated design that does not require additional mitigation, other than the instream woody material, willow pole cuttings, and soil-filled quarry stone with various native plants and trees planted on the entire slope.

Submitted By: Markus Boedtker ((916) 557-6637). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**
The current design concept was developed with PDT input including geotechnical design and environmental planning. It has been analyzed and described within the EIS and any additional mitigation has been assessed (and costs added).

It is agreed that this design should be analyzed further in PED to determine if there's a more effective design but the current design should provide adequate costs for alternative selection.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Markus Boedtker ((916) 557-6637) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5501904 Civil Figure 6-1 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Figure 6-1 should be changed to the most recent Sac Bank design showing in-stream woody material, soil-filled quarry stone, and native trees and shrub plantings along the entire slope. This design is the only one that does not require additional mitigation outside of the bank protection work.

Submitted By: Markus Boedtker ((916) 557-6637). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**
The current design was developed with input from the PDT including geotechnical design and environmental planning. This design has been determined to be adequate to develop costs for alternative selection. For feasibility design, the PDT will need to either refine or revisit the design to determine if it is effective in setting costs for PED. Additional design effort or cost and schedule risk analysis will be performed to ensure costs are adequate for PED.

In PED, the final design will be determined based on additional analysis and coordination with environmental planning, geotechnical design, levee safety, and others.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Markus Boedtker ((916) 557-6637) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502007 Civil n/a General Comment n/a

Comment Classification: **For Official Use Only (FOUO)**

This report is actually confusing. The report is the erosion attachment of the Common Features GRR and therefore it should evaluate the erosion and the necessary erosion protection for all channels considered in the American River Basins (north and south). It should describe in the same manner all channels such as Sacramento River north and south of the American River, American River, Natomas Cross Canal, NEMDC, Arcade and Dry Creek, eventually Pleasant Grove Creek if considered necessary. The erosion on the American River was detailed studied at the request of an expert elicitation team. Therefore there were additional subsurface investigations performed in the

riverbanks and riverbed to evaluate the erosion conditions of the soils. The results of this additional study should be included as a separate enclosure to this report and only the conclusion of the study and the proposed remediation actions should be described in the main erosion appendix. As the report is structured it goes back and front from detailed analyses and descriptions (for American Rover) to poor or lack of description, or even wrong description, of the conditions of the other channel.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

Intro section text has been revised to clarify how erosion was handled on each reach for the study. Some reaches were handled as part of the Natomas PAC, and other small reaches were assumed to need minimal additional erosion analysis that will be deferred to PED.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502023 Civil 1.3 BAckground n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Since this is the erosion report for the entire project area this figure should show also the Natomas Cross Canal and the levees on the Arcade and Dry Creek and the other tributaries discussed in the text. If these tributaries have no impact it should not even be mentioned in the text (i.e. Feather River is also a tributary and is not included). Also each channel name should be shown on the figure not only the American River and Sacramento River. This report will go to ATR outside the district which don't really know where these channels are located.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

Intro section text has been revised to clarify how erosion was handled on each reach for the study. Some reaches were handled as part of the Natomas PAC, and other small reaches were assumed to need minimal additional erosion analysis that will be deffered to PED.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5502024 Civil 1.3 & 1.4 Background n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The background description of the Natomas Cross Canal, NEMDC, Arcade and Dry Creeks should also be included

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

Intro section text has been revised to clarify how erosion was handled on each reach for the study. Some reaches were handled as part of the Natomas PAC, and other small reaches were assumed to need minimal additional erosion analysis that will be deffered to PED.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502026 Civil 1.3 Background n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The study done by AYRES in 20032 is complex and should be also used and listed in the references.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **For Information Only**

I am not aware of an Ayres report dated 2002; however, section 1.7.1.4 of the erosion report summarizes the 2-D analysis Ayres conducted which computed 2-D velocities and shears for a range of large steady-state discharges (Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events" dated July 2004 by Ayres Associates). Furthermore examples of the results from this investigation are presented in Section 4.2.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502029 Civil 1.3 Background n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

This is the erosion report for the entire American River Basin which includes the north and south basins with the tributaries and also Sacramento River. The report should clearly justify why the additional investigation was performed only in the American River riverbad and not also on Sacramento River, particularly that there is a known extremely deep (about 80 feet) scour in the Sacramento River close to the confluence with the American River.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**
The erosion report is for the American River Common Features GRR. Text has been added to clarify how erosion conditions were addressed for each of the reaches in the study. The Sacramento River below the confluence does have an assessment of the erosion conditions in this report.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502086 Civil 1.4 Background n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The title Middle Reach – Verona to Sacramento, it does not really make sense. Is this the City of Sacramento or only on Natomas? It should be described probably as Verona to American River confluence. Same to the next reach of the Sacramento it should be described as Confluence with the American River to Freeport eventually. Just River Miles are not sufficient to describe the reach. Show these reaches also on Figure 1-2

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**
This text has been revised to remove the "middle" terminology and include more description of the reach.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502091 Civil 1.4 Background n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

As a general comment, the report is mostly an HH report but also it is related to levees. Therefore, it would be nice to have also the levee unit and levee mile shown in parentheses, since this is the unit shown on the O&M manuals

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

I concur that it would be "nice" to include a lot of the detailed mapping and other supporting information in th erosion report. However, inclusion of this information could require a lot of effort (which isn't readily available) and as stated in the comment, it is already available in the O&M manuals should this information be required. I am not sure how providing this detailed information would add to the discussions present in the document. The levee units and/or levee stationing is not referenced anywhere within the document.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502150 Civil 1.4 Background n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Sacramento River South. There is a scour hole (stable in the last years) about 80 feet deep in the Sacramento River south of the American River. Even if the location of the channel did not move the last 150 years there are scours that should be considered and riverbank and levee erosions during high flood events that should be considered.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

Clarified that even though the channel has not changed location much in 150 years, that local scour and erosion issues can still develop. Here is the language:

"The location of the channel has been relatively stable for the past 150 years although local scour and erosion can still be an issue."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502151 Civil 1.4 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The description of the two reaches is wrong. The riverbanks are more used by the public on the Sacramento River north reach where there are houses and restaurants constructed on the waterside of the levees plus numerous docs. Both levees on the middle and south reaches are constructed of sand. What is typical on the middle reach closer to the American River is the fill placed on the riverbank against the levee and the numerous structures (residence and commercials) constructed on the fill. The south reach has no structures on the waterside of the levee but heavy vegetation, boat docks and indeed boating activity. Show a picture on the middle reach with boats and houses on it since this is the typical there. Indicate also the south reach has rock protection on the majority of the reach but there are places where the rock is missing.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Check and Resolve**

This section can be re-worded. Below is how this was done. The main changes are noting the waterside structures in the middle reach, noting that the middle reach is also constructed in the same manner as the south reach, and clarifying the general public foot access along the south reach contributes to levee and bank erosion while the waterside private residences of the middle reach limits the public access along the levee and banks.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

2-0 Evaluation **Check and Resolve**

I believe the word "middle" was either removed or clarified and discussed in the revised text. This revised text should be available soon (maybe by close of business today).

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

Backcheck not conducted

Current Comment Status: **Comment Closed**

5502154 Civil 1.4 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Background description of the other channels (NCC, NEMDC, Arcade and Dry Creek) is missing. A brief description of these channels should be included, at least to justify why there is no analyses done and no protection recommended.missing

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **For Information Only**
Please refer to Section 1.3, paragraph 3, exclusion of these tributaries from this report (including the rational for doing so) is discussed therein.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502156 Civil Figure 1-4 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Add (or replace this one)a picture of the Middle Sacramento River showing the fill on the waterside and the constructions on the fill.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**
Replaced with aerial photo showing the waterside fill with houses on top of the fill.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5502160 Civil Par. 1.5.1 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Was the discharge in 1986 130,000 or 134,000 cfs?

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **For Information Only**
Verified with Marcia Bond that the peak release from Folsom Dam was 130,000 cfs from report put together immediately after the event. Verified this by looking at actual gage records, too. Other gages downstream may have recorded higher discharges due to additional inflows and this may be where some people think of the peak flow in the LAR as 134,000 cfs. But the peak discharge from Folsom Dam was 130,000 cfs.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502161 Civil Par. 1.5.1 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

I believe significant erosions occurred also after the 2006 flood event.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**
Added language to clarify:

"In addition, erosion also occurred during a flood event in 2006."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502167 Civil Par. 1.5.2 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

It is important to describe more the bypass system and when it was constructed. This study will be reviewed by ATR and others outside the district and it is important for them to understand the bypass system and how it works.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **For Information Only**
The erosion report focuses on the segments of the lower American River and the Sacramento River in the study area. The report is an attachment to the Engineering Appendix which supports the GRR documentation. Those reports should provide an adequate description of the overall flood control system without the erosion report having to duplicate that information.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502172 Civil Par. 1.5.2 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The subparagraph describing how the levees were constructed is wrong. Levees on the Sacramento River north and south of the American River, considered as part of this study were all constructed in the same manner, of dredged material from the river, and therefore these levees have the same consistency of fine uniform sand extremely erodible. The difference is the fill placed on the riverside berm north of the American River where all these buildings were constructed.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

The paragraph was written to only describe the construction of the Sacramento River levees south of the American River confluence. The comment describes the method used in construction of the Sacramento River levee north of the American River. The text has been revised to describe the construction of the Sacramento River levees both norht and south of the American River confluence. The levees on the Sacramento River in Natomas were constructed with trainer dikes using excavated material from the center of the levee by dragline. The core was then filled using hydraulic dredges placing fine sand. There is no information which shows this was the case on the Sacramento River leves south of the American River. Instead the best information availble indicates the levees were constructed with clamshell dredges placing material on the channel bank to enlarge the original levee constructed in the mid 1800's.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5502182 Civil Fig. 1-8 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The Figure 1-8 represents flood fighting of seepage and slope instability of the levee and has nothing in common with erosion. Remove and replace it with an erosion picture but not with a seepage and slope stability issues picture

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

Photo deleted. The intent was to show levee performance during a flood on the Sacramento River regardless of failure mode and this photo was available. However, it can be confusing to have a seepage/slope stability photo in a document focusing on erosion and therefore is deleted.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502195 Civil Par. 1.5.2 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The conclusion of the paragraph contradicts the paragraph 1.4 -Background, that indicated that the erosion on the Sacramento River is mostly due to waves created by boating and public activity

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Check and Resolve**
Section 1.4 concludes by stating:

"The causes of erosion in this reach are boat wake, wind-wave, mass failure, fluvial processes, and public use."

Section 1.5.2 states by stating:

"Since the completion of the Sacramento River Flood Control Project, significant floods have caused considerable erosion related damage to the levee system."

Erosion during floods occurs by fluvial process and it therefore appears to be consistent with section 1.4 where fluvial processes is mentioned as one of the erosion mechanisms.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

2-0 Evaluation **Check and Resolve**
Fluvial processes (section 1.4) = erosion by floods (section 1.5.2. So I believe they are consistent. Is there some specific language that you want changed?

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014
Backcheck not conducted
Current Comment Status: **Comment Closed**

5502206 Civil Par. 1.6 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Even if there were no significant erosion observed at locations with concrete rubble on the slope, concrete rubble is not recommended for slope protection. It may hide undetected rodent holes or erosions underneath the concrete, there is no bedding or filter material between the rubble and the levee and also there is no correct rock size distribution. The only restriction in the past was that there should not be any R-bars sticking out of the rubble for safety of boating and other public activity.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **For Information Only**

Agree. The erosion report is only reporting observations of conditions from monitoring and is not endorsing use of concrete rubble.

Text changed to clarify:

"These sites reportedly have concrete rubble (does not meet USCAC standards) on the bank and at the toe that is in poor condition; no significant changes in condition have been observed between annual inspections."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5502211 Civil Par. 1.6 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The title should not be DWR but CVFPB

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

Thank you. The text will be corrected.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502619 Civil Par. 1.7.1.1 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Somehow erosion of the riverbed and riverbanks has been mixed with seepage and stability. I agree erosion has an impact on seepage or piping and on the stability and this may need to be more detailed discusses (such as shortening the seepage path, undermining the levee foundation leading to slope failure and so on). But as it is explained and related to scouring and exposure of bridge footing it does not make sense.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Check and Resolve**

Paragraph 1.7.1.1 is a summary of a relatively comprehensive geomorphic analysis. It includes mutliple different observations and recommendations. One observation is that degradation could undermine levee foundations. Another observation is that seepage and piping may be more of an issue than erosion. However, it does not link the seepage and piping to scouring and exposure of bridge footings.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

2-0 Evaluation **Check and Resolve**

The following was deleted per recommendation by Mike:

"The report concludes that bank erosion is less of a problem as compared to seepage or piping although the report cites specific locations where erosion protection is needed."

The only place where the term "seepage" is now used in this section is:

"It is important to note that at the time this report was written, many of the seepage and stability mitigation features had not been constructed along the LAR."

This last sentence is important to keep so that the reader is aware of the time context of the statements and recommendations made by the report.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

Backcheck not conducted

Current Comment Status: **Comment Closed**

5502621 Civil Par. 1.7.1.4 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

What was the reason of the selection of the flow of 145,000 cfs?

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

This section of the document is a summary of work already performed. At one time, this flow was one of the design flows for additional work at Folsom (the enlarged outlets that were then changed to a Spillway).

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502622	Civil	Par. 1.7.1.	n/a	n/a

Comment Classification: **For Official Use Only (FOUO)**

Why is Ayres study done in 2002 for USACE not included. It has important information on shear stresses and velocities associated with different discharges.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **For Information Only**

I am not aware of an Ayres report dated 2002; however, section 1.7.1.4 of the erosion report summarizes the 2-D analysis Ayres conducted which computed 2-D velocities and shears for a range of large steady-state discharges (Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events" dated July 2004 by Ayres Associates). Furthermore examples of the results from this investigation are presented in Section 4.2.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502624	Civil	Par. 1.7.1..5	n/a	n/a

Comment Classification: **For Official Use Only (FOUO)**

What is the frequency associated with 160,000 cfs and why was this the analyzed discharge?

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**

This section of the document is a summary of work already performed. The flow of 160,000 cfs was chosen because that is the design flow of the Joint Federal Project Spillway. The flow of 160,000 cfs is approximately a 200-yr outflow from Folsom and this frequency will be re-evaluated by the Folsom Water Control Manual Update.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5502661 Civil Par. 1.8.1 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Indicate what bench and levee, rich or left bank. Also indicate between what RM the investigation was done.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Check and Resolve**

The erosion attachment was intended as a summary of the erosion study performed as part of the ARCF GRR and as such several details of the study have not been included in the text of the report. We chose not to include a table of explorations as this was considered not a summary item but instead data included in one of the many reference reports.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5502663 Civil Par. 1.8.2 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Were the JET tests performed on samples collected from the riverbed or river banks?

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

Revised Jan 28 2014.

1-0 Evaluation **Concurred**
The erosion rate tests were performed on samples from both banks and from the riverbed.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502677 Civil Par. 2. n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Concrete cobbles should be considered as inadequate for slope protection. The voids in the cobbles may be used for rodent animals also there is no bedding material between the cobbles and the levee embankment or riverbank and the erodible fine material may migrate into the voids in the cobble. Also these cobbles may hide defects in the levee slopes such as internal erosions, slope failures, rodent holes and other

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **For Information Only**
Agree. This document is reporting observed conditions from the field and is not advocating or even suggesting that concrete rubble is appropriate for slope protection.

Added a clarifying sentence at the end of the first paragrah in section 2:

"As shown in Figure 6-3, the tentatively selected plan is to replace the historic revetment (e.g. cobble) with modern revetment to protect the banks from anticipated future flows."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502680 Civil Par. 2 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Par. 2. All the repairs shown on the figures 2-2 to 2-7 show riprap placed 1-2 feet above the water line, when the water was at a pretty low elevation. Is the riprap covered by brush and grass or it is only on a short height of the slope? Is this riprap considered adequate?

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

Revised Jan 28 2014.

1-0 Evaluation **For Information Only**
A channel stability analysis (Ayres Associates, 2010) was used to determine areas requiring revetment with the assumption that all areas without modern revetment will be protected. Modern protection was determined by areas defined as rock riprap with overall condition of good or very good.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5502689 Civil Par. 3.1 & 3.2 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Are the par. 3.1 and 3.2 not related only to the American River? If so say that in the title.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 28 2014

1-0 Evaluation **Concurred**
Titles for these two sections have been modified as follows:

3.1 Geologic and Geomorphic Mapping and Analyses of the Lower American River

3.2 3-Dimensional Stratigraphic Model of the Lower American River

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503129 Civil Par. 4,3 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The threshold analyses is currently ongoing but there are results are not yet available. This project si going on for more than 5 years. If something is not yet ready to be published I believe t would be better not to mention it at all. The report should be complete at this phase not with gaps.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

Section 4.3 has been deleted as suggested. However, this is used as an example of ongoing work to be completed in the future to address observations and recommendations from the expert panels (section 1.7.2.3, last sentence has been added so it now reads: "The District envisions that, as appropriate, the remaining work efforts will be addressed in future studies. For example, there is currently an ongoing channel widening threshold analysis to support changing operations at Folsom Dam."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503155 Civil Par. 5.1, Fig. 5-1 & 5-2 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Were the studies by NHC in 2009 and 2012 not done as a contract with USACE? In this case,. Why the channel degradation in Fig, 5-1 and 5-2 are in meters?

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**

Figure 5-1 and 5-2 originally started in another (non-USACE and non-NHC related) document that was in meters. NHC plotted new data on top of this borrowed figure for illustration purposes and did not atttempt to find the original data supporting the original work effort and convert it to feet for NHC's report to USACE. However, it still provides good information and the effort and cost to convert these figures to feet far exceed the benefits and it may not be possible. However, it is important that the reader understand these figures are in meters and this as been added to the caption as:

"The elevations are given in meters in NGVD 1929 vertical datum and not in feet."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503183 Civil Par. 5.4.1 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

It should be mentioned that the erosion component of the fragility curve is part of the judgment curve and was not estimated based on any analyses but on the experience of an expert elicitation panel, considering the location of the index points, the conditions of the foundation and levee material, water velocity at that specific location, and on past history.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

The discussion in Section 5.4.1, para. 1 will be expanded to include this information. The proposed modification now reads:

"...Furthermore, the engineering judgment component consists of considerations for vegetation, animal burrows, encroachments, utilities, and erosion. It should be noted that the erosion component was not estimated based on any analyses, but on the experience of an expert elicitation panel, considering the location of the index points, the conditions of the foundation and levee material, the water velocity at that specific location, and on past history."

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503201 Civil Fig. 5-12 to 5-14 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Fig. 5-12 to 5-14 are not representative for the erosion report. The high risk of poor performance of the levee without the project is not due to erosion but mostly due to seepage or stability, erosion being a small part of the curve. The reduction in risk is not after erosion measures are considered but after seepage and stability deficiencies are mitigated. The figures should be replaced with the Judgment curves at the same locations , with or without project, to demonstrate the impact of the erosion control measures and the impact of the erosion on the poor performance of the levee.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

The report text has been updated to show the judgment with- and without-project curves as figures. The report text has been updated to explain the differences between the with- and without-project curves, the changes to the erosion portion of the curve, the residual risk captured in the with-project judgment curve, that the American River curves capture the existing cutoff walls, and that the Sacramento River combined curve has seepage and slope stability components as well.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503225 Civil Par. 5.4.1 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

How par. 5.4.1 is written, it lead to the conclusion that cumulative probability of poor performance greater than 50% without project is reduced due to erosion measures to less than 20 percent. This is not correct, the majority of reduction of the probability of poor performance is done by the seepage and mitigation measures, and partially only by erosion protection measures. This is the reason I insist to replace the geotechnicalperformance curves with the judgment curves (Figures 5-12 to 45-14) before and after project which indicates the reduction of probability of poor performance by erosion control measures.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
The report text has been updated to show the judgment with- and without-project curves as figures. The report text has been updated to explain the differences between the with- and without-project curves, the changes to the erosion portion of the curve, the residual risk captured in the with-project judgment curve, that the American River curves capture the existing cutoff walls, and that the Sacramento River combined curve has seepage and slope stability components as well.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

2-0 Evaluation **Check and Resolve**
Report should be available by close of business today.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014
Backcheck not conducted
Current Comment Status: **Comment Closed**

5503226 Civil Par. 5.4.2 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Same comment as for Par. 5.4.1 - American River

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

The report text has been updated to show the judgment with- and without-project curves as figures. The report text has been updated to explain the differences between the with- and without-project curves, the changes to the erosion portion of the curve, the residual risk captured in the with-project judgment curve, that the American River curves capture the existing cutoff walls, and that the Sacramento River combined curve has seepage and slope stability components as well.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5503259 Civil Par. Fig 6-1 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

The cross section should indicate what is the material placed within the launchable rock. If this is a launchable rook the mass of rock should move in case of undermining of the slope or riverbed. However, I assume there is a mass of soil within that rock, so the rock will be replaced by that material in case of undermining and the purpose of this launchable rock is lost, unless the entire mass is rock Also, the rock size distribution is dictated by the velocity in the channel. However, this launchable rock is not designed based on any velocity, it is "one size fits all" rock and may be easily washed away by high velocities. Also I am not sure the launchable rock respects the required specification for rock quality.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

Revised Jan 29 2014.

1-0 Evaluation **Concurred**

The material within the launchable rock portion of the design will be 100% rock. There is no soil within the rock mass that launches. The launchable section is buried to lower the amount that needs to launch and above that section soil is allowed. The rock size was determined on average velocities and verified with recent designs. The launchable rock (specification) is not as critical as volume of rock in determining costs. The design should provide an adequate volume of rock for alternative selection with actual site specific design occurring in PED.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503280 Civil Par. 6.3. n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

I suggest revising the title of the paragraph removing the word "Trench". This is not a trench but a mass of rock placed on the riverbank. There is no trench excavated in the riverbank of riverbed.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Non-concurred**

In this case, the launchable section will be placed in an excavated trench along the waterside levee toe. The detail in the erosion protection report is not as clear as the details in the engineering appendix. See attached detail. The Bank Protection method has a launchable component that is on the riverbank.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014
(Attachment: engineering_appendix_exerpt.docx)

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503383 Civil Par 7.1.3 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

It should mention that the raise of discharge due to Folsom Dam modification leading to higher velocities in American River will have no impact on the propose slope protection. The proposed slope protection was not designed based on the velocity or depth of water, it is a launchable rock with no particularly designed rock size based on velocity and it is placed on the levee to the top of the levee. I assume it is to the top of the levee, however I did not see any recommendation regarding the top of slope protection on Sacramento or American River.

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

We added the following to paragraph 6.1 "The erosion protection was designed to convey the 0.5% ACE (200-year) future condition as described in Chapter 4."

The rock size was determined on average velocities and verified with recent designs. See response to comment 5503390 for discussion on whether design extends to top of levee.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503390 Civil Par 7.1.3 n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

General Comment: I understood the proposed protection is either launchable rock of launchable rock trench. However, I did not see any information if the protection on American River is on the riverbank only or it extends on the slope also, and I did not see any information on the height of the slope protection on the levee (if it is extended on the levee also0. One of the issue of the existing slope protection is that height may not be adequate, therefore on some places where the protection exists it needs to be raised either to the top of the levee or to the design water elevation. Also I did not see any conclusion of the extensive erosion investigation on American River on the riverbed erosion and the proposed mitigation (probable the launchable rock trench, but it is not specifically indicated).

Submitted By: Mary Perlea (916-557-7185). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
The erosion protection is either Bank Protection or Launchable Rock Trench. The Bank Protection protects the existing bank away from the levee toe. This toe protection is intended to protect the levee away from the levee and, typically, velocities at the levee are low enough that slope protection isn't required to the crown.

The Launchable Rock Trench will deploy when the existing berm is eroded away. The river will be allowed to meander and, therefore, the velocities along the levees may be high enough to require protection. The end result is a fully-protected slope to the crown.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mary Perlea (916-557-7185) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503634 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.1, paragraph 1. Is the rationale for the proposed erosion protection based on a quantification of the risk associated with erosion? Justification for project features normally has to go through such an analysis and that should be discussed further here.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Text added to clarify and confirm that a risk analysis was done for the feasibility study.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503635 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.2, paragraph 2. The Natomas PAC did consider erosion, specifically for the Sacramento River north of the American River and the east side tributaries (NEMDC, Natomas Cross Canal, etc). This may not be clear in the PAC documentation, but it should be referenced and discussed. Does this new erosion appendix supersede anything discussed in the Natomas PAC for erosion?

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Intro section text has been revised to clarify how erosion was handled on each reach for the study. Some reaches were handled as part of the Natomas PAC, and other small reaches were assumed to need minimal additional erosion analysis that will be deferred to PED.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503636 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.3, paragraph 1. When talking about the system, it is not clear if you are referring specifically to the American River. If so, suggest referring to as the American River levees or American River levee system. It mentions the 1955 event required an emergency flood fight – was that for the American River levees? Please also see paragraph 4 of Section 1.5.1 for similar comment on "system".

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

I was hoping that the section title "Background – Lower American River (LAR) Overview" would help to tell the reader that this section was focusing on the Lower American River. With that said, the subject paragraph (Section 1.3, 1st para.) has been modified to the following:

"The American River levees were originally intended to convey a release from Folsom Dam of 115,000 cubic feet per second (cfs). During several events since the construction of Folsom Dam, flows have equaled or exceeded the design capacity and caused significant erosion distress. All four significant flood events since the completion of the Federal flood control system in the mid 1950s (1955, 1966, 1986, and 1997) caused considerable damage to the American River levee system due to erosion. The 1986 event had an imminent threat of levee failure. And, all four events required extensive repair after the event so the American River levee system could perform for the next major event. The objective release from Folsom Dam is currently under review as part of the Folsom Dam Reoperations Study and the Joint Federal Project is currently constructing improvements to the dam for a release of 160,000 cfs. Based on past performance and recent investigations, erosion is a serious threat to the American River levees that must be addressed."

Tibbitts let me know that flood fights were along the Feather in 1955 so that sentence has been deleted from the subject para. Additionally, the paragraph (Section 1.5.13, 4th para.) has been modified to the following:

"Sacramento experienced significant flood events again in 1964, 1986, and 1997. The 1964 flood event was the first time the complete American River levee system was tested with a flow of 115,000 cfs. The 1964 flood event showed considerable stress on the levee system for a flow of 115,000 cfs. An emergency flood-fight along the left bank of the American River near H Street was required to pass the flood event."

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

This looks good, thanks.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503639 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.3, paragraph 4. To help tell the story, it would be good to discuss the purpose for convening the expert panel in 2010 - mainly due to questions and uncertainties regarding previous design recommendations and the environmental sensitivity of doing extensive erosion work on the American River including grade control.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Thanks for the suggestion. The subject paragraph has been modified to:

"Following the 2010 report a panel of experts in engineering fields associated with erosion was convened by West Consultants for the USACE due to questions and uncertainties regarding previous design recommendations and the environmental sensitivity of doing extensive erosion work on the American River including grade control. The panel was tasked to consider the adequacy of studies conducted to..."

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503640 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.3, footnote 2. The text appears to be cutoff.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **For Information Only**
No; this short statement was made to differentiate that all of the references to river miles are based on the USGS index and not the Comp Study index.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503642 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

6. Section 1.3, paragraphs 5&6. Paragraph 6 seems to be repeating what is already said in paragraph 5. For clarity, please combine.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Considering that para. 5 told the story of additional data collection and investigations in a past-tense form and para. 6 told the story more from a point of view what was expected of the investigations, I went with just deleting para. 6 since all of the critical information is present in para. 5 and then the past vs. present issue goes away.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503643 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.4, paragraph 2. Using the term "middle" reach is confusing for purposes of this discussion. It also mentions multiple diversion structures, but only the Sac Weir is located along this reach.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Text has been revised removing the "middle" terminology. The reference to multiple diversions has been replaced with a description of the Sac Weir only.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503644 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Figure 1-4 and Figure 1-5 should include in the title the river mile or range of river miles they are supposed to represent.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Concur, figure titles has been been revised.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503646 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.5.1, paragraph 5. Peak flow for 1986 was 134,000 cfs.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **For Information Only**

Please cite reference for the 134,000 cfs. Please don't include Tibbitts' September 2012 report on the Nov/Dec 2011 Advisory Panel – Dan hasn't been able to cite his source of the 134,000 value. I have spent some time investigating this item and cannot find any documentation that the peak flow (or peak release from Folsom) was anything but 130,000 cfs for the 1986 event. Corps' discharge records for Folsom Dam show a maximum release of 130,000 cfs. Please refer to the attachment which includes excerpts from the Folsom Dam & Lake water control manual (Dec. 1987) and from the Short Period Computation Sheet used during the flood event to track inflow, lake volume, and outflow by WATMAN.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014
(Attachment: Pages_from_Folsom1987CompleteManual3.pdf)

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503648 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Figure 1-7. Add text noting peak flow of 115k to Jan 1997 hydrograph.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

Will do.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5503650 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.7.1.4, paragraph 1. Other flows beyond 145,000 cfs were part of the study including 160,000 cfs. This should also be briefly discussed. 145,000 cfs was important because it was the flow used for levee certification.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added the following clarifying language to the end of the section:

"Other discharges such as 160,000 cfs were also included in this document."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503652 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.7.2. For better flow of the document, recommend removing 1.7.2.2 - 1.7.2.4 discussions on hydraulics and sediment transport and moving them up in the hierarchy – so they stand out a bit more. In brief, sections could be set up as follows (Sections 1.8 and 1.9 remain the same):
a. 1.7.2.1 2010 Panel
b. 1.7.2.2 2011 Panel
c. 1.7.2.3 2012 Panel
d. 1.10 Hydraulic and Sedimentation Studies
e. 1.10.1 Sedimentation Studies Completed Tasks
f. 1.10.2 Sedimentation Studies Tasks in Progress
g. 1.11 Levee Screening Tool

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Changes made as indicated.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503653 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.7.2.3, paragraph 1. Ayres analysis for bankline migration indicates 1957 to 1998 and then states NHC confirmed Ayres analysis with 1998 to 2010 study. These are different time periods, so not sure how it can be confirmatory. Are the years correct or does there need to be some additional discussion?

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Changed subject sentence for clarity to:

"NHC confirmed Ayres findings of no significant recent bankline migration by using aerial photos combined with survey data from 1998 to 2010 to develop more accurate banklines. NHC noted that significant differences shown in the previous Ayres analysis were the result of Ayres incorrectly identifying the top of bank from aerial images without the aid of relatively accurate topographic data."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503654 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.7.2.4, paragraph 1. Is it correct saying USACE has not performed a review? It would seem if we are including results, that some level of review of the information has occurred– it does say results seem reasonable. It would certainly seem appropriate to indicate results are draft and have not undergone the full review process. Please also reference the appropriate section for geotechnical studies so it is clear what the source of the new information for the bed and banks is.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Changed the first paragraph to:

"This information is based on draft results that have not been fully reviewed by USACE and should be viewed with caution as they are subject to change."

Also, added the reference to the geotechnical information, section 1.9.2.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503657 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.7.2.4, paragraph 1. The results are called into question based on the hydrologic inputs and notes they should not be used for estimating long term trends, though the results do seem to be discussed later on in the report. It is not clear why they couldn't be used as a source for long term prediction of trends, despite uncertainties.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**
The explanation can be found in the paragraph:

"Other studies have found that trends from a single flood event may be opposite of the long-term trend and therefore these results should not be used for estimating long-term aggradation/degradation trends."

This is a summary of the following. NHC conducted HEC-6T sediment modelling for the Sac Bank project that included long-term hydrology (1997 - 2008)from actual gage data as well as only specific events (e.g. 1/50 ACE, 1/100 ACE). A comparison of the results for the same reach (Lower American River to Freeport) shows that the reach is degradational during a specific event but aggradational over the long-term. The implication is that using single event hydrology (e.g. the 1/100 ACE event) or a series of single event hydrology (e.g. 1/100 ACE event followed by a 1/200 ACE event) may provide evidence for the opposite trend (degradation) than if a wider range of flows (e.g. 1997 - 2008 "continuous" hydrology) is used for the same reach. So while specific event modeling is likely more conservative for design and cost of erosion counter-measures for this reach, it may not be helpful if long-term trends are needed for other purposes, such as for determining if future sedimentation will bury spawning gravel. Despite this limitation, the results do represent the latest geologic understanding and may still be informative and perhaps conservative relative to feasibility level designs and costs. There is a lot of uncertainty associated with all sediment models as noted in the comment. However, the Sac Bank Sediment Study shows that using event specific hydrology vs. long-term hydrology for the exact same model can lead the model to show opposite trends. Therefore the relative differences may lead to incorrect conclusions even though both models are subject to considerable inaccurracies.

If necessary, this longer explanation can be provided. However, I feel it disrupts the flow of the document and does not contribute significantly to the overall conclusions.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**
This is good discussion and would be appropriate to add as a footnote so it doesn't disrupte the flow of the document.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Text was revised to add the discussion. This new proposed text is:

"The calibrated model was run for multiple synthetic hydrologic scenarios designed to mimic short-term and long-term morphological conditions. This does not include a full set of hydrographs over decades of future conditions but uses a series of individual events to approximate short-term and long-term conditions. This hydrologic approach to the sediment modeling is useful for relative comparison purposes and should not be used to estimate actual future conditions. Other studies have found that trends from a single flood event may be opposite of the long-term trend and therefore these results should not be used for estimating long-term aggradation/degradation trends.

NHC conducted HEC-6T sediment modeling for the Sacramento and Lower American rivers (NHC 2012) that included long-term hydrology (1997 - 2008)from actual gage data as well as only specific events (e.g. 1/50 ACE, 1/100 ACE). A comparison of the results for the same reach (Sacramento River from the Lower American River confluence to Freeport) shows that the reach is degradational during a specific flood event but aggradational over the long-term. The implication is that using single event hydrology (e.g. the 1/100 ACE event) or a series of single event hydrology (e.g. 1/100 ACE event followed by a 1/200 ACE event) may provide evidence for the opposite trend (degradation) than if a wider range of flows (e.g. 1997 - 2008 "continuous" hydrology) is used for the same reach. So while specific event modeling is likely more conservative for design and cost of erosion counter-measures for this reach, it may not be helpful if long-term trends are needed for other purposes, such as for determining if future sedimentation will bury spawning gravel.

Despite this limitation, the results do represent the latest geologic understanding and may still be informative and perhaps conservative relative to feasibility level designs and costs. There is a lot of uncertainty associated with all sediment models as noted in the comment. However, the Sac Bank Sediment Study shows that using event specific hydrology vs. long-term hydrology for the exact same model can lead the model to show opposite trends. Therefore the relative differences may lead to incorrect conclusions even though both models are subject to considerable inaccurracies.

The results from this study (NHC 2013) include:...."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503658 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.7.2.6, paragraph 2. There should be more detail in terms of what was done and what wasn't done to address each of the conclusions and recommendations from the various panels including the why and the why not. While geotechnical, geologic, and geomorphic studies were referenced in Section 1.8, follow-on hydraulic and sedimentation studies were not. It would be good to draw a clear connection from the recommendation to the actual follow-on work or study. It would be especially important to note recommendations that were not addressed in some fashion and the reasoning for not doing so. While budget and schedule are important, there should also be some technical reasoning perhaps from a risk standpoint that played into it.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**

For the most part most of the items mentioned have been followed through with the exceptions noted below. The exceptions noted have been added to the text as follows in the parentheses. These include the following 2 bulleted items:

• Existing modern bank protection sites need to be analyzed to assure they can withstand a flow of 160,000 cfs. (Note: This recommendation has not been followed to date. The feasibility study assumes that recent erosion protection was designed and constructed adequately to withstand this discharge without the need for additional analysis beyond what was conducted for the design. It has not been verified that each site was designed for 160,000 cfs.)

• Because of the large extent of bankline/levee requiring armoring, a site prioritization method needs to be developed so that the sites being the most urgent will be addressed first when construction begins. (Note: This recommendation to develop this site prioritization method has not been completed at this time and will need to be developed in the future.)

In addition, language has been added at the end to highlight that some of the recommendations mentioned that were followed through are provided in parentheses:

"Some of the recommendations were not addressed due to budget and schedule considerations. Some of these recommendations that were not completed are noted above in parentheses. The District envisions that, as appropriate, the remaining work efforts will be addressed in future studies."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**

The 2nd to last bullet in 1.7.2.2, for note in () change to "The mehtod was not considered practical for use in the stability study and was not conducted". You probably should consult with Mike K, to make sure that is correct.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**

I am checking with Mike now. I have modified the language as indicated:

"• Characterization of materials is primarily being completed by the EFA and JET testing. Other methods to characterize engineering properties of geologic materials should be utilized. An example of one would be the NRCS soil/rock erosion model. Additionally, lab test results needs to be correlated to behavior in the field. (Status: The method was not considered practical for use in the stability study and therefore was not conducted)"

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Open Comment**

I am ok with the proposed modified language pending review by Mike.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

3-0 Evaluation **Concurred**

Confirmed that Mike is OK with the proposed language.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 10 2014

3-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 10 2014

Current Comment Status: **Comment Closed**

5503660 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 1.8.4, paragraph 3. Results were to identify locations requiring further study and investigation. Are those areas identified in this report? This should be addressed in some manner so it doesn't leave it as a question.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**

The study referenced in the comment was developed as a standalone document that described the surficial geology to varying levels of detail dependent on the location within the general study area. This mapping was developed using the best existing data. Where the quality of the data was improved it was incorporated into the study, but also highlighted where data gaps still existed. At one point additional investigation contracts were in process but that study was differed to PED. The erosion attachment assumes a certain level of detail in the data and resulting conclusions which comprised the study and admittedly assumes more detailed required for PED and construction. I believe several parts of the report address the idea of further study during PED, but a specific account of where further study is needed would essentially be a description of the PED scope which is likely too detailed and comprehensive for this report.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503661 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 3.1, paragraph 7. The report in general seems to be saying erosion of the hard outcrops is not an issue, though it does state here several mechanisms of how they erode. Time scale likely is a key consideration in terms of how long it takes for these processes to occur and should be discussed briefly here.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**
The geotechnical and geologic study did vastly improve the knowledge of the properties and location of what was originally thought to be an erosionally resistant clay layer. The study referenced in the comment did find that due to the location and properties of the material, the risk posed to the flood control structure due to erosion of the so called ERU was likely low. Based on the new understanding of the material, it also proposed general failure mechanism of the ERU. However, those mechanisms were not studied. Any inference of the time required for the ERU to undergo its likely erosion process would require substantial additional data collection and analyses, based on the previous conclusion regarding consequence of failure of the ERU, that study would not be relevant to the flood control structure.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Open Comment**
Please add this explanation as a footnote in the document.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Added the following explanation to section 7.1.2 in coordination with Mike (copied and pasted from Mike as he suggested):

" Field observations suggested that erosion of the exposed erosionally resistant sediment occurs over time at both the granular- and outcrop-scale. However, the mechanisms and time scale associated with that erosion are not well understood and were not studied. Due to the location and properties of the material, the risk posed to the flood control structure from erosion of the erosion resistant sediment were estimated to be low and no further study of its erosion mechanisms or time scale were performed."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 10 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 10 2014
Current Comment Status: **Comment Closed**

5503663 Hydraulics n/a n/a n/a
Comment Classification: **For Official Use Only (FOUO)**

Section 3.2, paragraph 4. Along with describing the various stratigraphic features, the relative erodibility of these units should be discussed and how this information was used in the overall study.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
The subject section of the report gave a general summary of the process used to develop the layers of the model. These layers were developed by grouping material based on similar properties, which included erodibility as well as several other properties. This is described in as much detail as is relevant for this report in paragraph 3 of Section 3.2. As much of the erosion rate testing was in progress and also not nearly comprehensive enough to assign to each layer, the relative erodibility is evident by the material types and their mechanical properties described in the report.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Section 4.2 discusses the erodibility of materials lining the American River channel considering predicted velocities and shear stresses. This is an important link, that answers the comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503666 Hydraulics n/a n/a n/a
Comment Classification: **For Official Use Only (FOUO)**

Section 3.2, paragraph 5. Not sure Bouldery and cobbley are official terms. Please confirm.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Confirmed

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503668 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 4.1, paragraph 1. The Folsom mini-raise should be referred to as 3.5 ft raise. This should be corrected throughout report.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Will do.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503671 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 4.1, paragraph 1. Indicates it will be able to discharge 160k, but isn't that part of what the study is trying to figure out or justify? The reality is the JFP and Dam Raise projects, based on the 2007 PACR simply assumed downstream capacity was 160k without recognizing the current downstream limitations.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Concur, text has been revised to describe the "intent" of this what the project will accomplish not necessarily providing a technical opinion.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **For Information Only**

The GRR is not a design level document but is primarily concerned with conservatively estimating project costs, benefits, and environmental impacts. Additional analysis will need to occur during implementation to verify the assumption that existing rock (either mdoern revetment or cobblestones) are designed for 160,000 cfs. If the rock is designed and constructed in accordance with standard engineering practice and USACE guidelines, it should reasonably be expected to provide adequate erosion protection. However, continued maintenance is needed and may include installing additional bank protection as necessary. In addition, the bank protection needs to be monitored during and after flood events. Duration is not necessarily part of the riprap design criteria. However, this should be considered during design of the riprap along with the consequences when selecting an appropriate factor of safety. Site selection and prioritization will also need to occur during implementation.This information should be included in the cost schedule risk analysis and the risk register. Additional languag was added to address this in sections 4 and 7.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 10 2014

2-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 10 2014

Current Comment Status: **Comment Closed**

5503673 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Table 4-1. These values were derived for the Common Features Study, but may have changed, specifically as part of the Water Control Manual update. This caveat should be added here in the text.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

Concur, caveat has been added to text.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5503675 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 4.1, paragraph 4. Flow duration was identified as a source of uncertainty and could certainly be critical with the potential for large flows at longer durations under the new operation scenarios. How was this captured in the risk informed decision making, i.e. development of fragility curves?

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

In developing the levee performance curves the best available data was used, including flood hydrographs which gave flow and duration information. This information was used in the estimation of the levee performance for each loading shown in the judgment curve. Of course, with increasing stage came increased loading on the levee (velocity and shear stress) as well as increased duration for which erosion flows would be seen on the levee slope.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503676 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.1, paragraph 5. It notes that "this information with estimated relative sea level rise and other pertinent information should be used to inform risk based decisions". Which risk based decisions is it to inform? The feasibility study?

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **For Information Only**

This can be used to inform feasibility level or design level risk based decision. For example, if scour counter-measures represent a significant component to the feasibility cost, adding the cost in would be conservative and may reduce risk by improving assurance that critical bridges used for evacuations are passable. It can also be used for design based decisions such as computing scour depths for design of erosion protection.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**

Comment response also indicates can be useful for design purposes, if true, indicate that as well at the end of paragraph 5.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Added additional sentence at the end so that it reads:

"This information together with estimated relative sea level rise and other pertinent information should be used to inform risk based decisions. This includes both feasibility and design level decisions."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503678 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.1, paragraph 6. Please be more explicit on describing "model differences".

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
This section has been revised for clarity and to call out the differences explicitly as indicated below (differences are now bulletted):

"The future trend noted in Figure 5 5 does not include more recent data on erosion resistance formation beneath the American River that could limit future vertical erosion. A more recent update of the model includes this new geotechnical information and draft results are shown below in Figure 5 9. The model used in figure 5-9 includes the updated geotechnical information but has other differences with the model used in Figure 5 5. The significant differences between the models used for Figure 5 5 and Figure 5 9 are:

• Figure 5 9 model includes the updated geotechnical information while Figure 5 5 model does not

• Figure 5 9 model is based on synthetic event hydrology while Figure 5-5 model is based on actual historical hydrology
• Figure 5 9 model is "fixed" at the downstream boundary by a rating curve while the Figure 5 5 model is allowed to adjust dynamically based on changes to the Sacramento River (i.e. Figure 5 9 is not "linked" to the Sacramento River HEC-6T model while Figure 5 5 is).

Therefore Figure 5 9 cannot be compared directly with Figure 5 5. The amount of scour seems to be much less than previously predicted which may be partially explained by model differences noted above. Despite these differences, by referencing Table 5 1 which lists the average expected channel erosion by reach for the Lower American

River for 50 to 100 years of simulation, it can be concluded that it is possible the channel may erode nearly fully to the erosion resistant material between RM 6.5 and 10 (as shown in Figure 5 9). It is also possible that the bed may erode to or nearly to the erosion resistant surface for portions of the reach above RM 15 (above where the current federal levees end). Especially since the depth of active erosion likely exceeds that observed or predicted by the models. This makes protecting the levee toe critical for flood risk reduction and future degradation upstream of the levees may have detrimental impacts on environmental and recreational interests in this reach."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503680 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.1, paragraph 6. The non-continuous hydrographs were expected to represent the main opportunities for scour/aggradation. Please explain.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**
The non-contious hydrograph may show the main opportunities for scour/aggradation. However, it appears that the model may not be entirely representative of actual conditions because the downstream end is "fixed" by the downstream rating curve rather than being dynamically linked to the Sacramento River HEC-6T model. This "fixed" boundary may propogate upstream and affect the final solution. In addition, as indicated in another comment and in the report (section 5.1, paragraph 5), using individual events may be conservative for a design and feasibility cost perspective as it is likely to show more scour than long-term hydrology. This is likely OK for the feasibility study but the results should not be used to portray long-term trends for environmental considerations. Only for representing flood events.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503683 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.1.1, paragraph 1. Please define "lower half of the study reach" more explicitly.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Revised language to clarify:

For the Sacramento River, simulated degradation or aggradation generally increase from 1 to 5 ft, with a prevailing aggrading trend in the lower half of the study reach (less than 1 ft in the lower portion – which is the lower ½ of the reach from Colusa to Freeport).

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5503686 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.1.1, paragraph 2. Explain the basis for decreasing other flows so total annual runoff does not change. Why does the total annual runoff remain the same?

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **For Information Only**
For climate change, predicting whether this area will become wetter or drier is not simple. Based on conversations with hydrologists, the overall annaul rainfall over the long-term may not change significantly. Given the uncertainty involved, assuming that the overall amount of rainfall remains unchanged is reasonable for a sensitivity analysis. However, climate change is often thought by experts to exagerate heavy precipitation and exagerate low rainfall. Therefore by increasing some of the highest flows and decreasing some of the lowest flows is expected to be a reasonable assumption for modeling the sensitivity of the sediment model to climate change. It is not expected that it is modeling climate change exactly, but is modeling one of an infinite number of possibilities to get a sense for the model sensetivity to climate change.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503687 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.1.1, paragraph 3. Hydrology developed for the HEC-6T for the American River was supposed to represent future operating conditions with Folsom projects in place and so that should be noted. However, with that said, there certainly will still be uncertainty in future hydrologic conditions as noted.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added a clarifying sentence:

"The HEC-6T model developed by the ARCF GRR (e.g. Figure 5 9) used hydrology that is thought to be representative of changes to operations at Folsom Dam."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

5503688 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.1.1, paragraph 4. Please note source of HEC-6T results – I assume they come from the latest NHC modeling, but wasn't sure.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added language clarifying the results are from the HEC-6T model developed for the Sac Bank project:

"In general, however, degradation predicted by the model for the lower American River (the HEC-6T model developed for the Sac Bank Project, see Figure 5 5) agrees with the stage-discharge records obtained for the American River gage at Fair Oaks which shows ongoing channel degradation."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014

1-2 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503690 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.1.2. If studies during PED yield results showing the need for grade control, how will this be taken under consideration seeing that the decision now is not to include it as part of the plan and only as OMRR&R? This could create a difficult situation down the road with the need to include, but without authorization to do so. Later in the document (Section 5.2.4), it indicates consequences with including in the plan are greater than not including. This should be explained further.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**
If grade control is needed in the future but not included as part of this feasiblity study originally, it is assumed the appropriate USACE planning and/or permitting process and necessary Congressional action will need to be followed. For example, perhaps a LRR and a new EIS/EA will be needed and new authorization may be needed. See planning for more detailed explanation.

The explanation for why not including grade control is the lower risk feature is currently explained. In summary the thought is that:

1) It is inconclusive if grade control will be needed (even by experts) and whether it is needed or not is well witin the uncertainty of any technological tools used to analyze the situation.
2) The need for grade control is likely to occur oover a longer period of time that can be monitored and remedial actions put in place and not during a single flood event. This "ductile" failure mode lowers the risk (similar to a ductile failure that can be observed in advance of failure and fixed in a structure lowers the risk more than having brittle failure that occurs suddenly without warning).
3) By including grade control, it guarentees financial expenditure likely on the order of $50 million) and associated detrimintal environmental impacts to address a percieved need when the need is debatable.

A monitoring approach will allow for determining if the need develops and take appropriate action in a timely manner only if needed and is considered lower risk than spending $50 million dollars and impacting the environment on something that likely is not needed.

Please advise on what if anyting needs to be added to explain further.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**
The revised discussion is good. Only change - in first paragraph spell out OMRRR and in second paragraph use abbreviation only.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Agreed and completed as suggested so the OMRRR is spelled out in 1st paragraph and abbreviated subsequently.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503692 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.2.1, paragraph 5. Please define "Common Feature GRR project vicinity".

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Modified sentence to clarify that only the Sacramento River within the ARCF GRR project is included in this statement:

"Therefore the Channel Evolution Model indicates lateral erosion and channel widening for both the Lower American River and Sacramento River within the Common Features GRR project."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503694 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.2.3, paragraph 1. It notes work conducted along selected reaches. I assume that includes the American River. If so, please add, "including the American River".

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added:

"The work was conducted along 300 miles (483 km) of Sacramento River main stem and selected reaches, including the Lower American River."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503697 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.2.3. Only a few of the sites are within the study area and the basis for selection is not apparent. Some additional discussion would be helpful.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**
The basis for selection of the sites can be determined by reading the original USDA report for the Sacramento River Bank Protection Project. This is referenced and the reader can look here for how the Sacramento River Bank Protection Study set up this study and why they selected the sites. This is intended to be a summary document and not provide all the details, only the pertinent information (e.g. focus on the conclusions with references to other documents for more details). Paragraph 4 notes that the number of sites and location of the sites is not ideal for the ARCF study but still provides valuable insights to overall erosion trends for the study area and is in agreement with other findings:

"Of the 50 intensive sites analyzed, seven are within the Common Features GRR study area along the Sacramento River and three are located in the Common Features GRR study area along the Lower American River. While this may be appropriate for large scale studies like the Sacramento River Bank Protection Project, it is likely not a large enough sample for more narrowly focused feasibility studies such as the Common Features GRR. Also, no sites were located in the area constricted by levees between RM 5 and 10 on the Lower American River. In addition, the hydrology used for estimating erosion 48 years into the future generally had higher flow rates than long-term averages and therefore may over predict long-term sediment loading and bank retreat. However, the study still provides valuable insight into erosion in the Common Features GRR project. The estimated percent of total sediment derived from the banks agrees remarkably well with the results from a historic channel shift analysis (NHC 2012). This study by the USDA confirms the results of the Channel Evolution Model and the observations from annual erosion surveys and air photo analysis."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503698 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.2.4, paragraph 3. Work required to protect infrastructure is not currently in the plan but no reasoning is provided for not including it, especially since it has been identified as a potential issue.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added additional language:

"For both the Lower American River and the Sacramento River, infrastructure encroaching in the floodway, such as bridges and pipelines, need to be adequately protected from reasonably anticipated scour during design and construction. This effort is not included in the tentatively selected plan. It is assumed this effort will occur during future analysis and design efforts and likely needs to be coordinated with multiple agencies and infrastructure owners. Civil Design has also determined that the additional cost of the scour and erosion counter measures for the infrastructure is not significant compared to the overall cost of the erosion protection currently included in the tentatively selected plan and is well within the associated cost contingency.:

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503702 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.3.1, paragraph 2. Please confirm results of wind-wave analysis by NHC. 46 miles of levees at high risk seems high. Is that high risk from failure due to wind-wave action or high risk of erosion happening? This should be briefly discussed.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**
Section 5.3.1, paragraph 1 states:

"Each site was assigned the highest risk computed for the site for either levee face erosion or overtopping for any wind direction at the site."

Therefore the high risk is from wave erosion or overtopping from waves for any wind direction.

Please see original report on wind-wave for additional information as this is only reporting the values in this original report on the wind-wave analysis and a determination on whether the values are apporpriate or not can only be made during a technical review of the wind-wave analysis. This is beyond the intent of this summary document.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503703 Hydraulics n/a n/a n/a
Comment Classification: **For Official Use Only (FOUO)**

Section 5.3.1, paragraph 2. It is not clear if high risk areas are included in the current plan of the GRR. Also there may be overlap with what was included in the Natomas PAC.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Text has been revised to better describe the risk.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**
Change the last sentence of paragraph 2 of 5.3.1 to read, "The study included reaches that are part of the Natomas PAC".

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Agreed and completed as suggested.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503706 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.3.3, paragraph 1. I would not think that relying upon the waiver process for ETL 1110-2-1571 would be a reasonable approach in the feasibility study. This may be a planning question.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Concur, this is a high risk. However, the feasibilility study believes they have concurrence on this path from higher level reviews and policy makers.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503708 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.3.3. Further work is to happen during the refinement of the tentatively selected plan – when would that happen, is there really time for that? Comment also applies to Section 5.3.5 on scour analysis.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Text has been revised. This work will likely be done during PED.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**
Strike, "of the study" at the end of section 5.3.3.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Agreed and completed as suggested.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503710 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.4.1, paragraph 1. To my knowledge, levee performance curves were developed prior to gathering of additional geotechnical, geophysical, geomorphic data and further HEC-6T modeling. What, if anything, has been done to validate previous levee failure curves with new information? In addition, duration of flows have been identified as a key component in potential of erosion and has not been accounted for.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
The levee performance curves were developed in 2011 as required by the contemporary schedule. The judgment curves (erosion as a component) were developed using an expert elicitation in June 2009, as is the case for all the ARCF GRR judgment curves. The validity of erosion component of the performance curves was brought up at the expert panel meetings and at PDT meetings. It was found that the estimated levee performance captured by the curves was reasonable based on the available data and expertise. In consultation with PM and the PDT the decision was made to not pursue developing more rigorous analytical methods to refine the erosion portion of the curve.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Open Comment**
The response to comment is an important point of discussion and should be included in the documentation somewhere under Section 5.4.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Added the following as a new paragraph after the 2nd paragraph of section 5.4.1 on page 58 in coordination with Mike (copied and pasted paragraph Mike edited that contains Mikes edits):

"The levee performance curves were finalized in 2011 with the judgment curves (erosion as a component) that were developed using an expert elicitation in June 2009. The validity of the erosion component of the performance curves was discussed at the expert panel and project team meetings. It was found that the estimated levee performance captured by the curves was reasonable based on the available data and

expertise. In consultation with the project team the decision was made not to develop more rigorous analytical methods to refine the erosion portion of the curve."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 10 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 10 2014
Current Comment Status: **Comment Closed**

5503713 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.4.1, paragraph 2. The fragility curves should show or it should otherwise be stated that the major component of the residual risk is erosion.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
This comment should be addressed by the document editor, the levee performance curves were included in the report by the editor and I too commented on the need to break out the component curves or only show the judgment curve and its components.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503714 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 5.4.2, paragraph 2. Please reference the appropriate NHC study discussed here.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added refernce to NHC 2012:

"The results of this effort by NHC (NHC 2012) are shown in Table 5 2 for the portion of the Sacramento River in the ARCF project footprint."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503715 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 6.1, paragraph 2. Please be more specific on "future studies". Design during PED?

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **For Information Only**
Originally, we used the terminology "during PED Studies". However, we were instructed, by Graff, to change the terminology to "future studies" since the project is already in PED.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014
Current Comment Status: **Comment Closed**

5503716 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 6.2, paragraph 4. It is hard to follow what is being said here. Please clarify.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Removed last sentence. Basically it's saying that the design cross section (geometry) yielded sufficient rock for launching (so it should be conservative). The cross section also yielded enough environmental mitigation features to offset requirements (so no additional mitigation required).

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503718 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Table 6-1. No information is provided on the assumed rock size. As discussed with the civil designers, rock sizing and gradation were preliminary estimates mainly for purposes of cost estimates. No further detailed design has taken place. This should be noted as part of Section 6.2, paragraph 3.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

Added the following text to section 6.2:

Rock gradations were deemed less important for determining costs for this design level. The geometry of the design yielded sufficient volumes of rock to meet anticipated launchable rock requirements and sufficient mitigation features to offset environmental impacts. The launchable rock volume requirements were determined based on average velocities for above-mentioned typical sections. Site-specific design for erosion protection sites will occur in PED.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

Current Comment Status: **Comment Closed**

5503719 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 6.4, paragraph 2. It references Figure 6.3, noting no erosion protection features along the left levee of the Sac River north of the American. The figure only shows a small portion of that levee upstream of the American and so really doesn't illustrate no erosion fixes in that reach.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

The text will be modified to:
"Figure 6-3 depict s the footprints of the proposed erosion protection for both the Lower American and Sacramento Rivers. There are no proposed erosion protection features located along the left levee of the Sacramento River upstream of the American River confluence. The..."

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Open Comment**
The frist sentence of 6.4 is repeated twice. Later on in 6.4, "PED" should be changed to "site specific design".

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Changed as requested.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503720 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Table 6-2. I was under the impression all un-reveted locations would receive treatment. What ultimately was the basis for including or not including protection? This needs to be clearly discussed.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added to end of section 6.4 (after last paragraph):

A channel stability analysis (Ayres Associates, 2010) was used to determine areas requiring revetment with the assumption that all areas without modern bank protection will be protected. Modern protection was determined by areas defined as rock riprap with overall condition of good or very good. Additionally, there are some areas of high ground and areas with significant existing berm where protection is not required as shown in Figure 6.3.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**
The Ayres report did not by itself recommend bank protection at all areas without modern bank protection. My understanding was other information was used, such as the 2004 Ayres report that looked at velocities and shear stresses for flows up to 160k. Newer studies should also be referenced to help support the conclusions reached, assuming this can be done.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**

We have discussed this issue with James Elsberry to get a better understanding of how Civil Design selected the locations of where bank protection was proposed and not proposed. H&H probably should have had a more involved role in the process. Nonetheless, the text of Section 6.4 will be modified as follows:

"6.4 Erosion Protection Footprints

Along the American River, the rationale used to determine where bank protection was required for the feasibility study involved consideration of several factors. The most important factors included: 1) the velocity computed by Ayres' 2-dimensional hydraulic modeling (Ayres 2004) for a discharge of 160,000 cfs, 2) the erodibility of the material near the levee prism, and 3) the past performance of the levee segment with respect to erosion. Figure 6-3 depicts the footprints of the proposed erosion protection for both the Lower American and Sacramento Rivers.

Using the above criteria, bank protection was determined to not be required along two segments of the right bank of the American River. The upstream segment, extending between the upstream end of the levee (~RM 14.4) and RM 10.4 and the downstream segment extending between a point near Cal Expo (RM 5.5) and the confluence with the Sacramento River (RM 0). In addition to following the above criteria, a portion of the upstream segment contains a 4000 foot-long reach wherein the channel includes a wide right overbank consisting of high ground (i.e., the location of a sewage treatment plant) in which the water surface elevation for a discharge of 160,000 cfs does not get near the levee and the levee essentially exists as a "freeboard" levee."

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 10 2014

2-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 10 2014

Current Comment Status: **Comment Closed**

5503722 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 7.1.2, paragraph 4. This is critical information and should be emphasized in the 3D stratigraphic discussion of the various layers.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Check and Resolve**

Section 3.2 of the report includes a detailed description of the geotechnical characteristics of the post-1850 alluvium as well as sample figures which show the location of the unit. As this unit was identified by engineering and geologic interpretation, few exploratory borings were drilled where this unit is present. These materials are the result of hydraulic mining erosion of soil and alluvium in the Sierra

Nevada and downstream deposition of this eroded material within the American River channel. The purpose of the 3-d model was not to make a judgment on the performance of the system but to graphically show the subsurface. Therefore the interference on the performance of this layer is correct in Section 7.1.2 but was appropriately not included in section 3.2.

Submitted By: Michael Kynett (916 557 7898) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503723 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 7.1.3, paragraph 1. Recognizing the issue of erosion on the American River, they likely would operate differently. To make it fully functional and to realize the flood damage reduction benefits intended for the project, the erosion work is needed. Some additional discussion should be provided.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
The subject paragraph has been modified to:

"Once the JFP auxiliary spillway is constructed and functioning, new operations criteria are planned which would result in larger flood flows being conveyed through the American River with greater frequency compared to past conditions. These higher flood flows would exert additional pressure on the banklines and levees resulting in greater erosion, sediment transport, and potentially changes to the planform of the low-flow channel. Nonetheless, it is important to note that without inclusion of the proposed erosion protection features; the flood damage reduction benefits intended for the project cannot be fully realized since the lower American River channel will not be able to safely convey the new larger discharges."

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**
Add to the end of paragraph 1 of 7.1.3, "and flow restrictions from Folsom would likely be put in place.".

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
Agreed and comleted as suggested.

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503726 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 7.1.4, paragraph 2. It indicates un-revetted portions are at risk, but what about revetted portions without modern bank protection? Though the statement indicates un-revetted portions should be protected, not all un-revetted locations are being recommended for fixes.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Changed to read "most un-revetted portions of the ...."

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**
In paragraphs 2 of 7.1.4, instead of referencing "un-revetted" portions as needing protection, it really should be saying portions without modern bank protection.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
1) A basic assumption of the feasibility study was that all of the historic revetment sites (i.e., cobble sites) would be replaced with modern bank protection. Therefore, there are no revetted portions without modern bank protection in the current plan.

2) The text has been modified to replace the terminology of "un-revetted portions" with "portions without modern bank protection" as follows:

"The available information indicates that many of the levee segments without modern bank protection are at risk of erosion related failures along the Sacramento River and Lower American River in the Common Features project study area. The levees therefore need to be protected..."

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 10 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 10 2014
Current Comment Status: **Comment Closed**

5503727 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 7.2. Some discussion should be added about how additional study would help prioritize the erosion work, noting that because of all the extensive work needed it would likely not take place all at once, but over a number of years.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Text has been added to include this additional task.

Submitted By: Jesse Schlunegger (916-557-6777) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Open Comment**
The text was added to the end of 7.3, and I think really should be added to the end of paragraph 4 of 7.2. The important point to make is one of the purposes of the need for additional study is to prioritize sites.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014

2-0 Evaluation **Concurred**
The last sentence of paragraph 4 of 7.2 was modified as follows (section 7.3 is not modified):

"These sites must be assessed in future studies to confirm that these sites are stable, prevent erosion for discharges up to and including 160,000 cfs, and to prioritize sites to be constructed over a period of years."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 07 2014

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503728 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 7.2, paragraph 3. It indicates that there is a need for bed protection to be assessed during final design, but this isn't consistent with what is stated Section 5.1.2.

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added clarifying language in section 5.1.2:

"Grade control is not anticipated to be necessary but the need for this should be monitored as part of routine operation of the constructed project."

To be consistent clear and , the language in section 5.1.2 was changed from:

"The need for bed protection at key locations will need to be assessed and included, as required, in the final design during the future studies."

To this:

"The need for bed protection at key locations will need to be monitored in the future as part of operating the project."

Submitted By: Todd Rivas (916-557-7523) Submitted On: Feb 06 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503729 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Section 7.2, paragraph 4. Please reference repair sites being discussed for assessment in future studies – modern or cobble sites or both?

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**
Added to end of section 6.4 (after last paragraph):

"A channel stability analysis (Ayres Associates, 2010) was used to determine areas requiring revetment with the assumption that all areas without modern bank protection will be protected. Modern protection was determined by areas defined as rock riprap with overall condition of good or very good. Additionally, there are some areas of high ground and areas with significant existing berm where protection is not required as shown in Figure 6.3."

Sites shown in figure 6-3 and described in section 7.2 are modern bank protection sites.

Submitted By: Thomas Goebel (916-557-7175) Submitted On: Feb 05 2014

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 07 2014
Current Comment Status: **Comment Closed**

5503734 Hydraulics n/a n/a n/a

Comment Classification: **For Official Use Only (FOUO)**

Additional editorial comments – See attached document.

(Attachment: Erosion_Attachment_01232014_SS.docx)

Submitted By: Ethan Thompson (916-557-7142). Submitted On: Jan 29 2014

1-0 Evaluation **Concurred**

Thanks. The report has included almost all of the recommended modifications.

Submitted By: Scott Stonestreet ((916) 557-7719) Submitted On: Feb 04 2014

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Ethan Thompson (916-557-7142) Submitted On: Feb 06 2014

Current Comment Status: **Comment Closed**

Public / SBU / FOUO
Patent 11/892,984 ProjNet property of ERDC since 2004.

QUALITY CONTROL CERTIFICATE
Real Estate Division, Acquisition and Management Branch

PROJECT NAME: AMERICAN RIVER COMMON FEATURES GRR
PRODUCT: REAL ESTATE APPENDIX FOR FRM MILESTONE
ACTUAL COMPLETION DATE: August 3, 2015

PROJECT MANAGER: DAN TIBBITTS

The Real Estate Appendix is intended to inform the reader of the major Real Estate factors which were considered in the investigation and influenced decisions documented in the main report. It also presents a summary of the real estate costs, inventory, and analysis and assumptions associated with the lands, easements, right of way, relocations and disposal required for the tentatively selected plan. This DQC effort has verified that the Real Estate analysis is compliant with clearly established U.S Army Corps of Engineers policies, regulations, and that the assumptions, methods, data and tools used are appropriate for purposes of a real estate plan and that the level of detail and scope are reasonable and consistent within the context of the Real Estate Appendix.

REAL ESTATE LEAD
I have ensured that the above products were prepared in accordance with standard quality control practices. I have also incorporated or resolved issues identified during District Quality Control (DQC) Review.

Lead Realty Specialist Name	Title: Realty Specialist	
Laurie Parker	Laurie Parker	8/10/2015
Print Name	Signature	Date

REVIEWER
I have reviewed the products noted above and find them to be in accordance with project requirements, standards of the profession, and USACE policies and standards.

DQC Reviewer: Name	Title: Chief, Civil Works Section	
Paul Zianno	Paul Zianno	8/7/2015
Print Name	Signature	Date

QUALITY CONTROL CERTIFICATE
Real Estate Division, Acquisition and Management Branch

PROJECT NAME: AMERICAN RIVER COMMON FEATURES GRR
PRODUCT: REAL ESTATE APPENDIX FOR PUBLIC REVIEW MILESTONE
ACTUAL COMPLETION DATE: FEBRUARY 2015

PROJECT MANAGER: DAN TIBBITTS

The Real Estate Appendix is intended to inform the reader of the major Real Estate factors which were considered in the investigation and influenced decisions documented in the main report. It also presents a summary of the real estate costs, inventory, and analysis and assumptions associated with the lands, easements, right of way, relocations and disposal required for the tentatively selected plan. This DQC effort has verified that the Real Estate analysis is compliant with clearly established U.S Army Corps of Engineers policies, regulations, and that the assumptions, methods, data and tools used are appropriate for purposes of a real estate plan and that the level of detail and scope are reasonable and consistent within the context of the Real Estate Appendix.

REAL ESTATE LEAD
I have ensured that the above products were prepared in accordance with standard quality control practices. I have also incorporated or resolved issues identified during District Quality Control (DQC) Review.

Lead Realty Specialist Name	Title: Realty Specialist	
Laurie Parker	Laurie Parker	2/19/2015
Print Name	Signature	Date

REVIEWER
I have reviewed the products noted above and find them to be in accordance with project requirements, standards of the profession, and USACE policies and standards.

DQC Reviewer: Name	Title: Chief, Civil Works Section	
Paul Zianno		2/24/2015
Print Name	Signature	Date

Common Features Real Estate Plan February 2015
DQC Comments
Reviewer: Paul Zianno, Chief, Civil Works Section

REPORT SYNOPSIS

DQC COMMENT	RESPONSE	BACK CHECK
Based on previous comments from HQ, make sure the maps are attached to the RE Plan and not on a DVD. You can send the DVD, just make sure the maps are attached to the REP. Page 4	Will include hyperlink in the document in lieu of a DVD. The reviewer can click on the link and the data will come up instantly	X
Please identify what the letters mean on the map. Need to identify as phases. Page 9	Concur	X
After reading through this section it needs to be rewritten describe in specific detail with the description of the estates required. List all of the estates required for this project and under each one describe the location, acreage, owner description (private or non-federal), tract #. Need to break out by Title of the Sacramento and American River Systems Mitigation discussion can be at the end of this section. Laurie, Please identify what the letters mean on the map. Need to identify as phases. Page 12	Concur -- rewriting section as stated above	X
Is this a Road Easement? Page 12	Yes it is a Road Easement	X
This is a non-standard estate? Page 12	No the mitigation is at a bank or on site. It could potentially become non standard if fee is not available on site.	X
This is also a non-standard estate? Page 12	Due to the SWIF variance this is no longer a requirement of the project and these section will be removed from the report	X
You need to include specifically and spell out each estates required for the project. Also, include the acreage, tract numbers and the number of and type owners impacted by this acquisition. Adding a Table showing all the estates with the required information might be beneficial to the reader. Page 15	Concur the table will be shown in Section 4. Description of LERRD's.	X
Is this a Road Easement? Page 13	No This was a vegetative free zone. Due to the SWIF variance it is no longer needed and will be removed from this report	X
Expand, include info as stated in comment 7. Page 13	This description is incorrect. It will be rewritten to reflect new levees, levee raises, seepage berms, cutoff walls, and floodwalls. There is no new setback in this project.	X
Road Easement? Page 13	Yes this is the road easement. I will rename the easement.	X
Road Easement or a non standard estate? Page 13	This would have been a nonstandard estate but due to the SWIF variance it is no longer a requirement and shall be removed from the report.	X
All of these estates need to be expanded to include the info I discuss in comment #7. Page 13	Concur this section is being rewriting in Section 4. Description of LERRD's.	X
Who are the owners? Specify. Page 13	No owners are identified at this time only areas where potential borrow may be available. Borrow may not be suitable after testing so more than one site has been identified and is shown in Figure 2 Proposed Borrow Sites	X

We need to explain to the reader how the SWIF relates to theis porposed Mitigation Sites. It might be better to include the SWIF discussion in this section. Page 15	Concur I will move the SWIF discussion to the mitigation sites. The SWIF variance relates to more than just mitigation areas. The SWIF eliminates the road easements and the vegetative free zone for almost the entire project.	X
The document needs to specifically state whether we are buying land for mitigation or are is the project purchasing mitigation bank creditd. Should include a map showing these proposed sites, owner description (Private or non-federal sponsor owned). Is this amount included in the 01 Account? Need to specify. Page 15	The project will be purchasing mitigation credits. There are no banks proposed yet to map.	X
Is this paragraph a part of the Flood Protection Levee Easement, if so, this section needs to be included in that discussion above. Page 17	Concur: This has been moved to the discussion above	X
This Figure needs to be referenced in the discussion on Borrow Easements. Need to include acreage, owner description, Tract number, if known, Need to discuss Environmental impacts, suitability of material, and costs associated with the Borrow Material. Page 18	We know how many cubic yards and how many acres of borrow we need but we do not know if the material is suitable so we have over identified borrow areas. At this time in the feasibility study I have not been provided which actual parcels we are going to use. Based on the Natural Resources Conservation Service soil survey data, there are approximately 425 million Cubic Yards of material that potentially meets geotechnical requirements for level fill within an approximate 25 mile radius of the City of Sacramento. A map that proposed potential sites was created and several potential sites identified. The rough assumptions the Corp used was the material had to meet geotechnical requirements either by open undeveloped land or agricultural areas, and was located between ground surface and a depth of 2.5 feet below ground surface. In the high confidence areas in each basin the estimated amount of borrow needed within a 25 mile haul route radius is calculated below with costs for borrow. The high confidence areas were defined as areas where up to 48 inches of borrow could be excavated as opposed to the low confidence areas where only up to 12 inches of material would be available where 3 times the amount of land would be required. Potential land costs for borrow sites were developed by the Appraisal Section, Sacramento District, Corps of Engineers. The below quantities estimate the potential quantities of material required and the cost. American River South Basin High Confidence Area requires 69.76 AC of land for 275,743 CY of borrow = $453,400 + (35% cont + 15% severance= 226,700) = $680,100 American River North Basin High Confidence Area requires 0.64 AC of land for 2,519 CY of borrow =$4,186 (35% cont + 15% severance $2,093) = $6,279 Natomas Basin High Confidence Area requires 337.43 AC of land for 1,333,747 CY of borrow = $2,193,295 (35% cont + 15% severance = $1,096,647.50) = $3,289,942. The below map shows high confidence areas of available borrow where up to 48" of material can be excavated at one time.	X
These Figures need to be referenced in the above text regarding the SWIF, Bank Protection, and Road Easement estate discussions. Page 19	Concur. The SWIF discussion will occur all in the same portion of the report.	X
Need to be more specific in what this entails. Does the project impact high traffic rail lines that will have to be relocated? What about Railroad bridges and approaches thereto? Is that bridge in the picture below need to be relocated?	Yes the railroad bridge and track crossing over the Sacramento Bypass will be unable to utilize that bridge for two years. The other easement areas should not prevent the trains from moving and include no closure structures. Page 20	X
Is this paragraph needed if so it needs to be wrapped up in the estate text above. Page 21	No this paragraph has been deleted it is not needed.	X

What's the required estate for these features. Need to revise the Table. Page 22	The estates are shown in Section 4 description of LERRD's. These tables have been deleted.	X
What does the Letters mean in the Figure please specify. Page 24	I will provide a definition of the letters in the report.	X
What are the estates required for these reaches? Page 25	The estates are shown in table 1 of Section 4. These tables have been deleted.	X
Again, these paragraphs need to be included in the required estate s language above. Page 26	These tables have been moved see comment L54.	X
Not quite sure what this figure is trying to show and is it needed in the REP? Page 32	These are the design feature maps that accompany the estates required tables. They are showing the construction area and the improvements we are making. This is needed in the REP.	X
Same as comments 26 above. The paragraphs below need to be included in the discussions on the required estates.	Concur will add this to Section 4. Page 33	X
In a previous section you mention that permanent flowage easements are required. Please clarify. Page 39	I will revise this to say permanent	X
There is no mention of Non-Standard Estates? What about the Environmental Mititgation lands required for the project?	No non standard estates have been identified thus far. Environmental mitigation is will be at banks. Page 37	X
We need to expand this paragraph on how we are going to apply Navigational Servitude. The ER 405 talks specific to the requirements. Page 39	Will include longer discussion.	X
Not quite sure why this map is shown here? It's not referenced in the text? Need to spell out NAT Page 40	I will delete this map	X
Based on the Figure below, the flowage easement will impact an industrial area? Is that one of the acquisitions for this project? Could be a business relocation under PL 91-646. Page 41	I have inserted a new map that does not show the relocation of any businesses. Civil Engineering has a new map I will be including.	X
This value seems low and it does not match Table 7. What are the contingency costs? Page 44	25% contingency included already	X
Need to describe specifically whether these relocations are business or residential. Any mobile home parks impacted? Page 44	The relocations are 13 residential, 2 commercial buildings and 2 marinas. No mobile homes impacted	X
Briefly describe what these UF Relocations are. Page 47	Concur I will add a category	X
Does the report need this table? Can we delete it and use the Table 8 below? A little confusing Page 47	I can delete it.	X
Briefly describe these relocations Page 48	Concur	X

QUALITY CONTROL CERTIFICATE

Economic Risk Analysis Section, Planning Division

PROJECT NAME: AMERICAN RIVER COMMON FEATURES GRR, CALIFORNIA
PRODUCT: ECONOMIC APPENDIX
Actual Completion Date: 13-Aug-15
PROJECT MANAGER: DAN TIBBITS

The economic analysis noted below describes in a clear and concise manner the major assumptions, methods, data, and analytical tools used in the analysis, and summarizes the results of the analysis using table and text formats. This DQC effort has verified that the economic analysis is compliant with clearly established U.S. Army Corps of Engineers policies, principles and procedures; that the assumptions, methods, data and analytical tools used are appropriate for purposes of an economic analysis; that the level of detail and scope of the analysis are appropriate for purposes of an economic analysis; and that they results are reasonable and consistent within the context of an economic analysis.

Specific product reviewed: This DQC review focused on the updated net benefits and benefit-to-cost ratios and other small changes incorporating review comments. Also reviewed were the FDA files and methodology for Emergency and Cleanup costs. This iteration represents the draft FINAL Economic Appendix for the FRM milestone and the CWRB.

ECONOMIC LEAD

I have ensured that the above products were prepared in accordance with standard quality control practices. I have also incorporated or resolved all issues identified during District Quality Control (DQC) review.

Lead Economist:	Title: Economist	
Timi Shimabukuro	SHIMABUKURO.TIMI.R.1232082522 Digitally signed by SHIMABUKURO.TIMI.R.1232082522 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=SHIMABUKURO.TIMI.R.1232082522 Date: 2015.08.13 11:42:31 -07'00'	13 Aug 2015
Print name	Signature	Date

REVIEWER

I have reviewed the products noted above and find them to be in accordance with project requirements, standards of the profession, and USACE policies and standards.

DQC Reviewer:	Title: Chief, Economic & Risk Analysis Section	
Nicholas Applegate	APPLEGATE.NICHOLAS.JAMES.1246006640 Digitally signed by APPLEGATE.NICHOLAS.JAMES.1246006640 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=APPLEGATE.NICHOLAS.JAMES.1246006640 Date: 2015.08.13 09:50:39 -07'00'	13 Aug 2015
Print name	Signature	Date

RESOURCE PROVIDER

I have reviewed the quality control process and ensured that comments have been adequately address, documented and resolved.

Section Chief:	Title: Chief, Economic & Risk Analysis Section	
Nicholas Applegate	APPLEGATE.NICHOLAS.JAMES.1246006640 Digitally signed by APPLEGATE.NICHOLAS.JAMES.1246006640 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=APPLEGATE.NICHOLAS.JAMES.1246006640 Date: 2015.08.13 09:51:05 -07'00'	13 Aug 2015
Print name	Signature	Date

Economic and Risk Analysis Section
District Quality Control Review Comments
American River Common Features GRR
August 2015

Comments submitted by: Nick Applegate, Chief, Economic Risk Analysis Section, SPK
Responses submitted by: Timi Shimabukuro, Regional Economist
Backcheck submitted by: Nick Applegate, Chief, Economic Risk Analysis Section, SPK

Editorial Comments:

1. **Comment:** List of Tables: The bookmark link for Table 17, 44 and 46 appears to be broken, i.e. *"Error! Bookmark not defined."*
   Response: Concur. The List of Tables has been updated.
   Backcheck: Change verified, comment closed.

2. **Comment:** Sec 2.7.4, par 4. "The maximum clean-up cost of $10/ft2 was used for the West Sacramento economic assessment…" I believe this should say "ARCF" instead of "West Sacramento." Please revise.
   Response: Concur. This sentence has been revised.
   Backcheck: Change verified, comment closed.

3. **Comment:** Pg. 41, "(The Emergency Cost analysis was performed after the determination of the Final Array of Alternatives. Since none of the alternatives include the Natomas Basin, the emergency cost analysis did not include the Natomas Basin. More information about the Final Array of Alternatives is presented in Chapter 4.)" I'm not sure you need the parenthesis around these two sentences. Consider removing.
   Response: Concur. The parentheses have been removed.
   Backcheck: Change verified, comment closed.

4. **Comment:** Pg. 41, "Tables 17 below display the results of the HEC-FDA analysis." Change to "Table 17 below displays the results of the HEC-FDA analysis."
   Response: Concur. This sentence has been edited.
   Backcheck: Change verified, comment closed.

5. **Comment:** Sec 3.3.3, par 2. "the AEP values listed in Table 19 for each index point…" I think you may mean Table 18 as Table 19 doesn't have AEP's. Please verify.
   Response: Concur. The reference to "Table 19" has been changed to "Table 18."
   Backcheck: Change verified, comment closed.

6. **Comment:** Sec 3.3.4, par 1. Fix Table reference from Table 18 to Table 19.
   Response: Concur. Reference to "Table 18" has been changed to "Table 19."
   Backcheck: Change verified, comment closed.

Technical Comments:

7. **Comment:** Section 2.2, par 1. Given the CWRB in Dec, we will most-likely be required to update prices to October 2015 using the new FY16 discount rate (when it comes out). We could update to Oct 2015 now using a trend analysis, but it's probably prudent to wait until the new discount rate is out.
   Response: Concur. Costs and benefits will have to be updated once the FY16 (October 2015) federal discount rate is available.
   Backcheck: Comment closed.

8. **Comment:** Section 2.3, par 1. "200-yr event." At the very least, recommend footnoting this to explain what a 200-yr event actually means. For example: "200-yr" refers to an event with a 1/200 (0.5%) chance of occurrence in any given year, also known as the 0.5% Annual Chance Exceedance (ACE) event. These terms will be used interchangeably throughout this document."
   Response: Concur. A statement identifying the various terms and that either is used throughout the Economic Appendix has been added.
   Backcheck: Change verified, comment closed.

9. **Comment:** Figure's 5 and 6 aren't very high quality and are difficult to read. Do we have any better graphics that show the delineation of the EIA's? In the case of Figure 5, there are no boundaries to understand where one area ends and another begins.
   Response: Concur. Figures 5 and 6 will be replaced with better quality maps during the next report update (October 2015).
   Backcheck: Comment closed.

10. **Comment:** Table 43. Costs for the "Fix Creeks" increment appear to have risen by ~$30M (15%) since the last iteration in March. What is the reason for this cost increase? This increase is significant because it appears to make that increment economically infeasible. Later discussions related to Emergency/Cleanup benefits seem to indicate a $1.45M annual benefit that is not included in this table, which would bump the BCR back up over 1:1. Can the emergency/cleanup benefits be added to this table?
    Response: Concur. Costs have increased for the tributaries. Alternative 1 has an additional $1.25 million in benefits associated with the prevention of emergency cost losses; Alternative 2 has an additional $1.45 million in benefits. The damages/benefits related to the prevention of emergency cost losses have been incorporated into the incremental analyses. Including the emergency cost benefits increases the BCRs for the "Creeks" increment to 1.0 (Alternative 1) and 1.2 (Alternative 2).
    Backcheck: Verified, comment closed.

11. **Comment:** Pg. 59, Emergency Cost discussion. Recommend moving this entire section (including Tables 45 & 46) up to the beginning of Section 4.11 and prior to the incremental Net Benefit Analysis tables. Then add in the emergency/cleanup benefit totals into the incremental tables 42, 43 and 44.

Response: Concur. The Emergency Cost section was moved up (to Section 4.9) prior to the incremental analyses. The incremental analyses now incorporate the damages/benefits related to emergency cost losses.
Backcheck: Verified, comment closed.

12. **Comment:** Tables 47 and 48. Please add a footnote to the Total First Costs indicating that Cultural Resources were removed per policy. I.e. "Cultural resources data recovery costs ($6.17M) are not included in economic costs per USACE policy."
Response: Concur. Footnotes explaining that cultural resource preservation costs have been excluded from the economic analysis have been added to Tables 44-45 and 49-50.
Backcheck: Verified, comment closed.

13. **Comment:** Attachment 3, OSE discussion. Please add a subsection with the same discussion of social justice for the "creeks" area that was added to the main report.
Response: Concur. A section discussing the social justice aspect of making FRM improvements to the creeks has been included in the OSE analysis/report (Life Safety Evaluation/Population at Risk section).
Backcheck: Verified, comment closed.

HEC-FDA Comments (Emergency/Cleanup):

14. **Comment:** The FDA models and output files associated with Emergency costs were reviewed and there were no significant issues. The Inventory values were input correctly using $10/square foot for cleanup costs on all structures and $11,244 for all residential structures for Temporary Housing assistance. Depth-damage curves were appropriately applied. The results and proportions relative to structure/content damages are consistent with the findings of the Authorized Sutter feasibility study (which used a similar methodology). Adding these categories into the final array makes the Economic analysis more complete. No response necessary.
Response: No response necessary.
Backcheck: Comment closed.

QUALITY CONTROL CERTIFICATE

Environmental Planning Section, Planning Division

PROJECT NAME: American River Common Features Project GRR
PRODUCT: Habitat Mitigation Monitoring and Adaptive Management Plan
ACTUAL COMPLETION DATE:

PROJECT MANAGER: Dan Tibbits

The District has completed review of the habitat mitigation monitoring and adaptive management plan for the American River Common Features Project General Reevaluation Report. Certification is hereby given that all quality control activities defined in the Project Review Plan appropriate to the level of risk and complexity inherent in the product have been completed. Documentation of the quality control process is enclosed.

Compliance with clearly established principles and procedures, utilizing clearly justified and valid assumptions, has been verified. This includes assumptions, methods, procedures and materials used in analyses; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets consistency with law and existing Corps policy. All appropriate DQC comments have been incorporated into this project. The undersigned recommends certification of the quality control process for this product.

ENVIRONMENTAL LEAD

I have ensured that the above products were prepared in accordance with standard quality control practices. I have also incorporated or resolved all issues identified during DQC review.

Environmental Lead: Anne Baker Title: Senior Environmental Manager

Print Name	Signature	Date
		12/1/15

REVIEWER

I have reviewed the products noted above and find them to be in accordance with project requirements, standards of the profession, and USACE policies and standards.

DQC Reviewer: Dan Artho Title: Senior Environmental Manager

Print Name	Signature	Date
		12/1/15

RESOURCE PROVIDER

I have reviewed the quality control process and ensured that comments have been adequately addressed, documented, and resolved.

for Resource Provider: Josh Garcia Title: Chief, Environmental Analysis Section

Print Name	Signature	Date
Zimmerle, Mark T.		1/7/16

DQC BACKCHECK -- Appendix I Mitigation and Monitoring Plan_DFA.docx

Main document changes and comments

Page 4: Comment [DFA1] **L2PDRDFA** **11/24/2015 3:37:00 PM**

Repeat of statement above. Suggest deleting. Or is this supposed to be on American River?

RESPONSE: Combined the sentences so that the description seems less repetitive.

DFA BACKCHECK: Comment was in reference to the discussion about levee raising on the Sac River in the third sentence of the paragraph. However, this is more of an editorial comment than a content-related comment and the paragraph as it currently stands sufficiently provides the summary of the proposed measure. COMMENT CLOSED.

Page 5: Comment [DFA2] **L2PDRDFA** **11/24/2015 3:38:00 PM**

Does this apply to Sacramento River as well? Might want to indicate so in the Figure title if that is the case.

RESPONSE: Figure 1 is the American River scenario, while Figure 2 is the Sacramento River scenario. The rivers have been added to the two figures.

BACKCHECK DFA: Perfect. COMMENT CLOSED.

Page 2: Comment [DFA3] **L2PDRDFA** **11/30/2015 4:00:00 PM**

Are the HSIs for the future without project estimated to be the same as the future with-project? If so, you need to state that. If not, you should show a separate table for the FWOP HSI values for each target year.

Response: The FWOP HIS output is different so we've added in the table that show the values for each target year.

BACKCHECK DFA: Comment Closed.

Page 2: Comment [SRR4] **Sarah Ross** **11/22/2015 9:36:00 PM**

Add reference to paragraph above

Page 3: Comment [DFA5] **L2PDRDFA** **11/30/2015 4:00:00 PM**

This table shows the Mayhew Drain HEP results, correct? If that is the case, then you should indicate as such in the Table title. I would also recommend adding a footnote to the table explaining how this information was applied to ARCF mitigation requirements.

Response: Added Mayhew drain project to the title of the table and added a foot not explaining how the information was applied to ARCF.

BACKCHECK DFA: Acceptable. Comment closed.

Page 3: Comment [DFA6] **L2PDRDFA** **11/30/2015 4:05:00 PM**

Where are the results of the CE/ICA? Recommend showing the standard line and bar graphs that plot the CE plants and the incremental cost comparison between mitigation proposals.

Response: The CE/ICA results can be found at the end of Appendix I.

BACKCHECK DFA: Text needed a reference to where the CE/ICA is located. Reference included. Comment Closed.

Page 3: Comment [DFA7]	L2PDRDFA	11/30/2015 4:05:00 PM

Should this be AAHU's?

Response: Concur

BACKCHECK DFA: Comment Closed.

Page 5: Comment [DFA8]	L2PDRDFA	11/30/2015 4:06:00 PM

Indicate the specific source of these requirements; e.g., BOs, CAR, FWS Mitigation Policy, etc.

RESPONSE: Concur. Revised sentence to refer to the BOs and CAR.

BACKCHECK DFA: Comment Closed.

Page 6: Comment [DFA9]	L2PDRDFA	11/30/2015 4:06:00 PM

Make sure to remove this reference to West Sac GRR in the ARCF MMAMP, and vice-versa for the West Sac plan.

Response. Concur. Will remove all references to the other GRR when we finalize the HMMAMP

BACKCHECK DFA: Comment closed.

Page 6: Comment [DFA10]	L2PDRDFA	11/30/2015 4:07:00 PM

See comment above.

Response. Concur.

BACKCHECK DFA: Comment closed.

Page 7: Comment [DFA11]	L2PDRDFA	11/30/2015 4:08:00 PM

General question: Does onsite mitigation require purchase of land in fee title to guarantee land remains habitat mitigation in perpetuity?

Response. Yes, onsite mitigation must be purchased & protected in perpetuity. It might not be possible for bank protection sites though. For the Parkway, we are leasing the land, so there is an additional fee for land lease. Do you want us to add more info about this into the plan?

BACKCHECK DFA: Not necessary, if identified as such in the EIS. Comment closed.

Page 10: Comment [DFA12]	L2PDRDFA	11/30/2015 4:09:00 PM

Is this supposed to be 50%?

RESPONSE: Yes. The percent sign has been added.

BACKCHECK DFA: Comment closed.

Page 10: Comment [DFA13]	L2PDRDFA	11/30/2015 4:09:00 PM

Is there a specific depth that should be identified, or distance from shoreline?

Response. The specific depth is currently unknown and would be determined through preconstruction monitoring and modeling efforts. As a result, at this time based on current science the full width of the river/channel should be monitored. The table has been revised to reflect this.

BACKCHECK DFA: Comment closed.

Page 14: Comment [DFA14] **L2PDRDFA** **11/30/2015 4:13:00 PM**

What are these performance standards based off of? Recommend indicating the source that these standards were derived from.

RESPONSE: Added in the note below the table.

Dan, it would be helpful if you can weigh in on whether or not Natomas is a reasonable source for HQ purposes. I'm trying to use the proximity/habitat quality argument on why its valid, but it is not a Corps project, and I'm worried that they would prefer to see something from the Corps as a source. Sutter had very similar, but slightly lower performance standards that we could use as a Corps source – they range from 80% to 60% over time. I would be comfortable with switching to those if you think it is a stronger argument.

BACKCHECK DFA: Suggest keeping these in light of the fact that success criteria from several different projects were considered. Comment closed.

Page 15: Comment [DFA15] **L2PDRDFA** **11/30/2015 4:13:00 PM**

Where are the reference reaches? How do the success criteria relate to the reference reaches?

Response: I'm not sure that "reference reaches" was an appropriate goal. I think it would be more accurate to say that our long-term goal is to provide replacement habitat similar to the habitat that was impacted by project construction. The goal is compensation, not enhancement. The language has been adjusted to reflect this.

BACKCHECK DFA: Concur. Comment closed.

Page 16: Comment [DFA16] **L2PDRDFA** **11/30/2015 4:14:00 PM**

What sources, literature, expert opinion, etc., supports these performance standards?

Response. See above response and added footnote

BACKCHECK DFA: Comment closed.

Page 21: Comment [DFA17] **L2PDRDFA** **11/30/2015 4:15:00 PM**

What is the basis for these standards?

RESPONSE: Added note to table establishing the source of the standards.

BACKCHECK DFA: Comment closed.

Page 24: Comment [DFA18] **L2PDRDFA** **12/1/2015 8:59:00 AM**

I don't think you have included sufficient justification for development of a physical model for this study as called for by HQ review comments. Perhaps indicating that existing info and model outputs suggested a jeopardy opinion to green sturgeon. Also, why are both an EFM and Physical model necessary?

Response. Added language clarifying that the purpose of this modeling effort is to address the differing resource needs for each listed species and inform design refinements for the projects.

BACKCHECK DFA: Still not clear if this is needed per BiOp requirements. I'll defer to SME's about the need for this, but suggest presenting stronger justification for this extra cost. Comment closed.

Page 25: Comment [DFA19] **L2PDRDFA** **12/1/2015 8:54:00 AM**

Would it be from SAM or from the EFM Model developed for green sturgeon?

RESPONSE: I think the idea right now is that we don't know what the EFM model will tell us yet, therefore the SAM is still the best available tool, and the performance standards are currently developed from the SAM. With the long term goal to refine them based on the results of the EFM model. I reworded this paragraph slightly to focus on the present standard being from SAM. Also reworded the paragraph associated with the below bullet list to reflect that those could be future performance standards developed from EFM.

BACKCHECK DFA: Comment closed.

Page 26: Comment [DFA20] **L2PDRDFA** **12/1/2015 8:54:00 AM**

What establishes these as appropriate standards for sturgeon mitigation success? Is there literature, studies, etc., that supports this?

Response. The District fisheries team met with NMFS to coordinate appropriate performance standards based on the current best available science. Their determination was that the current best data is based on the SAM analysis, therefore they selected outputs from the SAM that they felt were likely relevant to sturgeon and that would likely remain relevant even with the future modeling efforts.

BACKCHECK DFA: Comment closed.

Page 30: Comment [DFA21] **L2PDRDFA** **12/1/2015 8:47:00 AM**

Per WRRDA 2007, you will need to identify the costs of monitoring separate from the costs for adaptive management.

Response. Concur. The section has been revised to present the monitoring costs separate from the adaptive management costs, and a total for the overall plan.

BACKCHECK DFA: Comment closed.

Header and footer changes

Text Box changes

Header and footer text box changes

Footnote changes

Endnote changes

FLOOD RISK MANAGEMENT
PLANNING CENTER OF EXPERTISE
REVIEW MANAGEMENT ORGANIZATION

AGENCY TECHNICAL REVIEW REPORT
SEPTEMBER 2015

Of the:

AMERICAN RIVER WATERSHED
COMMON FEATURES
GENERAL REEVALUATION REPORT
SEPTEMBER 2015 and ENVIRONMENTAL IMPACT STATEMENT/ ENVIRONMENTAL IMPACT REPORT
SEPTEMBER 2015

Sacramento District

US Army Corps of Engineers ®

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AGENCY TECHNICAL REVIEW REPORT

1. Scope and Purpose of Review
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8. ATR Completion Statement.

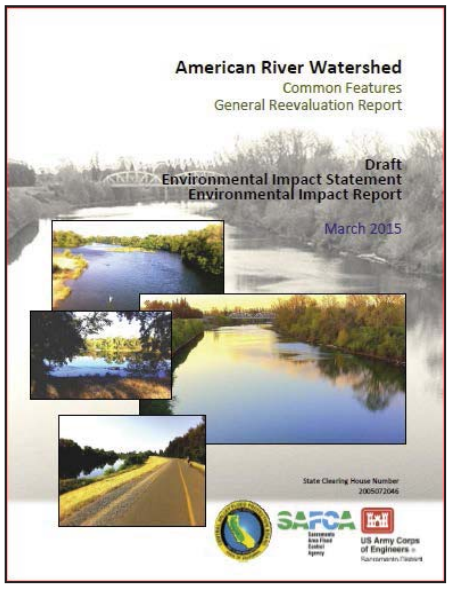
ENCLOSURES

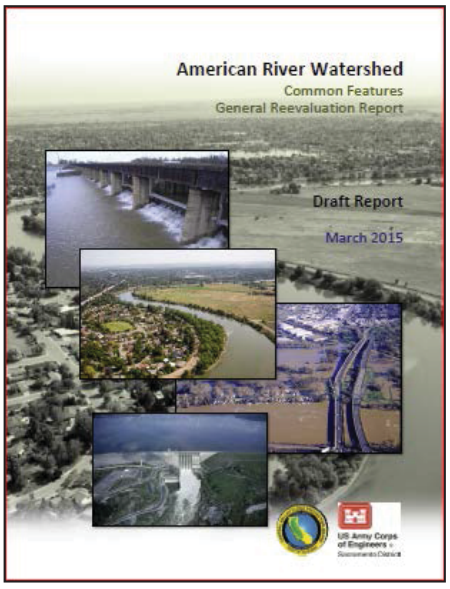
Enclosure 1: DRCHECKS REPORT OF ALL COMMENTS

Enclosure 2: COMPLETION STATEMENT OF AGENCY TECHNICAL REVIEW

Agency Technical Review Report

Subject: Review report for the **AMERICAN RIVER WATERSHED, COMMON FEATURES, FINAL GENERAL REEVALUATION REPORT, September 2015, and FINAL ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT, September 2015**, Sacramento District. Document covers below show the draft general reevaluation report (GRR) and National Environmental Policy Act document covers for the environmental impact statement/environmental impact report (EIS/EIR) as examples of the final report covers. At the request of the review team lead, the District provided track change documents to the review team to facilitate examination of the revisions made to the report between the backcheck documents used to complete the ATR of the draft GRR and EIS/EIR documents in the spring of 2015 and the final GRR and EIS/EIR documents used in August 2015 to start the ATR of the final GRR and EIS/EIR documents. Final report cover versions were not necessary.





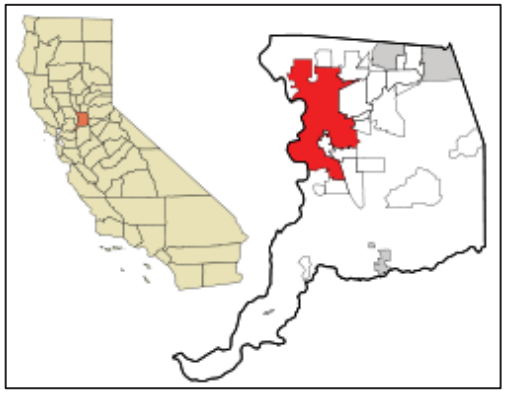
1. **Scope and Purpose of Review**. The purpose of this review report is to document agency technical review (ATR) for the subject product. The review was conducted for the Sacramento District (District). The primary point of contact for the District was Dan P. Tibbitts, CESPK-PM-C, Project Manager. The ATR team (ATRT) was lead by Marc L. Masnor, P.E., CESWF-PEC-PF (Tulsa, OK) for completion of the ATR. The Flood Risk Management (FRM) Planning Center of Expertise (PCX) was the Review Management Organization (RMO).

A previous ATR was initiated in September 2014 and completed in June 2015 for the draft general reevaluation report and draft environmental impact statement/environmental impact report.

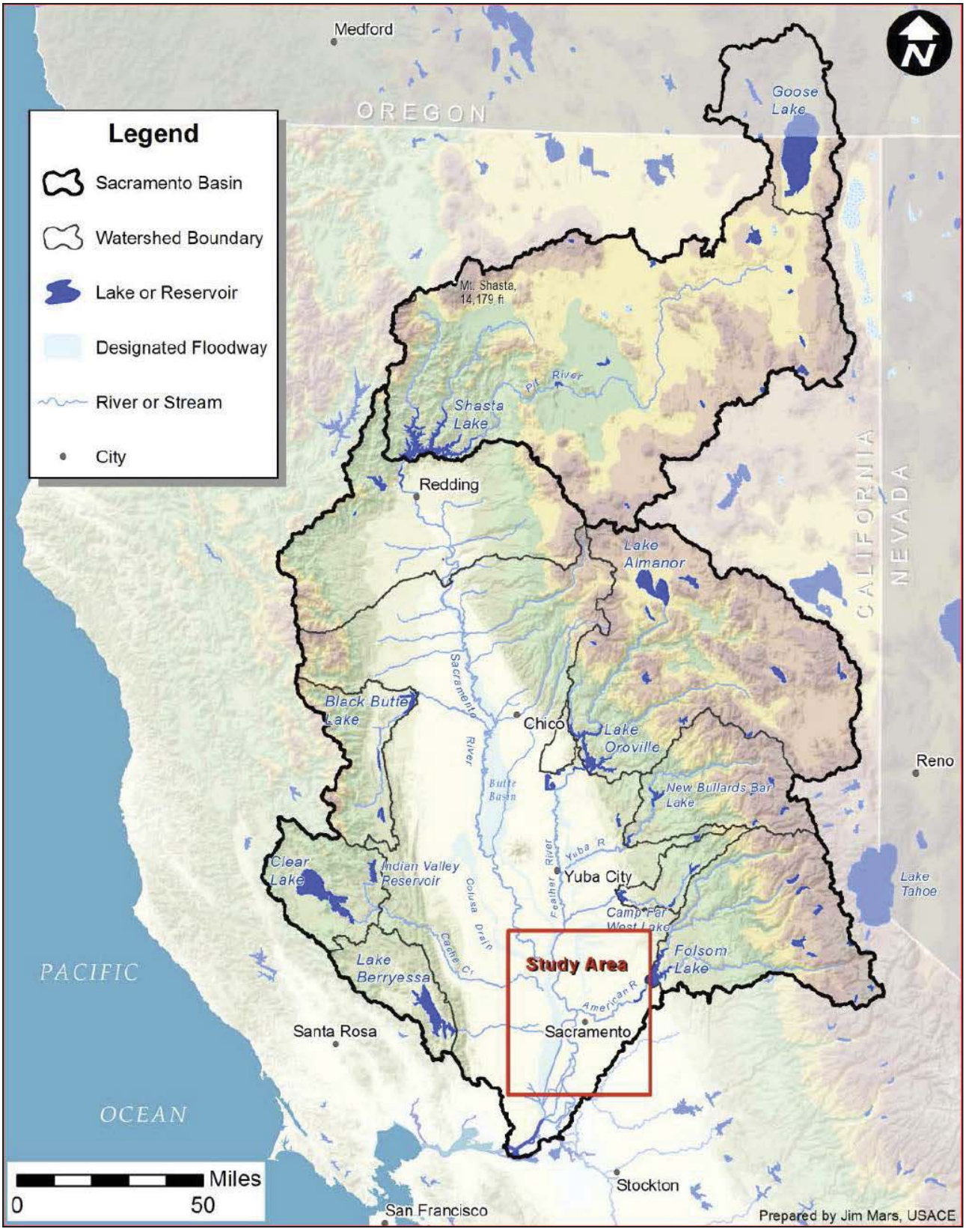
This ATR was initiated in August 2015. Comments were entered by the ATRT between August and September 2015. All comments were closed.

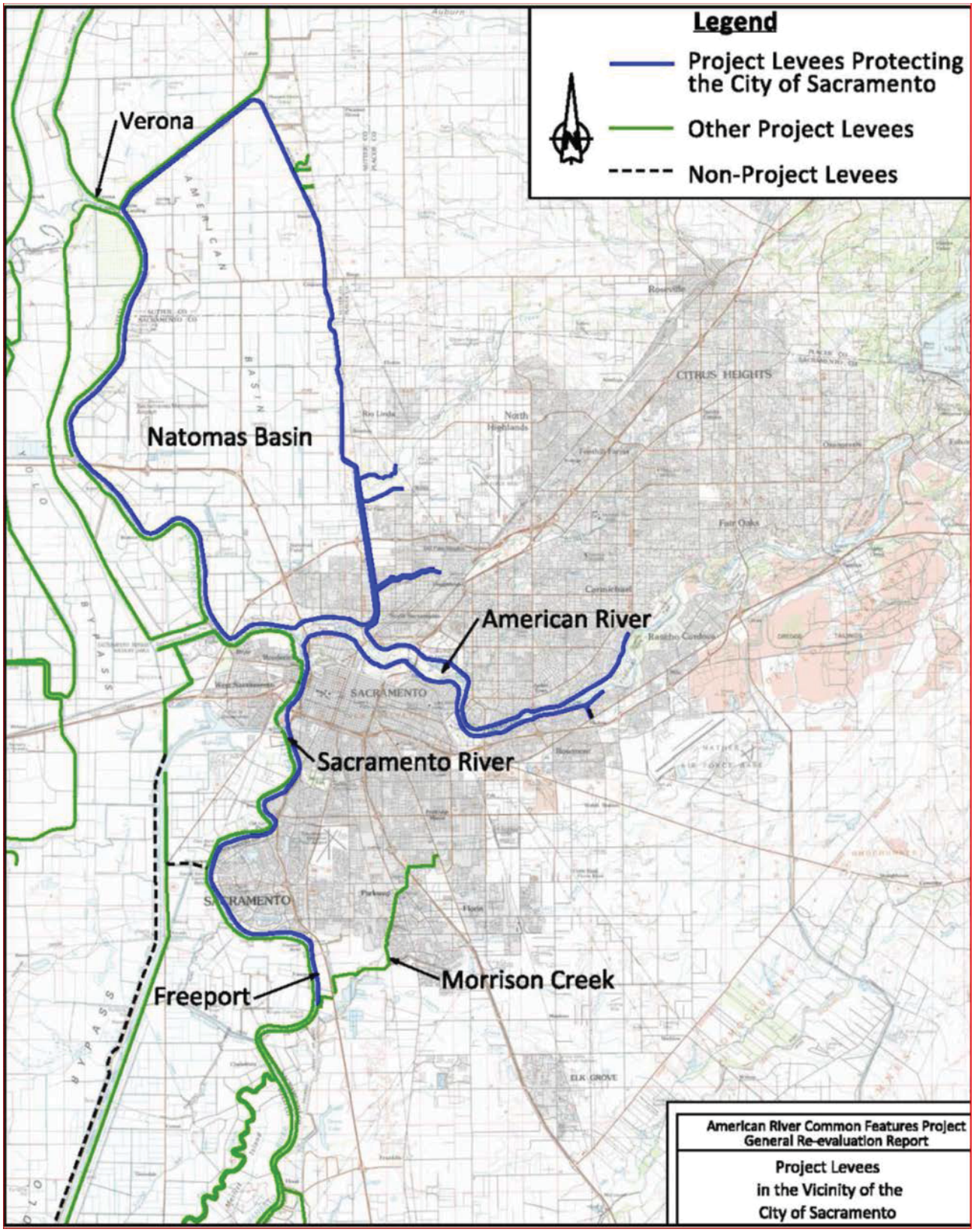
2. **References**. This review report was prepared in response to EC 1165-2-214, 15 December 2012, Water Resources Policies and Authorities, CIVIL WORKS REVIEW. The review documents reside online at ProjNet (www.projnet.org), DrChecks Project and Review titles: Project: ARCF - General Reevaluation Report (GRR), TSP & Attachments, American River Common Features (ARCF), California (P2 #149827), Review: Review: ATR Final EIS/EIR (10-14 Aug 2015) (00031).

3. **Project Description**. The study area is located in the general vicinity of the confluence of the Sacramento and American Rivers, and includes the City of Sacramento (right inset in red), CA (left inset), and surrounding areas in Sacramento County (left inset, county shown in red).



The Sacramento River is the largest river and watershed system in California and transports 31% of the state's total surface runoff. The upper watershed is drained by three rivers; the upper Sacramento River, the McCloud River, and the Pit River, which join at Lake Shasta, a 4.5 million acre foot reservoir formed by Shasta Dam. The Sacramento River then flows south through the northern Central Valley of California. The Sacramento River watershed covers an area of approximately 27,000 square miles. Major tributaries of the Sacramento River include the Feather River, the Yuba River, and the American River. (see figures next two pages)


Legend
Sacramento Basin
Watershed Boundary
Lake or Reservoir
Designated Floodway
River or Stream
City
Medford
OREGON
Goose Lake
Mt. Shasta, 14,179 ft
Pit River
Shasta Lake
Redding
Lake Almanor
CALIFORNIA
NEVADA
Sacramento River
Black Butte Lake
Chico
Lake Oroville
Reno
Butte Basin
New Bullards Bar Lake
Yuba R
Feather River
Yuba City
Clear Lake
Indian Valley Reservoir
Colusa Drain
Camp Far West Lake
Lake Tahoe
Cache Cr
Lake Berryessa
Study Area
Folsom Lake
American R
PACIFIC
Santa Rosa
Sacramento
OCEAN
Stockton
Miles
0
50
San Francisco
Prepared by Jim Mars, USACE


Legend
Project Levees Protecting the City of Sacramento
Other Project Levees
Non-Project Levees
Verona
Natomas Basin
American River
Sacramento River
Freeport
Morrison Creek
SACRAMENTO
CITRUS HEIGHTS
American River Common Features Project
General Re-evaluation Report
Project Levees
in the Vicinity of the
City of Sacramento

The study area consists of the north and south banks of the American River downstream of Folsom Dam, the Natomas Basin, the east bank of the Sacramento River, and areas surrounding five other smaller waterways which are sources of potential flooding. Each area is at risk of flooding from multiple sources.

The three basins are referred to as the American River South (ARS) basin, the American River North (ARN) basin, and the Natomas (NAT) basin. (see figure next page)

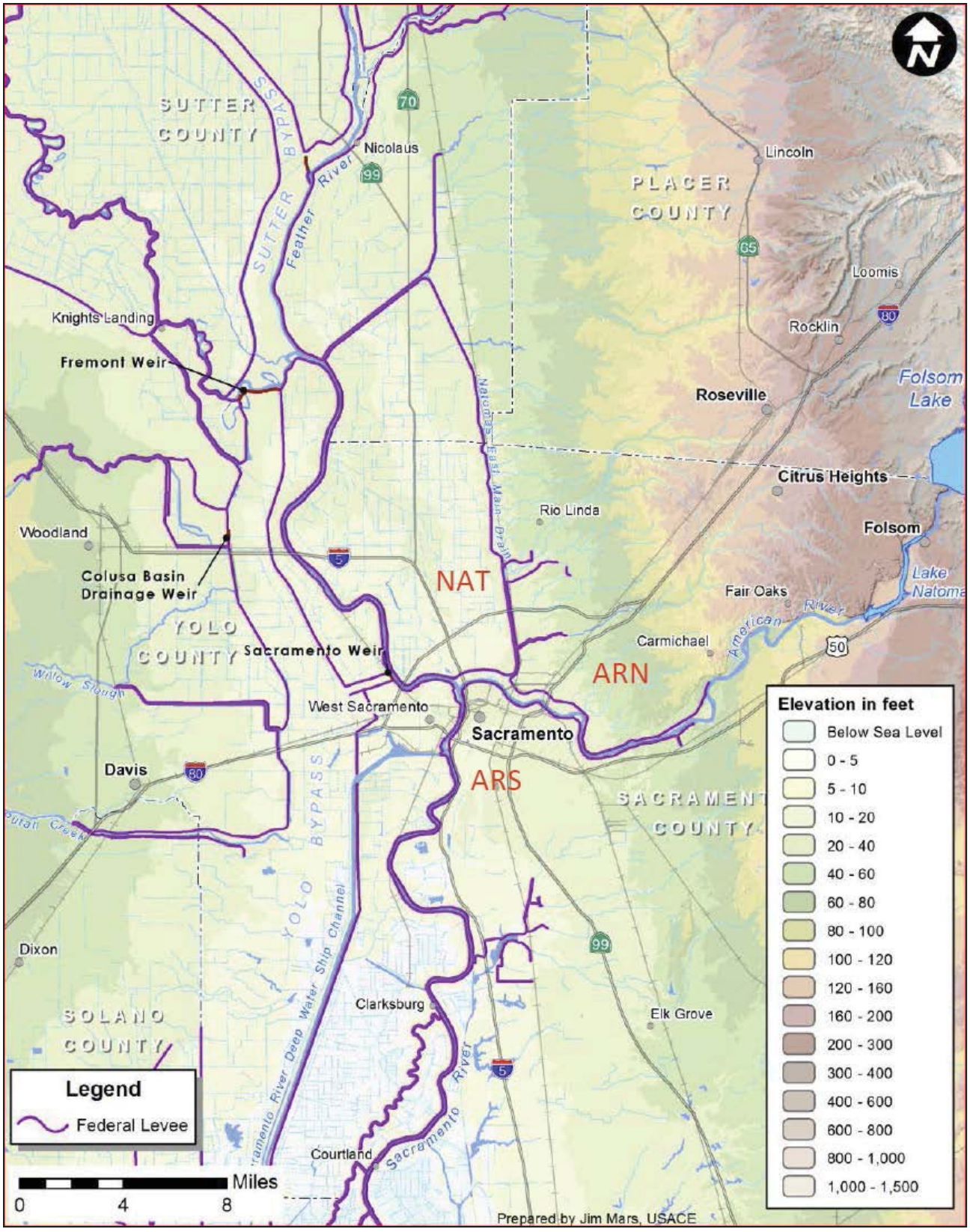
1. The ARS basin is protected by 25 miles of levee along the American and Sacramento Rivers. There are over 400,000 people at risk of flooding in this basin.

2. The ARN basin is protected by 25 miles of levee along the American River, the Natomas East Main Drainage Canal (NEMDC), Arcade Creek, and Dry/Robla Creeks. There are approximately 100,000 people at risk of flooding in this basin.

3. The NAT basin is protected by 42 miles of levee along the American and Sacramento Rivers, NEMDC, the Pleasant Grove Creek Canal, and the Natomas Cross Canal. There are approximately 100,000 people at risk of flooding in this basin.

The purpose of the study is flood risk management. Potential FRM measures range from modifying and/or increasing conveyance through raising and strengthening levees, widening channels and bypass areas, modifying weirs and bypasses. Non-structural floodplain management measures would also be considered. The estimated cost for the project is approximately $2 billion.

The authorized project features were developed to work in conjunction with the authorized Folsom Dam modifications and the increased flow releases that would be anticipated. These features included seepage remediation along approximately 22 miles of the American River and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas. Additionally, the authorization includes construction of seepage remediation and levee raises along four stretches of the American River and construction of levee strengthening and raising of 5 miles of the Natomas Cross Canal levee in Natomas.


SUTTER COUNTY
SUTTER BYPASS
Feather River
Nicolaus
70
99
Lincoln
PLACER COUNTY
65
Loomis
Rocklin
80
Knights Landing
Fremont Weir
Roseville
Folsom Lake
Natomas East Main Drain
Citrus Heights
Rio Linda
Folsom
Woodland
Colusa Basin Drainage Weir
NAT
Fair Oaks
Lake Natoma
American River
YOLO COUNTY
Sacramento Weir
Carmichael
50
ARN
Willow Slough
West Sacramento
Sacramento
Davis
80
ARS
SACRAMENTO COUNTY
Putah Creek
YOLO BYPASS
Deep Water Ship Channel
Dixon
99
Clarksburg
Elk Grove
SOLANO COUNTY
5
Sacramento River
Courtland
Legend
Federal Levee
Miles
0
4
8
Elevation in feet
Below Sea Level
0 - 5
5 - 10
10 - 20
20 - 40
40 - 60
60 - 80
80 - 100
100 - 120
120 - 160
160 - 200
200 - 300
300 - 400
400 - 600
600 - 800
800 - 1,000
1,000 - 1,500
Prepared by Jim Mars, USACE

4. **Review Team**. Disciplines identified in the review plan for the ATR were met by the following team members. Team members that completed the ATR are identified.

ATRT Lead – Marc Masnor P.E., Civil Engineer, CESWF-PEC-PF (Tulsa, OK) – 918-669-7349, Marc.L.Masnor@usace.army.mil. Mr. Masnor is a civil works water resources planner in the Plan Formulation Section of the Southwestern Division Office (SWD) Regional Planning and Environmental Center (RPEC), headquartered in the Fort Worth District Office (CESWF) in Fort Worth, TX. He works from the Tulsa District Office (CESWT) in Tulsa, OK, 1645 S. 101st East Ave, Tulsa, OK 74128-4609. He has 37 years of experience with the Corps of Engineers, Tulsa District, Tulsa, OK. Marc is a SWD regional technical specialist (RTS) for plan formulation and National Environmental Policy Act evaluation of flood risk management (FRM), ecosystem restoration (ECO), and water management and reallocation studies (WMRS). As a senior plan formulation specialist and regional technical specialist, he assists in the development of unique or complex formulation and analysis techniques within the framework of Corps of Engineers guidance; Federal, state, and local laws and regulations; and stakeholder interests. He has been both study manager and project manager for many Tulsa District planning studies that involved flood risk management, ecosystem restoration, comprehensive watershed studies, water supply, reservoir storage reallocation, navigation, hydropower, and chloride control. Mr. Masnor has worked in hydrology, design, project management, and civil works planning offices within the Tulsa District and has completed a wide variety of water resources studies in Kansas, Oklahoma, and Texas. Studies included the evaluation of navigation and hydropower expansion on the McClellan-Kerr Navigation system; a system of 122 small reservoirs in the Grand-Neosho Basin; chloride control evaluations in the Arkansas and Red River Basins; multiple purpose reservoirs system formulation; storage reallocation studies, regional needs studies; watershed ecosystem restoration evaluations; and several local levee, channel, detention, and buyout plans. He currently provides support for offices within (a) the RPEC and Districts within SWD, (b) three planning centers of expertise (PCX) review management organizations (RMO) for FRM, ECO, and WMRS, (c) multiple division office RMOs across the Corps, and (d) the Risk Management Center (RMC). He has participated in or lead roughly 100 ATRs or DQCs.

(a) He supports the RPEC and the SWD as the plan formulation RTS, as an agency technical review (ATR) team member or team lead for

continuing authority projects, as a district quality control (DQC) team member, and as a project delivery team (PDT) member.
(b) He supports three PCX RMOs as an ATR Team lead. In that capacity he selects and manages ATR teams to analyze pre-authorization feasibility studies conducted by Districts related to flood risk management, water management and reallocation, ecosystem restoration, and navigation. He has been the Southwestern Division Regional Manager for the FRM PCX National Manager, Eric Thaut (SPD) since 2008 through the present. Marc participates in a national team that develops tools in support of the PCX RMOs managing body called the PCX Guild. This team meets at the direction of the Guild to prepare supplemental review tools such as checklists, templates, and training materials for ATR and PDT teams.
(c) He supports Division RMOs as an ATR lead. In that capacity he selects and manages ATR teams to analyze post-authorization implementation studies including design documentation reports (DDR) and detailed project reports (DPR), and plans and specifications (P&S), generally for FRM, ECO, and WMRS. Other reviews include building replacements, water quality project modifications, and an upcoming desalinization plant.
(d) He supports the RMC RMO as an ATR lead, also to select and manage ATR teams for review of feasibility and implementation documents.

Plan Formulation - Eric S. Lynn, CENWK-PM-PF - 816-389-3258 Eric.S.Lynn@usace.army.mil. Mr. Lynn is a registered Professional Engineer in the state of Kansas and a registered Project Management Professional. He has a bachelors of science degree in environmental engineering from Rensselaer Polytechnic Institute and a Master's of Civil Engineering in Water Resources from the University of Kansas. Mr. Lynn joined the Corps of Engineers in Jan 2004 and serves as a Planner/Project Manager in the Planning Branch, Plan Formulation Section. Mr. Lynn's duties have included the management and successful completion of multiple Flood Risk Management Feasibility Studies under the General Investigations and Continuing Authorities Programs. Prior to serving with the Corps Mr. Lynn spent seven years working for local County and Municipal government agencies managing construction and rehabilitation of wastewater and stormwater infrastructure, including local sponsor maintenance requirements for Federal levees. Mr. Lynn is an approved plan formulation reviewer for FRM.

Economics - Michael Hallisy (CESPL-PD-E), 213-452-3815, michael.j.hallisy@usace.army.mil. Mr. Hallisy is the Chief of the

Economics Section for the Los Angeles District, Corps of Engineers. He has worked as an Economist for 21 years, including several years as SPD's Regional Technical Specialist in flood risk management economics, and the past seven years as the Chief of the Economics Section. He has also served temporary assignments as Division Economist for SPD and as Assistant Chief, Planning Division for SPL. In addition to his Corps work experience, he worked for 1.5 years for a financial consulting firm providing financial analysis and business valuations, primarily for litigation support cases. Michael holds a BS in Finance and Economics from the University of Oregon, and an MBA in Corporate Finance from the University of Texas at Austin. During his tenure with the Corps, Mike has served on dozens of ATR teams, primarily as an economics reviewer. He has also served as ATR Lead on several FRM studies. He is certified as an agency technical reviewer for both flood risk economics and risk analysis. Mr. Hallisy is an approved economic reviewer for FRM.

Biologist – Tiffany Bostwick, CESPL-PD-RN – 213-452-3845, Tiffany.Bostwick@usace.army.mil. Ms. Bostwick is a biologist and environmental coordinator with the Corps of Engineers Los Angeles District since 2002, and provides biological and environmental management support to the District on various flood risk management, navigation, and ecosystem restoration projects within the Corps civil works program. Prior to serving with the Corps Ms. Bostwick previously worked as a field crew member for the Maui Invasive Species Committee on the island of Maui, Hawaii. Ms. Bostwick earned a bachelor's of science degree in biology from the California Lutheran University. Ms. Bostwick was an initial team member and completed the review prior to the establishment of an approved list for environmental reviewers.

Archaeologist - Gregory D. Everhart, CESPA-PM-LE – 505-342-3352 gregory.d.everhart@usace.army.mil. Mr. Everhart serves as a District Archaeologist with the U.S. Army Corps of Engineers, Albuquerque District, in Albuquerque, New Mexico and is listed as a Corps Agency Technical Review Cultural Resources Subject Matter Expert. Mr. Everhart maintains credentials as a Principal Investigator to be listed on the New Mexico and Colorado lists of Permitted Professionals. Mr. Everhart has a Bachelor of Science degree in archaeology and came to the Corps Albuquerque District as an park ranger then as a archaeologist/student trainee working in that position from 1992 to 1997 while attending college. He was promoted to a Federal archaeologist position in September 1997 and has served in that professional position to this date (17 years). Mr. Everhart has an

intimate knowledge of the National Historic Preservation Act Section 106 consultation and compliance process working with the NM and CO State Historic Preservation Officers as well as with tribes and several Tribal Historic Preservation Officers. Mr. Everhart also has a thorough knowledge of the NEPA process and documentation thereof. Mr. Everhart has written over 100 archaeological survey reports and successfully conducted Section 106 consultation on those projects. He previously conducted independent technical and Agency Technical Reviews for three projects in CA.

Hydraulic Engineer - Shih (James) H. Chieh, CESPL-ED-HH - 213-452-3571, Shih.H.Chieh@usace.army.mil. Mr. Chieh is a registered professional engineer in California. James is a Senior Hydraulic Engineer, Hydrology & Hydraulics Branch, Los Angeles District. He conducts flood frequency analysis, rainfall runoff modeling, floodplain analysis, sediment transport analysis, and reservoir routing simulations for various water resources projects. He also conducts groundwater modeling, water budget analysis, and water quality analysis for various habitat restoration and wetland projects. He has served as ATR member and reviewed various project on hydrology, hydraulics, sediment transport, flood plain studies, and coastal engineering studies. He has both work and review experience in the area of hydrology (HEC-FFA, HEC-HMS), hydraulics (HEC-RAS, FLO2D), and groundwater (MODFLOW, MT3D). Mr. Chieh is approved for 50 HH&S areas of interest in CERCAP including the models and evaluations for this study.

Cost Engineering MCX - James G Neubauer, P.E. CENWW - 509-527-7332, James.G.Neubauer@usace.army.mil. Mr. Neubauer is the Technical Cost Engineering Lead for the Cost Engineering District of Expertise (DX) for Civil Works located in Walla Walla, WA. Jim has 12 years of civil and military cost engineer experience. He has been the lead estimator in Albuquerque, NM, Chief of Cost - Europe, and lead estimator Walla Walla, WA. He has 11 years civil works construction experience in Wyoming, Europe, and Walla Walla, WA. Mr. Neubauer has 5 years military and civil project manager experience for Europe and Albuquerque projects. Jim has participated on numerous technical review teams, including several projects with cost estimates greater than $1billion. Jim is the Cost DX ATR Coordinator, is a Certified Cost Engineer, and has his PM1 Certification.

Cost Engineering - Gary R. Smith, CENWW-EC - 651-731-3910, - grs52@comcast.net. Mr. Smith is a registered Professional Engineer in the state of Minnesota, has been a practicing engineer since 1974, and

has a bachelors of science degree in civil engineering from the University of Minnesota. Mr. Smith joined the Corps of Engineers in July 1974 and serves as a Cost Engineer for the Technical Center of Expertise Cost Engineering. Mr. Smith was approved and assigned to the ATRT by the Cost Engineering MCX.

Geotechnical - Glen M. Bellew, CENWK-ED-GD - 816-389-3553 Glen.M.Bellew@usace.army.mil. Mr. Bellew is a licensed Professional Engineer in the state of Missouri. He is a double graduate of the University of Missouri – Columbia, receiving a Bachelor's degree in Civil Engineering in 2002 and a Master's Degree in Civil Engineering with a Geotechnical emphasis in 2004. Mr. Bellew joinied the Corps in 2004, and he has worked extensively on flood risk management projects including dams, levees, and floodwalls. He has experience in feasibility studies, design, construction, risk assessments, inspection, and rehabilitation of flood risk management projects. Mr. Bellew served as a Regional Technical Specialist for 4 years prior to becoming Chief of the Geotechnical Design and Dam Safety Section in the Kansas City District in 2012. Although currently serving in a supervisory capacity, he remains actively engaged in geotechnical issues locally, regionally, and nationally. Mr. Bellew is approved for 32 different areas of interest in CERCAP, including various foundation and foundation risk assessment categoried.

Civil Design Engineer – Huma Nisar, CESPL-ED – 213-452-3665, Huma.M.Nisar@usace.army.mil. Huma Nisar is a Project Engineer for US Army Corps of Engineers at Los Angeles District. She assumed this position in June 2000. Ms. Nisar has a Bachelor of Science degree in Civil Engineering, from California State University Fullerton. Ms. Nisar has served in team leadership positions in the Civil Works sides of the Corps. She was involved in completing designs for key projects for both Chicago and Los Angeles District. She has extensive experience in levee and floodwall restoration, wetland enhancement, recreation facilities, environmental work and mitigation. From 1994 to 2000 she served with the Chicago District in Civil Design Branch as a Design Engineer. In 2000, Ms. Nisar assumed the Project Engineer position with the Los Angeles District. Prior to joining Corp of Engineers, She worked for McDonough and Associate as a Design Engineer on the Light Rail System for Chicago Area and for AT Curd Builders as a Field Engineer for MGM Grand Hotel project. Ms. Nisar is an approved civil engineering reviewer in CERCAP for earthen embankments, pump stations, and misc. structures.

Real Estate – Jason E. Meyer, CELRL-RE-C – 502-315-6956, Jason.E.Meyer@usace.army.mil. (Bio not available) Jason is an approved real estate reviewer.

Hydraulic Engineering and FRM Analysis – Michael K Deering, IWR-HEC-WRS – 530-756-1104 michael.k.deering@usace.army.mil. Mr. Deering is a registered Professional Engineer in the state of California, has been a practicing engineer since 1978, and has a Bachelors and Masters of Engineering degrees in civil engineering from UC Davis. Work Experience: 6 years - Senior Hydraulic Engineer, Water Resource Systems Division, Institute for Water Resources lead for the development of HEC-WAT with FRA compute option and member of the GUMP team for updating various policy and technical guidance. 2 years - Chief, Water Resource Systems Division IWR-HEC, Leading the Division in the development and application of Flood Damage Reduction, Ecosystem Restoration, and System Analysis software. Project Manager for the Helmand Valley Water Management Plan for Afghanistan. Lead manager for data and modeling project for Iraq. 2 years - Regional Design Team Lead, USDA – NRCS, Serviced four states providing engineering leadership and guidance to a group of design engineers and technicians. 7 years - Chief, Hydraulics/Hydrology Section and Senior Hydraulic Engineer, NWS. Chief, Civil Design Section, SPK provided engineering supervision to a staff of 22 engineers and technicians. 1 year - HEC, Planning Analysis Division –Senior Hydraulic Engineer assisting in the development of the next generation of the HEC-FDA and HEC – FIA. 1 year – Chief, San Joaquin River Section, SPK responsible levee rehabilitation projects associated with the PL84-99 Levee Rehabilitation Program. 13 years – Hydraulic Engineer, SPK – Hydraulic modeling technical expert particularly with multi-dimensional applications. 6 years - Design and Field Office Engineer -USDA– SCS - Flood risk management with risk analysis, impact analysis, ecosystem restoration, river hydraulics, stream stability and scour, surface water hydrology, water surface profile modeling, floodplain delineations, hydraulic structures. Mr. Deering is an approved FRM risk analysis reviewer and was assigned to the ARTR by the Hydrologic Engineering Center.

5. **Charge to Reviewers**. A charge was developed for the ATR of the draft GRR and EIS/EIR. There was no update to the charge for the final GRR and EIS/EIR. The ATRT Lead also discussed the roles and responsibilities with the ATRT members and the PDT. The ATRT Lead's electronic meeting notice to the ATRT provided the location and description of review documents, review schedule, labor codes and

amounts. The notice also identified the DrChecks project and review, and stated the requirement for four part comments. The notice provided schedule updates during the ATR.

6. Summary. The previous Draft ATR and targeted ATR reviews and coordination provided a strong foundation for the Final ATR. The Final ATR was completed without issues or controversy. All 56 comments received were closed to the satisfaction of the ATRT and the PDT.

The following paragraphs summarize the status of comments.

a. Critical. None. There was one comment with high significance regarding slurry wall placement and DSM method. This comment was closed after additional information provided.

b. Unresolved. None.

c. Lessons Learned. None.

7. **Dr. Checks Report**. The DrChecks report of all comments is attached as Enclosure 1.

8. **ATR Completion Statement.** Enclosure 2 contains the ATR completion statement.

Marc L. Masnor, P.E.
CESWF-PEC-PF (Tulsa, OK)
Regional Technical Specialist for Plan Formulation

Enclosure 1

DRCHECKS REPORT OF ALL COMMENTS

Comment Report: All Comments
Project: ARCF - General Reevaluation Report (GRR), TSP & Attachments, American River Common Features (ARCF), California (P2 #149827)
Review: ATR Final EIS/EIR (10-14 Aug 2015)
Displaying 56 comments for the criteria specified in this report.

Id	Discipline	Section/Figure	Page Number	Line Number
6188524	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

1. CONCERN: Observation: Some of the comments are based my observation of cost and schedule documents that are in conformance with the cost and schedule requirements. The purpose of these comments is to record the aspects of the cost and schedule documents that have been considered in the review. Your evaluation can be: concur. An evaluation is required in order for the reviewer to close the comment.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: Observation Comment. No Resolution Required. Include an evaluation that indicates concur or not concur.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **For Information Only**
Observation Comment - FIO - Concur

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**
Observation Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 21 2015

Current Comment Status: **Comment Closed**

6188525	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

2. CONCERN: Observation. ATR completion could be significantly delayed if additional rounds of backchecks and evaluations are required to get the clarification included in the documents.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **For Information Only**
Observation Comment - FIO - Concur

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**
Observation Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 21 2015

Current Comment Status: **Comment Closed**

6188527	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

3. CONCERN: Observation: Estimate Structure
5668 Notes
939 Unique Notes
9082 detail
1540 upper folder
3491 lower folder
19781 Lines of Data

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering

Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: Observation Comment. No Resolution Required. Include an evaluation that indicates concur or not concur.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **For Information Only**
Observation Comment - FIO - Concur

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**
Observation Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 21 2015

Current Comment Status: **Comment Closed**

6188529 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

4. CONCERN: Observation: Total Project Cost Summary
Total Project Cost Non Construction Cost Construction Cost
865,835,141 94,347,658 771,487,483 Direct Cost
27,066,458 (0) 27,066,458 Sub CMU
793,553,939 (1) 793,553,940 Cost To Prime
247,134,031 0 247,134,031 Prime CMU
1,140,035,631 94,347,659 1,045,687,971 Contract Cost

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: Observation Comment. No Resolution Required. Include an evaluation that indicates concur or not concur.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **For Information Only**
Observation Comment - FIO - Concur

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**
Observation Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 21 2015

Current Comment Status: **Comment Closed**

6188530 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

5. CONCERN: Observation: Direct Cost Overrides
$ % of Labor, Equip, Material % of Total Direct Construction
M 630 19,573,323 10.74% 3% 630 MATERIAL Overrides, $19,573,323, 10.74% of Direct Construction Matl, 2.54% of Direct Construction Cost

N 5963 461,442,925 60% 5963 NO Overrides, $461,442,925, 59.81% of Direct Construction Cost

E 499 2,652,620 1.09% 0.34% 499 EQUIPMENT Overrides, $2,652,620, 1.09% of Direct Construction Equipment, 0.34% of Direct Construction Cost

O 2077 278,511,021 36.10% 2077 OUTPUT Overrides, $278,511,021, 36.1% of Direct Construction Cost

L 493 145,271 0.06% 0.02% 493 LABOR Overrides, $145,271, 0.06% of Direct Construction Labor, 0.02% of Direct Construction Cost

Sb 243 10,251,716 1.33% 243 SUB BID Overrides, $10,251,716, 1.33% of Direct Construction Cost

Total 3942 311,133,951 40.33% 3942 TOTAL Overrides, $311,133,951, 40.33% of Direct Construction Cost

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: Observation Comment. No Resolution Required. Include an evaluation that indicates concur or not concur.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **For Information Only**
Observation Comment - FIO - Concur

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**
Observation Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 21 2015

Current Comment Status: **Comment Closed**

6188531 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

6. CONCERN: Observation: Direct Construction Cost Summary
243,303,759 31.5% Direct Construction Labor $243,303,759, 31.54% of Direct Construction Cost
244,101,024 31.6% Direct Construction Equipment $244,101,024, 31.64% of Direct Construction Cost
487,404,783 63.2% Direct Construction Labor + Equipment $487,404,783, 63.18% of Direct Construction Cost
182,199,187 23.6% Direct Construction Matl $182,199,187, 23.62% of Direct Construction Cost
69,954,926 9.1% Direct Construction Sub Bid $69,954,926, 9.07% of Direct Construction Cost
31,928,588 4.1% Direct Construction User $31,928,588, 4.14% of Direct Construction Cost
771,487,484 100% Direct Construction Cost

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: Observation Comment. No Resolution Required. Include an evaluation that indicates concur or not concur.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **For Information Only**
Observation Comment - FIO - Concur

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**
Observation Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 21 2015

Current Comment Status: **Comment Closed**

6188533 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

7. CONCERN: Observation: : 90% Direct Cost Productivity markup. The basis for this markup is explained in the cost appendix "Normal Productivity/Task Durations are based on production for 50 minutes/hr to allow for meetings/breaks, accessing the working area/office trailer to get supplies, etc. Because overtime is expected to go on for months, productivity is reduced to 90% of normal."
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: Observation Comment. No Resolution Required. Include an evaluation that indicates concur or not concur.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **For Information Only**
Observation Comment - FIO - Concur

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**
Observation Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 21 2015

Current Comment Status: **Comment Closed**

6188537 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

8. CONCERN: Each of the prime contractors has a folder that includes JOOH items that could be used to included a calculated JOOH. In fact these calculated JOOH costs are not included in the estimate. Please verify that it is intended to NOT include the calculated JOOH in the estimate. Then, consider deleting these calculated JPOOH costs from the contractor to avoid this comment in the future.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**

Concur - It IS intended to NOT include calculated JOOH in the estimate.
In the past, when there are many reaches, the Cost Engineer has sometimes done detailed JOOH for several reaches, then changed to an average. Contractors with the detailed JOOH markups (that typically automatically shows a markup for small tools and with Direct % based on items in the Overhead List folder) can easily be changed to JOOH with a Running %. I believe the opposite is not true. A new contractor needs to be created, a JOOH list added, and all tasks reassigned. If it was possible to omit the Overhead List folder from this 'detailed JOOH' contractor when wanting to 'override' with a Running % markup, I would do so. That would appear cleaner.
I'll note this for the future, but I still believe it easier to use a 'dummy' detailed JOOH contractor, where I'm actually using a Direct % markup for the feasibility study. Then, when preparing PED estimates I can change quickly to the detailed JOOH contractor and revise/update the Overhead List items to reflect the actual contract. My primary preference doing this is that I don't have to reassign tasks.
I hope I explain this clearly.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**

Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188538	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

9. CONCERN: There are 10 different detail items totaling $99,347,660 that have no contractor assigned to them or to any folder above them. That is why the total direct cost $865,835,141 is greater than the Cost to Prime $793,553,939. I suggest that an additional contractor layer be added at the top, Project Contractor with no markups, to capture these costs in the cost to prime. The items with no contractor assigned include:

DESCRIPTION DIRECT COST FREQUENCY
detail Riparian Mitigation - for LS Construction Improvements 30,922,200 9
detail Fish Monitoring 24,500,000 12
detail Riparian Mitigation - for WS Construction Improvements 16,854,200 8
detail Riparian Mitigation - for Rock Trench Erosion Control 14,579,400 8
detail Mitigation for Elderberries 6,375,000 8
detail Loss of RR Service 5,000,000 1
detail Riparian Mitigation - for SWIF Constr Improvements 558,360 2
detail Mitigation for Vernal Pools 300,000 1
detail Non-Riparian Mitigation - for Veg Removal 206,800 6
detail Non-Riparian Mitigation - for SWIF Constr Improvements 51,700 1

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**

All items described above (and all items with no contractor assigned) have been assigned to 'Prime Contractor NO MARKUPS.' The total direct cost is no longer greater than the Cost to Prime.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188539 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

10. CONCERN: The total amount of work assigned to a subcontractor may not be high enough at a direct cost = 82,073,465, 10.64% of the direct construction cost $ 771,487,483 . For this project, I would expect to see 25% to 50% of the work assigned to a subcontractor. It is likely that Slurry Wall Placement, DSM Method would be subcontracted and this alone is $103,705,497, 13% of the direct cost. It is possible that all or most of the hauling could be sub contracted at a cost of 67,574,638 or 9% of the direct construction cost. It is likely that acquisition strategy would require more sub contract work. Please consider what would likely be subcontracted and adjust the contractor assignments.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
Use of subcontractors have been re-examined. In general, cutoff wall placement (slurry or DSM) is assumed to be subcontracted. Hauling had reflected (and continues to reflect) use of a Trucking 'Broker' (basically already a sub). Notes have been added to the top folder of each reach to more clearly show subcontractor use and also to state that Bank Stabilization is assumed to be a separate contract from Levee Improvements and Relocations.
NOTE that use of subs for Alt 2 includes other changes as well. The portion of the work for widening the bypass is very similar to Levee Improvements and another contractor has been added to reflect this.
The prime contractor for the new Weir and Bridge has been renamed and modified to reflect concrete work for the structure with subs for the bridge (steel struct, 2nd tier sub for bridge painting) plus a miscellaneous sub for earthwork, relocations, and removal of existing rail line.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 11 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised documents for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents provided. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6188540 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

11. CONCERN: Filename ARCF_GRR-Feas_Report_Cost_Engr_Appendix-20150511.docx indicates "In general, a prime contractor for projects of over $10-12M (considered large business) has profit set at 8.48% based on PWG. Home Office Overhead is considered to be 7% for the Prime's own work..."

28 Prime Contractor has a direct cost = 87,743,041 and a HOOH = 10%. Verify if this should be changed to 7%

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
HOOH for prime contractor of extended weir has been left at 10% per comment 6188555.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188544 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

CONCERN: Filename ARCF_GRR-Feas_Report_Cost_Engr_Appendix-20150511.docx indicates "In general, a prime contractor for projects of over $10-12M (considered large business) has profit set at 8.48% ...".It appears that the profit is actually 10.00% or 10.01%. Please verify if the profit should be 8.48% or 10.00% and adjust so the appendix matches the estimate.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
PWG have been applied for each contractor/reach as suggested per comment 6188551 (using spreadsheets being sent as part of Backcheck Submittal). CE Appendix is updated to reflect the various PWG ranges.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188546 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

13. CONCERN: Filename ARCF_GRR-Feas_Report_Cost_Engr_Appendix-20150511.docx indicates " Job/Field Office Overhead (JOOH) is also set at 15% for small businesses and 10% for SubWork". It is not clear what is meant by 15% for small businesses and 10% for SubWork. Is this referring to a small business prime contractor markup on own work 15% and small business prime contractor markup on sub work 10%? Please clarify and reconcile with the estimate markups.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
It is believed that the markups by a small business for JOOH will be greater than those for large business, so these are set at 15% rather than 10%. After discussions with our RTS, markups for JOOH and HOOH previously indicated as prime markup on subcontractor's work have been removed. It is expected that the subs for this project will provide for their own JOOH and no HOOH markup by the prime for subcontractors is believed needed either. The ATR reviewer will be provided a spreadsheet of markups for all contractors and subs for clarification. Cost Engineering Appendix is updated to reflect the new markups.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised MII for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents provided. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6188550 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

14. CONCERN: The estimate is set up with a separate prime and sub contractor for each reach. Subcontractor markups are consistent at 15.00% 10.00% 10.00% 1.20% for JOOH HOOH Profit Bond. Prime contractor markups on sub work are consistent at 10.00% 10.010% 1.200% for JOOH_PRM Profit_PRM Bond_PRM. However Prime markup on sub work for HOOH is either 5% or 10%. Please explain this inconsistence in the prime contractor markup on sub work and reconsile with Filename ARCF_GRR-Feas_Report_Cost_Engr_Appendix-20150511.docx indicates "Home Office Overhead is considered to be 7% for the Prime's own work and 5% for SubWork for these relatively large projects. " and "In general, a prime contractor for projects of under $10-12M is considered small business and has profit set at 10%. Home Office Overhead is considered to be 15% for the Prime's own work and 10% for SubWork."

Description HOOH_PRM
2.2 Sub Misc Reach A, ARS 5.00%
4.2 Sub Misc Reach B, ARS 5.00%
6.2 Sub Misc Reach C, ARS 5.00%
8.2 Sub Misc Reach D, ARS 5.00%
10.2 Sub Misc Reach E, ARS 5.00%
12.2 Sub Misc Reach F, ARS 5.00%
14.2 Sub Misc Reach G, ARS 5.00%
16.2 Sub Misc Reach A, ARN 5.00%
18.2 Sub Misc Reach B, ARN 10.00%
20.2 Sub Misc Reach C, ARN 10.00%
21.2 Sub Misc Reach D, ARN 5.00%
22.2 Sub Misc Reach E, ARN 5.00%
23.2 Sub Misc Reach F, ARN 5.00%
24.2 Sub Misc Reach G, ARN 10.00%
26.2 Sub Misc Reach I, ARN 10.00%

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
After discussions with our RTS, markups for JOOH and HOOH previously indicated as prime markup on subcontractor's work have been removed. It is expected that the subs for this project will provide for their own JOOH and no HOOH markup by the prime for subcontractors is believed needed either. The ATR reviewer will be provided a spreadsheet of markups for all contractors and subs for clarification. Cost Engineering Appendix is updated to reflect the new markups.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised MII for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents provided. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6188551	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

15. CONCERN: Prime Contractor profit on subcontractor work is based on the same WPG for each reach with the resultant same profit. The profit % from the WPG is dependent on the contract amount, period of performance and level of subcontracting. These factors are different for each reach. Please address this assumption in the cost appendix.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
As suggested, PWG have been computed for all contractors/subcontractors for each reach based on Contract amount, duration, subcontracting, etc. Spreadsheet calculations for each PWG are being sent to the ATR reviewer as part of the backcheck submittal. This has also been explained further in the Cost Engr Appendix.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188554	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

16. CONCERN: Filename ARCF_GRR-Feas_Report_Cost_Engr_Appendix-20150511.docx. Several cost appendix references appear to conflict with the estimate documents as noted in "":

CONTRACTING PLAN Subcontractors are provided for two categories, miscellaneous/general and "bank stabilization from the waterside". Miscellaneous/General Subcontractors are expected to be utilized for hydroseeding, geotextile, vibration monitoring and paving. Bank stabilization from the waterside subcontractors are not applied in the estimate. Please clarify.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
After discussions with our Cost Engineering RTS for Civil Works, is is believed that the Prime Contractor for Bank Stabilization will do most of the work for bank protection (sans reveg and vibration monitoring).
For clarity, all subs not used have been delete. Typically only one misc sub is indicated, except for the Sac Weir Extension in widening the Sac Bypass. Notes have been added to the top folder in each reach to provide clarification.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188555	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

17. CONCERN: It is my opinion that Prime Contractor 7% HOOH and 10% JOOH on own work is not high enough to capture all costs. These rates are applied to the larger projects and to be understated could result in significant understated total costs. I suggest that these rates be increased to 10% and 13% based on experience with similar projects.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
Markups for all primes have been increased to 13% for JOOH. HOOH for most contracts (considered big business) have been increased to 10%. HOOH for small business is believed to have a somewhat higher HOOH markup (15%).

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188557 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

18. CONCERN: SPK - American River Common Features - CSRA - 2015-07-06 DRAFT - ALT 1 (NED).xlsm and other csra files. Cost Risk Model tab
TL5 Design Criteria and Assumptions low = $38,576,400
TL7 Vegetation Variance low = $43,712,400

Normally low values are negative indicating a possible cost savings. Please explain why these 2 low values are not negative. And then why the most likely is not between the low and the high

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
Risk TL5 and TL7 are modeled as a potential range of costs with a probability of occurrence. For example, Risk TL7 models the Very Unlikely chance that vegetation removal will be required. The probability of occurrence is 5% and if that vegetation removal is required costs could range anywhere from $43.7M to $72.8M.
(evaluation by William Bolte, NWW, 509-527-7585; Bill developed CSRA results)

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188558 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

19. CONCERN: SPK - American River Common Features - CSRA - 2015-07-06 DRAFT - ALT 1 (NED).xlsm and other csra files. Cost Risk Model tab. Please explain why the assumption parameters are set at custom 20% and 80% instead of Min Most Likely Max and why the parameters are not based on the Low Most Likely and High from the cost model

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
Assumptions were modeled at 20%, most likely and 80% data points which gives a higher resulting contingency then modeling the same numbers at Min, Most Likely and Max. Trying to define the tails is difficult to impossible, true worst case is infinity. The logic behind modeling at 20/mostlikely/80 is because we use the 80% confidence for our funding request. It's also a number we conceptually can understand. At the time this was originally modeled we then also would model the low as a 20% confidence for symmetry. But only recently, upon closer inspection, modeling $0 impacts at 20% confidence would result in risks with potential negative costs (savings) at the 0% confidence, which isn't possible. So we've now started modeling the lower bound as a minimum cost. I've updated this model to reflect a Minimum/Most Likely/80% cost distribution. The most likely costs have remained unchanged. Changing the lower parameter from 20% to minimum increased overall project contingency some 7%.
(evaluation by William Bolte, NWW, 509-527-7585; Bill developed CSRA results)

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188562 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

20. CONCERN: SPK - American River Common Features - CSRA - 2015-07-06 DRAFT - ALT 1 (NED).xlsm and other csra files. Cost Risk Model tab. ESTIMATE AND SCHEDULE RISKS

Estimate Assumptions and Quantities should be broken out into Estimate Assumptions, and Quantities .

Given the pdt discussion "No PED level survey is available. No specific designs/quantities based on surveyed cross sections has been developed, it does not seem reasonable to build a quantity opportunity into the model at this time.

Add a risk for modifications due to design changes as a worst case maybe 15% applied to all construction features

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
Variations in Quantities are modeled under Risk ET1 - Quantities and Estimate Assumptions are handled in Risk ET6 - Level of Estimate. As for the potential reductions in quantities that were modeled, quantities are thought to be conservative. As stated in the justifications of potential project impacts "Earthwork cross sections were developed in primarily 5 foot intervals, with no interpellations. Quantities were always rounded up to next larger typical cross section."
(evaluation by William Bolte, NWW, 509-527-7585; Bill developed CSRA results)

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188563	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

21. CONCERN: SPK - American River Common Features - CSRA - 2015-07-06 DRAFT - ALT 1 (NED).xlsm and other csra files. Cost Risk Model tab. CONSTRUCTION RISKS
Differing Site Conditions at 3% of Levees & Floodwalls and Bank Stabilization is not sufficient. Consider a much higher percentage as a worst case maybe 15% applied to all construction features

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements

SIGNIFICANCE: Medium

RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

1-0 Evaluation **Concurred**
Risk CO1 has been renamed Modifications and Claims to be more all encompassing. Risk has now been modeled with most likely defined as an increase of 3% of construction cost and 80% as a 5% increase in construction cost. Overall project contingency increased some 1%.
(evaluation by William Bolte, NWW, 509-527-7585; Bill developed CSRA results)

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 17 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6188565	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

22. The following 2 folder items include riprap purchase as detail items,. The material unit prices are 23.33 TON and 32.55 ton. It seems like the material price would be the same. Please explain why these material prices are not the same

22.1. lower folder Riprap (Rock Slope Protection) (EP) , 1,483,116 TON @ $47 per TON = $69,672,096, 9% of the estimated direct construction cost, used 5 times in the estimate, overrides = 0 23.33 TON

22.1.1. detail Riprap Placement (Work Cond - Average) , 1,483,116 TON @ $29 per TON = $43,339,374, 6% of the estimated direct construction cost, used 5 times in the estimate, overrides = 1 5.89 placement, 23.33 material

22.1.2. detail Hauling (TN), from commercial source or borrow site (20 CY end dumps) , 1,483,116 TON @ $18 per TON = $26,332,723, 3% of the estimated direct construction cost, used 5 times in the estimate, overrides = 1

22.2. upper folder Rip Rap (Waterside Placement) , 1,280,294 TON @ $48 per TON = $61,850,376, 8% of the estimated direct construction cost, used 4 times in the estimate, overrides = 0 15.76 32.55 ton

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 07 2015

Revised Aug 07 2015.

1-0 Evaluation **Non-concurred**
Riprap is anticipated to come from different suppliers/quarries dependent on waterside vs landside placement. The material price for riprap per these suppliers ARE NOT the same.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 21 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Aug 24 2015

Current Comment Status: **Comment Closed**

6197434	Risk Assessment	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Discussed updated report materials for the risk assessment/analysis with PDT member. PDT member responsible for executing the risk assessment and documenting the risk analysis stated that the applied procedure and the report language are essentially the same as in the previous version thus no further comments are provided here.

Submitted By: Michael Deering (5307561104). Submitted On: Aug 14 2015

1-0 Evaluation **Concurred**
Concur with Comment.

Submitted By: Sara Schultz ((916) 557-7368) Submitted On: Sep 04 2015

1-1 Backcheck Recommendation **Close Comment**
Concur with evaluation

Submitted By: Michael Deering (5307561104) Submitted On: Sep 08 2015

Current Comment Status: **Comment Closed**

6198478	Cultural Resources	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

No Comment.
I have reviewed Section 3.9 Cultural Resources, Section 4.2.5, and the appropriate cultural resources portions of Sections 5.0 and 6.2 of the Admin_FINAL_ARCF_GRR_EISEIR_13Aug15.docx and have No further Dr.Cks. comments.
I have coordinated with the cultural resources PDT contact and provided some small editorial type comments/recommendations for clarification purposes.

Submitted By: Gregory Everhart (505-342-3352). Submitted On: Aug 14 2015

1-0 Evaluation **Concurred**
Concur with comment. Thank you for your review.

Submitted By: Sara Schultz ((916) 557-7368) Submitted On: Sep 04 2015

1-1 Backcheck Recommendation **Close Comment**
Comment closed.

Submitted By: Gregory Everhart (505-342-3352) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6200594	Real Estate	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

The Real Estate Plan (REP) dated August 2015 that is to accompany the ARCF GRR has been reviewed. No further Real Estate comments are warranted at this stage of the planning procees. Additional review should take place during/after the PED phase or as revisions to the REP occur.

Submitted By: Jason Meyer (502-315-6956). Submitted On: Aug 17 2015

1-0 Evaluation **Concurred**
Concur with the comment. Thanks for your review.

Submitted By: Sara Schultz ((916) 557-7368) Submitted On: Sep 04 2015

1-1 Backcheck Recommendation **Close Comment**
Comment closed.

Submitted By: Jason Meyer (502-315-6956) Submitted On: Sep 08 2015

Current Comment Status: **Comment Closed**

6207088 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

23. CONCERN: Significant Detail Items: Labor, Equipment, Materials, detail Slurry Wall Placement, DSM Method
13% detail Slurry Wall Placement, DSM Method , 35,490 HR @ $2,922 per HR = $103,705,497, 13% of the estimated direct construction cost, used 28 times in the estimate, overrides = 1
Direct unit cost at 2,922 per hour is consistent across all applications.
I reviewed the work analysis indicated in a folder 2 levels up at 5.2.17.3 Cutoff Wall, DSM, 3' wide, 105 ft deep. This is the most expensive Slurry wall. The work analysis indicates that the number of panels is determined by dividing the wall length by the panel width to arrive at 874 panels.
Length of Wall 3,500.00 LF
Number of Wall Panals 874.00 EA
Panel Length 4.00 FT
Deep soil mixing is done with augers. If the wall width is 3 ft a 3 ft auger would be used. Overlaps would be significant, reducing the effective panel length to 2.4 ft.
My concern is that the wall is to be 3 ft wide and with panel overlaps, the effective panel width may be 2.4 ft wide requiring 1458 panels.
Width of Wall 3.00 FT
Overlap 80%
Effective Width 2.40 FT
Number of Wall Panels Required 1,458.33 EA
If this is correct, when applied to all the walls, costs could increase significantly.
Please verify the effective panel width.
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: High
RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
In a project recently constructed by SPK (Marysville Ring Levee), a 3-auger rig was utilized with an effective panel width of 4 ft (7 ft total width of panel with 3 ft overlap). This was assumed here. Cost engineer consulted Geotech Engineer on placement rate of panels and DSM cost in estimate is typically about $24-$25/SF. DQC cmt 17 has indicated wall price is consistent with what SPK has been seeing.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Open Comment**
Please include the evaluation information in MII. Please provide revised MII for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents provided. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6207091 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

24. CONCERN: Significant Detail Items: Labor, Equipment, Materials, detail Slurry Wall Placement, DSM Method , 35,490 HR @ $2,922 per HR = $103,705,497, 13% of the estimated direct construction cost, used 28 times in the estimate, overrides = 1
I suggest that a quote for this work be obtained to verify the estimated costs. Several DSM contractors will be willing to discuss this project and offer their opinion of costs.
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to

the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Non-concurred**
It is the experience of SPK Cost Engineering that quotes at feasibility stage are wide ranging with great uncertainty as contractors will not take the time to provide a detailed quote when no reasonable prospect of getting the work since on average the first construction projects are 4 to 6 years away.
DQC cmt 17 has indicated wall price is consistent with what SPK has been seeing in the last year or two. Cost engineer consulted Geotech Engineer on placement rate of panels and DSM cost in estimate is typically about $24-$25/SF. Geotech Engineer who often works in the field has verbally stated that upper limit for unit cost should be no more than $25/SF.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

Current Comment Status: **Comment Closed**

6207097 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

25. CONCERN: Significant Detail Items: Labor, Equipment, Materials, detail Slurry Wall Placement, DSM Method
13% detail Slurry Wall Placement, DSM Method , 35,490 HR @ $2,922 per HR = $103,705,497, 13% of the estimated direct construction cost, used 28 times in the estimate, overrides = 1
Notes indicate: "This is specialized construction. If cutoff wall construction is the major work, this job will be bid by a Prime Contractor. If cutoff wall construction is mixed in with other construction work, the cutoff wall construction will be subcontracted out, and the cost should include mob and demob."
I suggest that this work be included in the estimate as a subcontracted cost.
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
DSM slurry walls have been made a subcontracted cost in the revised estimates.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised MII for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents Received. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6207098 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

26. CONCERN: Significant Material Items: The following significant detail material items lack notes to support the costs.
detail Rip Rap , 1,280,294 TON @ $32.55 per TON = $41,673,570, 23% of the estimated direct Material Construction Cost, 5% of the estimated total Direct Construction Cost, used 4 times in the estimate, overrides = 0 Cost supported by note : "(Note: Price from San Rafael Quarry)". Quotes should include the source contact information, date, amount, and conditions such as includes sales tax, includes delivery, excludes loading.
detail Riprap Placement (Work Cond - Average) , 1,483,116 TON @ $23.33 per TON = $34,597,389, 19% of the estimated direct Material Construction Cost, 4% of the estimated total Direct Construction Cost, used 5 times in the estimate, overrides = 0 There are no notes to support the material cost for this material.
detail Borrow Site Loading , 2,222,787 LCY @ $7.4 per LCY = $16,447,960, 9% of the estimated direct Material Construction Cost, 2% of the estimated total Direct Construction Cost, used 47 times in the estimate, overrides = 0 There are no notes to support the material cost for this material.

BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: Please obtain material quotes that include the source contact information, date, amount, and conditions such as includes sales tax, includes delivery, excludes loading. If quotes is more than 2 years old, a new quote should be obtained.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Notes have been added to reflect riprap costs from the likely supplier for waterside placement and a possible supplier for landside placement.

For borrow, assumes material costs for developing any borrow site result in similar costs to that of purchase at a supplier.

A Central Valley supplier has indicated $7.17/TN for fill and engineered fill. Notes have been added to the estimate to reflect this. It is assumed that 1 LCY of fill ~1.1 TN. Unit Cost for 1 LCY is set at $7.90.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised MII for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents Received. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6207099 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

27. CONCERN: Notes for the following items refer to ProdQuant WORKSHEETS
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: Please provide the cited document
27.1. Significant Labor and Equipment Items: detail Levee Excavation , 3,588,117 BCY @ $10.2 per BCY = $36,595,442, 8% of the estimated direct Labor and Equipment Construction Cost, 5% of the estimated total direct construction cost, used 156 times in the estimate, overrides = 0
27.2. Significant Labor and Equipment Items: detail Random Levee Material Placement, Shaping, and Compaction, Sheepsfoot , 2,618,609 ECY @ $11.64 per ECY = $30,475,505, 6% of the estimated direct Labor and Equipment Construction Cost, 4% of the estimated total direct construction cost, used 167 times in the estimate, overrides = 0

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Production Quantity Excel spreadsheet will be provided with backcheck submittal.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised documents for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents Received. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6207100 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

28. CONCERN: Significant Labor and Equipment Items: detail Disposal of non compliant material , 2,653,337 LCY @ $10.64 per LCY = $28,233,443, 6% of the estimated direct Labor and Equipment Construction Cost, 4% of the estimated total direct construction cost, used 101 times in the estimate, overrides = 0
Direct Cost unit price varies from $16 to $0.12 per LCY. 5 of the 101 instances refer to (Note: for Haul Rate (Crew Output), see ProdQuant WORKSHEETS.xls)
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: Please provide the cited document and recheck the unit price development

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Unit Price development has been checked and Production Rate spreadsheet will be provided with backcheck submittal. Notes have been added at the folder levels reflecting the spreadsheet calculations.

Unit costs DO vary widely, primarily due to variations in cycle time and assumed minimum placement time. The various reaches in this project vary quite a bit when it comes to accessibility. For small quantities, such as at utility relocations, one hour has basically been used as the minimum placement time, even for very small loads (less than 1 full load).

The $0.12 was a bust and has been fixed.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised MII for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents Received. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6207101	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

29. CONCERN: Significant Labor and Equipment Items: detail Hauling (TN), from commercial source or borrow site (20 CY end dumps) , 1,483,116 TON @ $17.75 per TON = $26,332,723, 5% of the estimated direct Labor and Equipment Construction Cost, 3% of the estimated total direct construction cost, used 5 times in the estimate, overrides = 0
No notes to document crew and production rate development
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: Please provide notes to document crew and production rate development

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Unit Price development has been checked and Production Rate spreadsheet will be provided with backcheck submittal. Notes have been added at the folder levels reflecting the spreadsheet calculations.

The various reaches in this project vary quite a bit when it comes to accessibility and therefore, cycle time/haul time.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised documents for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents Received. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6207102	Cost Engineering	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

30. Significant Labor and Equipment Items: detail Delivery of Levee Material from Borrow Site , 2,222,787 LCY @ $11.7 per LCY = $26,009,756, 5% of the estimated direct Labor and Equipment Construction Cost, 3% of the estimated total direct construction cost, used 47 times in the estimate, overrides = 0
Direct Cost unit price varies from $16 to $10 per LCY. Some instances include note "(Note: for Haul Rate (Crew Output), see ProdQuant WORKSHEETS.xls)
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: Please provide the cited document and recheck the unit price development

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Unit Price development has been checked and Production Rate spreadsheet will be provided with backcheck submittal. Notes have been added at the folder levels reflecting the spreadsheet calculations. The notes in the CSI tasks relative to 'Note: for Haul Rate...' have typically been deleted.

Unit costs DO vary widely, primarily due to variations in cycle time and assumed minimum placement time. The various reaches in this project vary quite a bit when it comes to accessibility. For small quantities, such as at utility relocations, one hour has basically been used as the minimum placement time, even for very small loads (less than 1 full load).

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised documents for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents Received. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6207104 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

31. CONCERN: Significant Sub Bid Items: 94,347,660, 12% of the total direct cost consist of non construction items listed below. Notes included in the estimate are not very helpful in supporting the costs.
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: Please include a paragraph in the cost appendix discussing the source and development of these costs. Reference other documents for support.
31.1. detail Riparian Mitigation - for LS Construction Improvements , 184 ACR @ $168,055.43 per ACR = $30,922,200, 44% of the estimated direct Sub Bid Construction Cost, 114% of the estimated total Direct Construction Cost, used 9 times in the estimate, overrides = 1
31.2. detail Fish Monitoring , 21 EA @ $1,166,666.67 per EA = $24,500,000, 35% of the estimated direct Sub Bid Construction Cost, 91% of the estimated total Direct Construction Cost, used 12 times in the estimate, overrides = 1
31.3. detail Riparian Mitigation - for WS Construction Improvements , 163 ACR @ $103,400. per ACR = $16,854,200, 24% of the estimated direct Sub Bid Construction Cost, 62% of the estimated total Direct Construction Cost, used 8 times in the estimate, overrides = 1
31.4. detail Riparian Mitigation - for Rock Trench Erosion Control , 141 ACR @ $103,400. per ACR = $14,579,400, 21% of the estimated direct Sub Bid Construction Cost, 54% of the estimated total Direct Construction Cost, used 8 times in the estimate, overrides = 1
31.5. detail Mitigation for Elderberries , 75 ACR @ $85,000. per ACR = $6,375,000, 9% of the estimated direct Sub Bid Construction Cost, 24% of the estimated total Direct Construction Cost, used 8 times in the estimate, overrides = 1
31.6. detail Riparian Mitigation - for SWIF Constr Improvements , 5 ACR @ $103,400. per ACR = $558,360, 1% of the estimated direct Sub Bid Construction Cost, 2% of the estimated total Direct Construction Cost, used 2 times in the estimate, overrides = 1
31.7. detail Mitigation for Vernal Pools , 1 ACR @ $300,000. per ACR = $300,000, 0% of the estimated direct Sub Bid Construction Cost, 1% of the estimated total Direct Construction Cost, used 1 times in the estimate, overrides = 1
31.8. detail Non-Riparian Mitigation - for Veg Removal , 2 ACR @ $104,444.45 per ACR = $206,800, 0% of the estimated direct Sub Bid Construction Cost, 1% of the estimated total Direct Construction Cost, used 6 times in the estimate, overrides = 1
31.9. detail Non-Riparian Mitigation - for SWIF Constr Improvements , 1 ACR @ $103,400. per ACR = $51,700, 0% of the estimated direct Sub Bid Construction Cost, 0% of the estimated total Direct Construction Cost, used 1 times in the estimate, overrides = 1

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Language has been added to the Cost Engineering Appendix explaining the process under which the mitigation costs were estimated. The write ups include references to the documents that support/justify the mitigation cost esimates, including the Biological Opinions, Mitigation and Monitoring Plan, and the Cost Effectiveness/Incremental Cost Analysis.

Submitted By: Anne Baker ((916) 557-7277) Submitted On: Sep 03 2015

1-1 Backcheck Recommendation **Close Comment**
ATR lead has asked for this comment to be closed. Revised documentation has not been provided so that the comment evaluation can be verified. Since the comment is for additional cost support and not a change to the cost, the comment will be closed.
Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 07 2015

Current Comment Status: **Comment Closed**

6207105 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

32. CONCERN: Significant Sub Bid Costs, Quote lacks detail or does not exist, , and including this material cost as a sub bid item causes the sales tax to be not applied.
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: Please obtain material quotes that include the source contact information, date, amount, and conditions such as includes sales tax, includes delivery, excludes loading. If quotes is more than 2 years old, a new quote should be obtained. Please include these costs a s material costs so that the appropriate sales tax is applied.
32.1. detail Cement , 129,559 TON @ $110.67 per TON = $14,338,295, 20% of the estimated direct Sub Bid Construction Cost, 2% of the estimated total Direct Construction Cost, used 57 times in the estimate, overrides = 1
32.2. detail Fiber Rolls , 2,634,050 LF @ $3.5 per LF = $9,219,175, 13% of the estimated direct Sub Bid Construction Cost, 1% of the estimated total Direct Construction Cost, used 31 times in the estimate, overrides = 1
32.3. detail Dump Fees - from Clearing & Grubbing , 147,943 TON @ $33. per TON = $4,882,124, 7% of the estimated direct Sub Bid Construction Cost, 1% of the estimated total Direct Construction Cost, used 89 times in the estimate, overrides = 1
32.4. detail Approximate Pump Station Cost, Approx size 50 cfs , 1 EA @ $4,200,000. per EA = $4,200,000, 6% of the estimated direct Sub Bid Construction Cost, 1% of the estimated total Direct Construction Cost, used 1 times in the estimate, overrides = 0
32.5. detail Bentonite, 1ton bag , 128,432 EA @ $102.17 per EA = $13,121,897, 19% of the estimated direct Sub Bid Construction Cost, 2% of the estimated total Direct Construction Cost, used 36 times in the estimate, overrides = 1

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
32.1 Updated quotes are being obtained and will be added to the Cost Estimate.
32.2 Notes/Quotes have been added to the estimate.
32.3 Note/Quotes have been added to the estimate.
32.4 A general layout plan of the pumping plants is being provided by the Civil Designers. Quantities will be based on work on similar pumping plants for the Natomas PACR project. Most costs are updated to reflect current labor-equipment-material costs.
32.5 Notes/Quotes have been added to the estimate. Material Cost is $98/TON for bentonite, DDelivery (FOB) is $102.17/TON.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Aug 31 2015

1-1 Backcheck Recommendation **Open Comment**
Please provide revised MII for verification. Comment remains open.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 02 2015

1-2 Backcheck Recommendation **Close Comment**
Documents Received. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6207106 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

33. CONCERN: I have 4 CSRA files, each with a tab Base Cost Summary and a line item on row 29 that reads " Summary Construction Costs and L&D. Is it intended that the total for the line include the lands and damages?
SPK - American River Common Features - CSRA - 2015-07-13 DRAFT - ALT 2 (LPP).xlsm
SPK - American River Common Features - CSRA - 2015-07-06 DRAFT - ALT 1 (NED).xlsm
SPK - American River Common Features - CSRA - 2015-07-08 DRAFT - ALT 2 (LPP).xlsm
SPK - American River Common Features - CSRA - 2015-07-13 DRAFT - ALT 1 (NED).xlsm
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Per the Note on line 8, the Lands and Damages ARE NOT part of the Summary Construction Costs used in calculation of construction contingencies.

I will advise the preparer of the CSRA to revise the titles in Row 29 for future projects. - Note this is incidental as I don't believe these tables are placed in the CSRA report that will be attached to the Cost Engr Appendix in the final Feasibility Report.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Sep 11 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 14 2015

Current Comment Status: **Comment Closed**

6207107 Cost Engineering n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

34. I have one MII file called "CE-ARCF_GRR-MII4_2-20150708.mlp" with a total estimated amount = 1,140,035,630.76. And I have 4 CSRA files, each with a tab Base Cost Summary and a line item on row 29 that reads " Summary Construction Costs and L&D". (The total cost for that line do not actually include lands and damages).
How do I get from the costs in the MII file to the costs in the csra files in tab Base Cost Summary, Summary Construction Costs and L&D line item on row 29?
SPK - American River Common Features - CSRA - 2015-07-13 DRAFT - ALT 2 (LPP).xlsm
SPK - American River Common Features - CSRA - 2015-07-06 DRAFT - ALT 1 (NED).xlsm
SPK - American River Common Features - CSRA - 2015-07-08 DRAFT - ALT 2 (LPP).xlsm
SPK - American River Common Features - CSRA - 2015-07-13 DRAFT - ALT 1 (NED).xlsm
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
The costs in the upper part of the spreadsheet (rows 1-56) are compiled from the data input in rows 57- for all the reaches in the alternative. Rows 57- are not compiled directly from the MII file, but from the TPCS. The TPCS reflects the MII files (column M, Estimated Cost Column C) for each Reach of Alts 1 and 2 relative to construction costs.
Note that all these values have changed based on the ATR comments and must be input into the CSRA spreadsheet, from which a CSRA report is being developed for inclusion in the final feasibility report.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Sep 11 2015

1-1 Backcheck Recommendation **Close Comment**
Understood. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 14 2015

Current Comment Status: **Comment Closed**

6207109 | Cost Engineering | n/a | n/a | n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

35. It appears to me that the costs in the TPCS files do not match up with the costs in the csra files::
ARCF-TPCS Form-Alt2-Multi Phase - Multi Contract 20150804.xlsx
ARCF-TPCS Form-Alt1-Multi Phase - Multi Contract 20150804.xlsx
SPK - American River Common Features - CSRA - 2015-07-13 DRAFT - ALT 2 (LPP).xlsm
SPK - American River Common Features - CSRA - 2015-07-06 DRAFT - ALT 1 (NED).xlsm
SPK - American River Common Features - CSRA - 2015-07-08 DRAFT - ALT 2 (LPP).xlsm
SPK - American River Common Features - CSRA - 2015-07-13 DRAFT - ALT 1 (NED).xlsm
BASIS: ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works, ER 1110-2-1302 Civil Works Cost Engineering, ER 1110-1-1300 Cost Engineering Policy and General Requirements
SIGNIFICANCE: Medium
RESOLUTION: In the comment evaluations, please provide a detailed explanation of what has been changed to the cost and schedule documents in response to the comment, including the location of the change. Explain why the comment does not require a change to the documents if no change is made. Address each statement or concern in the comment. In most cases, the comment is intended clarify a concern and the clarification must be included in the documents, not just in the evaluation. This will help to expedite the backcheck process in order to close comments as soon as possible.

Submitted By: Gary Smith (651 260 1819). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
It was my understanding from the developer of the CSRA that, at the time of submittal, these matched, but that is irrelevant now as the costs have changed.

The revised CSRA spreadsheet and report will be checked versus the revised TPCS submitted for backcheck to insure the costs match.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Sep 11 2015

1-1 Backcheck Recommendation **Open Comment**
This comment will remain open until a set of matching files has been provided for verification:
MII
TPCS
CSRA
Comment remains open

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 14 2015

1-2 Backcheck Recommendation **Close Comment**
Matching Documents have been received. Comment Closed.

Submitted By: Gary Smith (651 260 1819) Submitted On: Sep 14 2015

2-0 Evaluation **Concurred**
Per this comment and relevant emails between reviewers and Cost Engineers.
Updated CSRA results (spreadsheet including contingencies) and TPCS files utilizing those contingencies have been sent today.

The cost indicated in the previously provided MII file and the TPCS do match. See cell M76.
Cell M19 is a summation of costs for Relocations, including Construction of Relocations (M76), PED for Relocations (cell M105) and Construction Mngt for Relocations (cell M111).
This is typical for all reaches.

Submitted By: Robert Vrchoticky ((916) 557-7336) Submitted On: Sep 14 2015

Backcheck not conducted

Current Comment Status: **Comment Closed**

6207452 | Economics | n/a | Econ Appendix, p. 33. | n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN: TEHRA – Depth damage for TEHRA – It does not appear that separate TEHRA curves were developed and applied for 1 story vs. 2 story vs. MH structures, although the depth of flooding causes substantially different percent damages to these different structure types. BASIS: Documentation included in updated Economic Appendix. SIGNIFICANCE: Low. RECOMMENDED ACTION: Recommend either updating the analysis to include separate functions by structure type or justify application of a single curve for all types.

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
The following verbiage will be added to the final Economic Appendix "Although this analysis uses the same depth-damage curves for all residential structures, in reality there would be some differences in TEHRA costs between 1-story vs. 2-story vs. Mobile Homes. Because the majority of the residential structures in the study area are 1 story, these differences will have a limited impact on the result and would not affect plan selection." There is also a precendent for using this same methodology in the Sutter Feasibility study.

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
Response adequately addresses concern.

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6207458 Economics n/a Econ Appendix, Table 14 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN: Table 14 shows that damages by Basin and ACE changed for ARS (F) and ARN (A) from the prior submittal, but the EAD by Index Point values shown on Table 15 did not change. BASIS: Damage estimates in referenced tables. SIGNIFICANCE: Low (likely). RECOMMENDED ACTION: Please explain/verify these results (why EAD did not change despite changes in damages by ACE).

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Changes will be verified to ensure consistency with FDA outputs. This update will be made at the same time the Appendix is updated for the final cerified costs. This will not impact the Recommended plan.

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
Closing comment, but please note resolution of this issue when submitting updated Econ Appendix.

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6207461 Economics n/a Econ Appendix, Table 17 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN: Emergency Costs – Table 17 shows without project EAD results for emergency costs separate from the other damage categories, which is fine. However, these damages/costs are part of total without project EAD. BASIS: The report should show total without project EAD that includes these damages/costs, as they represent approximately 13% of total computed damages. Also, this would serve as a matching reference later in the report where without project damages and benefits are shown for the ARS and ARN basins (Tables 46-50) that include emergency costs. SIGNIFICANCE: Low. RECOMMENDED ACTION: Recommend either moving the emergency cost analysis prior to the tables 15 and 16, and then including a column for these damages in the summary tables, or otherwise including an additional table after the emergency cost analysis showing total EAD that includes these costs.

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
The emergency cost analysis will be moved up prior to tables 15 and 16 and these costs will be added to the total EAD shown in those tables.

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
Comment closed - will review when updated econ appendix is submitted.

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6207465 Economics n/a Econ Appendix, Section 4.3-4.5 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN: These sections present without project damages and with project benefits that do not consider/include emergency costs. Preferably these costs would have been incorporated into these sections and result tables. BASIS: Project alternative evaluation should include all primary damage/benefit categories. SIGNIFICANCE: Low. RECOMMENDED ACTION: As noted preferably these costs should be incorporated into Sections 4.3-4.5. However, at a minimum, documentation should be added to the beginning of these sections that explain that the benefits presented do not include reductions in emergency costs, which are later discussed in Section 4.6, and why they are not included.

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Emergency costs were only run for the dominant reaches, so they cannot be incorporated into all of the relevant tables in Sections 4.3-4.5. Text will be added to the final document describing this nuiance.

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
proposed action adequately addresses concern.

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6207467 Economics n/a Econ Appendix, p. 55 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN: Report notes that Alt 2 provides benefits to West Sacramento (and no longer refers to potentially offsetting increases in damages). It would be beneficial to elaborate on the significance/magnitude of these potential benefits and whether if considered and factored into the analysis, could result in Alternative 2 having greater net benefits/being the NED Plan. BASIS: Report should consider all significant benefit categories in the determination of the NED Plan. SIGNIFICANCE: Medium. RECOMMENDED ACTION: As noted, recommend this section elaborate on the significance/magnitude of these potential benefits to West Sacramento that were not quantified and whether if considered and factored into the analysis, could result in Alt 2 being identified as the NED Plan.

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
The offsetting of damages still exist and this section will be updated as follows: "The City of West Sacramento is located on the right bank (west side) of the Sacramento River adjacent to the confluence with the American River and directly across the river from the city of Sacramento. Widening the Sacramento Bypass (Alternative 2) results in water surface elevation reduction downstream on the Sacramento River adjacent to the city of West Sacramento. However, these potential benefits are not effectively realized because the highest damages within West Sacramento are instead driven by flooding coming from the Yolo Bypass, which does not see any decrease in water surface elevation as a result of the Sacramento Bypass widening."

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
Thanks - this is an important clarification.

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6207470 Economics n/a Econ Appendix, Tables 46 & 48 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN: Please verify the results shown on these tables. Specifically, the incremental and cumulative average annual benefits for fixing and raising or widening the Sacramento River are exactly the same as reported in the prior submittal, although the without project EAD now appears to include the emergency costs. The total benefits of $308.5M for Alt 1 and $309.4M for Alt 2 correspond with the computed benefits earlier in the report of $264M for structs/contents, plus $44M for emergency costs. However, all of the assigned increase in benefits in the incremental benefit/cost tables are assigned to 2B (Fix American River). So while the incremental benefits for 2b were previously around $25M, they are now around $68M. Presumably the increase in benefits associated with the emergency cost reductions would be spread between the increments. Results on this table do not appear to be correct. BASIS: Evaluation of updated damages/benefits. SIGNIFICANCE: Medium. RECOMMENDED ACTION: Please verify results and revise as necessary.

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Need to verify this with the lead Economist when he returns from emergency leave, but presumably this is because the emergency costs were not calculated incrementally and instead only using the dominating without and with project FDA models. Resolution will be either a) the table will be revised to include emergency cost benefits spread out among the increments or b) text will be added describing why the benefit is not spread out.

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6207474 Economics n/a Econ Appendix, p. 60 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN:. The Fix Creeks increment has very marginal economic justification for the ARN Basin. Concern is risk of including features as part of the NED Plan that may not be economically justified. BASIS: Reported results. SIGNIFICANCE: Medium. RECOMMENDED ACTION: Recommend adding a discussion of the probability this increment is economically justified based upon the HEC-FDA results showing probability EAD reduced exceeds indicated values.

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Though the Fix Creeks increment is marginal and will likely remain very marginal, we are further justifying this increment based upon a social justice (OSE) argument as described in the text following Table 48. HQ made the same comment and were satified with the added OSE justification to move forward with including it as part of the NED plan. A probability table can be added to the report if absolutely necessary, but it will likely just show that it's essentially a 50% chance it will be above or below unity.

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
I am ok with not including the suggested table and instead just acknowledging the marginal justification. There is of course a risk that if there are any increases in costs for this increment this component of the project will not be economically justified.

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6207476 Economics n/a Econ Appendix, Section 4.13 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN: I would recommend renaming this section NED Optimization – Levee Raises for Alternative 1. BASIS: Title for this section of the appendix vs. the content. SIGNIFICANCE: Low. RECOMMENDED ACTION: Within this section, I would note that the two alternative levee heights were considered to verify that the NED levee scale was properly identified. This section is supporting the selected levee height as the NED levee height, rather than presenting an HEC-FDA sensitivity analysis.

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
This section will be re-named/revised as recommended.

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
response addresses concern

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6207477 Economics n/a Econ Appendix, Section 4.14 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

REVIEW CONCERN: Accuracy of statement that net benefits between alternatives are essentially equal. BASIS: Statement made in appendix regarding net benefits for Alts 1 and 2. SIGNIFICANCE: Low. RECOMMENDED ACTION: Recommend revising text to state that BENEFITS for the two plans are very similar and are essentially equal from an R&U perspective, rather than NET benefits. Given that the two plans have essentially the same benefits, the NED Plan is pretty clear as Alt 1, given it costs nearly $200M less.

Submitted By: Michael Hallisy (213-452-3815). Submitted On: Aug 21 2015

1-0 Evaluation **Concurred**
Statement will be revised as recommended.

Submitted By: Nicholas Applegate (916-557-6711) Submitted On: Sep 08 2015

1-1 Backcheck Recommendation **Close Comment**
response addresses concern.

Submitted By: Michael Hallisy (213-452-3815) Submitted On: Sep 09 2015

Current Comment Status: **Comment Closed**

6212786 Geotechnical n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

I reviewed the ARCF EIS/EIR located at \\155.88.8.200\pe\Elmo\Marc_Masnor\American_River_Common_Features\3_Final_GRR_ATR__Aug2015\Review_Documents_for_ATR_Comments. i have no comments on this document and no additional comments on the GRR.

Submitted By: Glen Bellew (816.389.3553). Submitted On: Aug 26 2015

Revised Sep 02 2015.

1-0 Evaluation **Concurred**
Concur with the comment. Thanks for your review.

Submitted By: Sara Schultz ((916) 557-7368) Submitted On: Sep 04 2015

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Glen Bellew (816.389.3553) Submitted On: Sep 08 2015

Current Comment Status: **Comment Closed**

6225189 Planning - Plan Formulation n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

I reviewed the American River Common Features Final General Reevaluation Report, Chapters 1-8, and Appendix A - Plan Formulation. I have no technical comments on these documents. Editorial comments were provided directly to the ATR Lead and the PDT.

Submitted By: Eric Lynn (816-983-3258). Submitted On: Sep 04 2015

1-0 Evaluation **Concurred**
Concur with the comment. Thanks for your review.

Submitted By: Sara Schultz ((916) 557-7368) Submitted On: Sep 04 2015

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Eric Lynn (816-983-3258) Submitted On: Sep 08 2015

Current Comment Status: **Comment Closed**

6225198 Hydraulics n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

I reviewed the final H&H appendices. I have provided my editorial comments to the PDT in an email.

No technical comment for this current review.

Submitted By: Shih-Huang Chieh (213-452-3571). Submitted On: Sep 04 2015

Revised Sep 04 2015.

1-0 Evaluation **Concurred**
Concur with the comment. Thanks for your review.

Submitted By: Sara Schultz ((916) 557-7368) Submitted On: Sep 04 2015

1-1 Backcheck Recommendation **Close Comment**
Comment closed.

Submitted By: Shih-Huang Chieh (213-452-3571) Submitted On: Sep 08 2015

Current Comment Status: **Comment Closed**

6229108 Civil n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

I have no further comments

Submitted By: Huma M Nisar (213-452-3665). Submitted On: Sep 09 2015

1-0 Evaluation **Concurred**
Thank you.

Submitted By: James Elsberry (916-557-5276) Submitted On: Sep 09 2015

1-1 Backcheck Recommendation **Close Comment**
The ATRT Lead has closed the "no comment" comment.

Submitted By: Marc Masnor (918-669-7349) Submitted On: Sep 10 2015

Current Comment Status: **Comment Closed**

6230558 Environmental n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Mitigation Monitoring Plan, Section 1.1 Purpose and Goals, para 1, last sentence, states that this plan "will also establish an adaptive management plan to allow for accomplishment of the goals and requirements of the mitigation...." Text is not clear whether the adaptive management plan would be a separate document or be contained within the mitigation and monitoring plan. If the intent is for the adaptive management plan to be an element of this plan, then recommend text be revised to clarify. Also, if the adaptive management plan element would be developed at a later time, then recommend adding text to state. If the intent is to have the adaptive management element in the plan now, then text should be clarified so reader has a clear understanding.

Submitted By: Tiffany Bostwick (213-452-3845). Submitted On: Sep 10 2015

1-0 Evaluation **Concurred**
Text modified to "This HMMP is a living document and will be modified as part of an adaptive management strategy to allow for the accomplishment of the goals and requirements in a constantly changing environment." Please note change of MMP to HMMP (Habitat Mitigation and Monitoring Plan) in order to be consistent with requests from NMFS.

Submitted By: Anne Baker ((916) 557-7277) Submitted On: Sep 10 2015

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Tiffany Bostwick (213-452-3845) Submitted On: Sep 11 2015

Current Comment Status: **Comment Closed**

6230559 Environmental n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Mitigation Monitoring Plan -- responsible parties, roles. The plan lacks information on who are the responsible parties for implementing the plan, when, etc. Plan should include text to identify the roles and responsibilities of the Corps versus the local sponsor or other partners with respect to implementation of this plan. Also, in the context of adaptive habitat management, plan should indicate the decision maker(s) and identify, as appropriate, any other parties/entities that would be involved in an advisory capacity.

Submitted By: Tiffany Bostwick (213-452-3845). Submitted On: Sep 10 2015

1-0 Evaluation **Concurred**
At this time some of the specifics (when implementation would take place) are yet to be determined, but the roles and responsibilities are part of the agreement between the Corps, USFWS, and NMFS. Added text: "The HMMP would be implemented by U.S. Army Corps of Engineers (Corps) staff through coordination with USFWS and NMFS. Monitoring would be conducted by qualified biologists from the Corps, USFWS, the Department of Water Resources (DWR), and the Sacramento Area Flood Control Agency (SAFCA) as necessary. Upon completion of the monitoring term as established by USFWS and NMFS, the land would be turned over to the non-Federal sponsor to be maintained in perpetuity."

Submitted By: Anne Baker ((916) 557-7277) Submitted On: Sep 10 2015

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Tiffany Bostwick (213-452-3845) Submitted On: Sep 11 2015

Current Comment Status: **Comment Closed**

6230560 Environmental n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Mitigation Monitoring Plan Table 3 - Did not find Table 3 referenced in the text, or explanation of significance of the table. Recommend adding text to provide context for inclusion of the table.

Submitted By: Tiffany Bostwick (213-452-3845). Submitted On: Sep 10 2015

1-0 Evaluation **Concurred**
Added text: Table 3 describes the types and amounts of habitat that would be potentially impacted by the project, the duration of the impacts, the amount of mitigation according to the requirements provided by USFWS and NMFS, and projected costs as estimated according to existing mitigation prices."

Submitted By: Anne Baker ((916) 557-7277) Submitted On: Sep 10 2015

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Tiffany Bostwick (213-452-3845) Submitted On: Sep 11 2015

Current Comment Status: **Comment Closed**

6230562 Environmental n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Mitigation Monitoring Plan Section 2.0. Para 4 identifies the consideration of application of adaptive management principles to the project. The text places emphasis on the potential changes to project objectives, expectations, assumptions, and success criteria. However, the text does not give consideration to potential changes or alternatives (adapting of) to management actions on the habitat/mitigation area based on monitoring results, which is one of the main aspects of adaptive management. Recommend adding text to identify the potential need for changes or alternatives in management actions on the habitat/mitigation area based on monitoring results.

Submitted By: Tiffany Bostwick (213-452-3845). Submitted On: Sep 10 2015

1-0 Evaluation **Concurred**
Added text: "In addition to modifying project objectives, there is a potential for changes to or adaptation of management actions based on monitoring results. The purpose of adaptive management is to enable strategic changes to improve the mitigation sites to functioning habitat."

Submitted By: Anne Baker ((916) 557-7277) Submitted On: Sep 10 2015

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Tiffany Bostwick (213-452-3845) Submitted On: Sep 11 2015

Current Comment Status: **Comment Closed**

6230563 Environmental n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Mitigation Monitoring Plan Section 2.6 Special Status Fish Species makes a number of references to a green sturgeon mitigation and monitoring plan. It is not clear in the text whether this is a separate MMP to be developed, or the green sturgeon element would be further developed within this MMP during design. Recommend text be revised to clarify.

Submitted By: Tiffany Bostwick (213-452-3845). Submitted On: Sep 10 2015

1-0 Evaluation **Concurred**
The green sturgeon plan would be a part of the HMMP described in the remainder of the document. Revised text: "The Corps' final EIS/EIR for the American River Common Features GRR includes a proposal to further develop this HMMP to include a refined green sturgeon plan with the specific elements that are described below."

Submitted By: Anne Baker ((916) 557-7277) Submitted On: Sep 10 2015

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Tiffany Bostwick (213-452-3845) Submitted On: Sep 11 2015

Current Comment Status: **Comment Closed**

Enclosure 2

COMPLETION STATEMENT OF AGENCY TECHNICAL REVIEW

COMPLETION OF AGENCY TECHNICAL REVIEW

The Agency Technical Review (ATR) has been completed for the **AMERICAN RIVER WATERSHED, COMMON FEATURES, FINAL GENERAL REEVALUATION REPORT, September 2015, and FINAL ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT, September 2015**, Sacramento District. The ATR was conducted as defined in the project's Review Plan to comply with the requirements of EC 1165-2-214, 15 December 2012, Water Resources Policies and Authorities, CIVIL WORKS REVIEW. During the ATR, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions, methods, procedures, and material used in analyses, alternatives evaluated, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing US Army Corps of Engineers policy. The District quality control review was found to be adequate. All comments resulting from the ATR have been resolved and the comments have been closed in DrChecks.

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Date: 2015.09.14 13:20:08 -07'00'

Miki Fujitsubo, NTS for
Marc L. Masnor, P.E.
ATR Team Leader
CESWF-PEC-PF (Tulsa, OK)

Date

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Date: 2015.09.14 13:54:31 -07'00'

Eric Thaut
Review Management Organization
Representative
CESPD-PDS

Date

Digitally signed by TIBBITTS.DANIEL.PATRICK.1257722526
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Date: 2015.09.15 08:06:46 -07'00'

Dan P. Tibbitts
Project Manager
CESPK-PM-C

Date

DISTRICT'S STATEMENT

CERTIFICATION OF AGENCY TECHNICAL REVIEW
SEPTEMBER 2015

Of the:

AMERICAN RIVER WATERSHED
COMMON FEATURES
FINAL GENERAL REEVALUATION REPORT
September 2015

And

FINAL ENVIRONMENTAL IMPACT STATEMENT/
ENVIRONMENTAL IMPACT REPORT
September 2015

Sacramento District

US Army Corps
of Engineers ®

CERTIFICATION OF AGENCY TECHNICAL REVIEW

Subject: Agency Technical Review (ATR) of the **AMERICAN RIVER WATERSHED, COMMON FEATURES, FINAL GENERAL REEVALUATION REPORT, September 2015, and FINAL ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT, September 2015, Sacramento District**.

Significant concerns and the explanation of the resolution of agency technical review comments for the subject ATR are as follows:

- None

References.

a. ATR guidance: EC 1165-2-214, 15 December 2012, Water Resources Policies and Authorities, CIVIL WORKS REVIEW.
b. The Review Management Organization for this review was the Flood Risk Management Planning Center of Expertise (FRM-PCX), Eric Thaut.
c. The ProjnetTM DrChecks Project and Review titles are: Project: ARCF - General Reevaluation Report (GRR), TSP & Attachments, American River Common Features (ARCF), California (P2 #149827), Review: ATR Final EIS/EIR (10-14 Aug 2015) (00031).
d. The ATR review report is titled: FLOOD RISK MANAGEMENT, PLANNING CENTER OF EXPERTISE, REVIEW MANAGEMENT ORGANIZATION, AGENCY TECHNICAL REVIEW REPORT, SEPTEMBER 2015, Of the: AMERICAN RIVER WATERSHED, COMMON FEATURES, FINAL GENERAL REEVALUATION REPORT, September 2015, And, DRAFT ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT, September 2015, Sacramento District, and contains the ATR Completion Statement.

I certify that all comments resulting from ATR of the subject report have been closed to the satisfaction of the agency technical review team and the project delivery team has completed revisions as indicated in the evaluation of comments.

Rick L. Poeppelman

16 Sept 2015

Rick L. Poeppelman, P.E.
Chief, Engineering Division
CESPK-ED

Date

for Alicia E. Kirchner
Chief, Planning Division
CESPK-PD

9-14-15

Date

ProjNet Report

Comment Report: Comment Evaluation/Backcheck Contribution by Michael Scuderi
Project: ARCF - General Reevaluation Report (GRR), TSP & Attachments, American River Common Features (ARCF), California (P2 #149827) **Review**: ATR Final EIS/EIR (10-14 Aug 2015) (*00031*)
(sorted by Discipline , ID)

Displaying 6 comments for the criteria specified in this report.

Id	Discipline	Section/Figure	Page Number	Line Number
6308793	Environmental	n/a	2. Mitigation Ratios for threatened and endangered species not explained	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

CONCERN: While the inclusion of the Mayhew HSI does help to explain why the 1:1.6 ratio is suggested there is an incomplete explanation of the mathematics that produced that number.
BASIS FOR CONCERN: ER 1105-2-100, C-3(e) (2) does require clear justification of ratios.
SIGNIFICANCE OF CONCERN: High
ACTION NEEDED TO RESOLVE CONCERN: Further explain the development of the 1:1.6 ratio for Mayhew and then carry this forward to American River example. A justification for the bump-up to 2:1 can be found at:
http://training.fws.gov/courses/csp/csp3112/resources/Mitigation/WetlandMitigationRatios.pdf and https://fortress.wa.gov/ecy/publications/documents/1006011.pdf and
https://fortress.wa.gov/ecy/publications/documents/1006011.pdf
http://escholarship.org/uc/item/6x36z0r6, and
http://www.ecy.wa.gov/programs/sea/wetlands/bas/vol2final/Appendix%208-F_Volume%202_.pdf are two examples of research into why higher ratios are justified for temporal loss.

Submitted By: Michael Scuderi (206-764-7205). Submitted On: Nov 30 2015

1-0 Evaluation **Concurred**
The District will update the HMMAMP to elaborate on how the 1:1.6 ratio was calculated for Mayhew. Additionally, further justification will be included regarding the need for 2:1 mitigation based on the quantity of habitat lost and the habitat quality and function lost through mitigation when creating new habitat to replace mature riparian habitat. Thank you for providing the attached articles as a resource for this justification.

Submitted By: Anne Baker ((916) 557-7277) Submitted On: Dec 01 2015

1-1	Backcheck Recommendation **Close Comment** Explanation sufficient. Revised language should be reviewed. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 03 2015.
1-2	Backcheck Recommendation **Open Comment** Revised language does not reflect justification for 2:1 ratio. Suggest either eliminate ratio or provide jsutification Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 18 2015.
1-3	Backcheck Recommendation **Close Comment** SPK provided justification of 2:1 ratio related to temporal loss and habitat benefits. Explanantion is sufficient to close out comments. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 18 2015.
	Current Comment Status: **Comment Closed**

Id	Discipline	Section/Figure	Page Number	Line Number
6308794	Environmental	n/a	3. Performance standards for mitigation measures are not included in mitigation plan	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

CONCERN: Performance criteria were changed to reflect physical aspects of the mitigation features (mainly survival) but are other measures such as percent cover better indicators of success. Also, that variable would better track with the HEP model (Northern Oriole) variables used in the impact analysis. Survivability might not be a consistent measure to use. Comment from Chemine Jackels "I imagine that percent survivability is difficult to assess after a couple of years. Percent coverage seems like a better metric, and should go up over time. We typically hold the contractor responsible for %100 survival after the first year. They need to replace plants that have died in the first year. These comments apply to all the vegetation monitoring metrics. "
BASIS FOR CONCERN: Required for Section 2036 of WRDA 2007. Performance criteria should be identified related to physical characteristics of the project and not on the survey of populations of species of concern.
SIGNIFICANCE OF CONCERN: Medium
ACTION NEEDED TO RESOLVE CONCERN: Consider adding other variables to monitor. At a minimum add some more explanatory text on why survivability is the best criteria to use (See my email notes also).
Submitted By: Michael Scuderi (206-764-7205). Submitted On: Nov 30 2015

1-0	Evaluation **Concurred** The District will update the performance standards. Concur that we will require the contractor to be responsible for 100% survivability during the first year. The District's assessment is that survivability percentage is a reasonable metric for the first three years, minimum. In addition, the District will monitor for percent cover starting at year one, and will include a performance standard for cover as a success criteria. The District also proposes to revise the criteria that requires the mitigation to meet "three consecutive years of survival" to "three consecutive years of survival following removal of supplemental irrigation". Submitted By: Anne Baker ((916) 557-7277) Submitted On: Dec 01 2015
1-1	Backcheck Recommendation **Close Comment** Explanation sufficient. Revised language should be reviewed. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 03 2015.
1-2	Backcheck Recommendation **Close Comment** Evaluation criteria changed to reflect cover as a criteria. Response is sufficient. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 08 2015.
	Current Comment Status: **Comment Closed**

Id	Discipline	Section/Figure	Page Number	Line Number
6308795	Environmental	n/a	3. Performance standards for mitigation measures are not included in mitigation plan	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

CONCERN: Why is there an expected decline in survivability from 75% to 60%
BASIS FOR CONCERN: It appears that there is a downward trend in vegetation survival that might continue after monitoring.
SIGNIFICANCE OF CONCERN: Medium
ACTION NEEDED TO RESOLVE CONCERN: Please explain if it is expected that survivability will level off and not continue declining trend. You can use or elaborate on past Sacramento projects.
Submitted By: Michael Scuderi (206-764-7205). Submitted On: Nov 30 2015

1-0	Evaluation **Concurred** The performance standards established in the table were not intended to portray a declining trend. Rather, they were intended to provide an outlet for meeting success in a scenario where a mitigation site is struggling. For example, if the site is not

	meeting success criteria following year 6, then the performance standard reduces to allow the mitigation to meet a lower standard instead. The District proposes to revise the performance standards to focus on percent cover in addition to survivability. The tables will be removed or revised to reflect the new standards. Ensuring that the vegetation meets survival criteria for three consecutive years following the removal of supplemental irrigation would ensure that any downward trends would not occur. Submitted By: Anne Baker ((916) 557-7277) Submitted On: Dec 01 2015
1-1	Backcheck Recommendation **Close Comment** Explanation sufficient. Revised language should be reviewed. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 03 2015.
1-2	Backcheck Recommendation **Close Comment** Survivability criteria have been downplayed verus usig cover as a monitoring criteria. Response sufficient. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 08 2015.
	Current Comment Status: **Comment Closed**

Id	Discipline	Section/Figure	Page Number	Line Number
6308797	Environmental	n/a	4. Adaptive Management is not included in mitigation plan.	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

CONCERN: No adaptive management plan was previously included
BASIS FOR CONCERN: Requirement of Section 2036 WRDA 2007
SIGNIFICANCE OF CONCERN: HIGH
ACTION NEEDED TO RESOLVE CONCERN:. AMP was added to HMMAMP. In section 2.6.4 at the beginning refer back to table 2. The only other factor to consider is are the costs details of the AMP sufficient for HQ review. Should not the costs be broken out by mitigation measure?
Submitted By: Michael Scuderi (206-764-7205). Submitted On: Nov 30 2015

1-0	Evaluation **Concurred** Will refer to the correct table in Section 2.6.4. The District will update the AMP to elaborate on the components of the cost estimate per year in tabular form. Submitted By: Anne Baker ((916) 557-7277) Submitted On: Dec 01 2015

1-1	Backcheck Recommendation **Close Comment** Explanation sufficient. Revised language should be reviewed. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 03 2015.
1-2	Backcheck Recommendation **Close Comment** Costs have been added to table. Thank you. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 08 2015.
	Current Comment Status: **Comment Closed**

Id	Discipline	Section/Figure	Page Number	Line Number
6308798	Environmental	n/a	5. Discounting of onsite mitigation and mitigation bank measures	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

CONCERN: Not enough detail is provided to justify the exact values of the discount rates. Why was .2 and .3 used and not 0 and .1? or some other numbers? It is also not clear how the temporal loss aspect factors into the mitigation determination.
BASIS FOR CONCERN: ER 1105-2-100 par. C-3(d)(5) requires justification for replacement rates.
SIGNIFICANCE OF CONCERN: HIGH
ACTION NEEDED TO RESOLVE CONCERN: Provide additional justification for discount rates even if it is BPJ or local expert analysis.
Submitted By: Michael Scuderi (206-764-7205). Submitted On: Nov 30 2015

1-0	Evaluation **Concurred** Justification for the 20% discount rate on onsite mitigation is provided through the HEP discussion. Please see Table 4 for justification of this discount. The District concurs that the additional 10% discount for mitigation banks is not justified. The ARCF GRR CE/ICA is being revised to remove this reduction. It was not applied to the West Sac GRR CE/ICA. Submitted By: Anne Baker ((916) 557-7277) Submitted On: Dec 01 2015

1-1	Backcheck Recommendation **Close Comment** Explanation sufficient. Revised language should be reviewed. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 03 2015.

1-2	Backcheck Recommendation **Close Comment** Discount has been explained by revised text. Removal of 0.10 for off-site is acceptable. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 08 2015.
	Current Comment Status: **Comment Closed**

Id	Discipline	Section/Figure	Page Number	Line Number
6308799	Environmental	n/a	Responses to 6, 7, and 8 HQ Responses	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

FOR INFORMAITON ONLY: Mitigation Plan rewrite is adequate.

Submitted By: Michael Scuderi (206-764-7205). Submitted On: Nov 30 2015

1-0	Evaluation **Concurred** Thank you for your concurrence/review. Submitted By: Anne Baker ((916) 557-7277) Submitted On: Dec 01 2015

1-1	Backcheck Recommendation **Close Comment** Closed without comment. Submitted By: Michael Scuderi (206-764-7205) Submitted On: Dec 03 2015.
	Current Comment Status: **Comment Closed**

Report Complete

Classified information is NOT permitted on this site. Do NOT share your ProjNet password. Questions and comments to Call Center , 1-217-367-3273 or 1-800-428-HELP (4357)

- Patent 11/892,984 property of ERDC since 2004.

CESWF-PEC-PF (Tulsa, OK) January 14, 2016

MEMORANDUM FOR RECORD

SUBJECT: Targeted Agency Technical Review of the Habitat Mitigation Monitoring and Adaptive Management Plan, December 2015 - AMERICAN RIVER WATERSHED, COMMON FEATURES, FINAL GENERAL REEVALUATION REPORT, and FINAL ENVIRONMENTAL IMPACT STATEMENT / ENVIRONMENTAL IMPACT REPORT, Sacramento District.

1. The Chief of Planning in Sacramento District requested the subject review. The District had received comments from HQUSACE in November 2015, regarding the mitigation plans for the subject project and WEST SACRAMENTO PROJECT, FINAL GENERAL REEVALUATION REPORT, AND FINAL ENVIRONMENTAL IMPACT STATEMENT /ENVIRONMENTAL IMPACT REPORT, September 2015. The District agreed with the comments and recognized that substantive revisions of the mitigation plans would be necessary. The HQUSACE comments applied to the methodology applied to the mitigation plans for the two projects. The agency technical review for both projects final general reevaluation reports and NEPA documents had been completed in September 2015. The Sacramento District contacted the Flood Risk Management Planning Center of Expertise to coordinate a targeted review.

2. The charge for the review reflected the HQUSACE comments and was summarized as verifying that mitigation plan revisions were consistent with the Water Resources Development Act of 2007, Section 2036. Because the methodology was the same for the two projects, the review document would be the subject project mitigation plan. The applicable mitigation plan revisions would be made by the District for both projects.

3. The revised mitigation plan was reviewed by Mr. Michael R. Scuderi, CENWS. Mr. Scuderi provided five technical comments and the subsequent sixth comment concluded that District evaluations and mitigation plan revisions had adequately addressed his comments. In general, the technical comments suggested additional discussion be added to more clearly present the mitigation plan.

4. The targeted review is complete. Mitigation plans for both projects have been revised. No further action by the District is required for agency technical review. A report of all comments is enclosed for the subject project.

District.

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1 Encl

Marc L. Masnor
ATR Team Lead

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION, CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1399

REPLY TO
ATTENTION OF

CESPD-PDP (FRM-PCX) 27 July 2015

MEMORANDUM FOR Commander Sacramento District, U.S. Army Corps of Engineers (CESPK-PM-C/Mr. Dan Tibbitts)

SUBJECT: Final Comment Response Record for the Independent External Peer Review (IEPR) of the American River Common Features General Re-evaluation Report (GRR)

1. References:

a. EC 1165-2-214, Civil Works Review, 15 December 2012.

b. Memorandum, CESPD-PDP (FRM-PCX), 8 June 2015, subject: FRM-PCX Transmittal of Final Independent External Peer Review (IEPR) Report for American River Common Features General Re-evaluation Report (GRR).

2. Enclosed is the Final Comment Response Record for the IEPR of the American River Common Features GRR.

3. The Flood Risk Management Planning Center of Expertise (FRM-PCX) coordinated the IEPR, which was conducted by an external panel of experts selected and managed by the Battelle Memorial Institute. The IEPR panel comments are documented in the Battelle report titled Final Independent External Peer Review (IEPR) Report for American River Common Features General Re-evaluation Report (GRR), dated 3 June 2015.

4. Seventeen IEPR final comments were developed by the panel, one of which was identified as having high significance. The Comment Response Record documents the Sacramento District responses to the panel comments and the IEPR panel backcheck of the responses. Concurrence was reached between the panel and District on all of seventeen responses; however, the panel provided clarifying statements as part of its concurrence with the District response to the final panel comments 1, 7, 14 and 15.

5. Based on the Comment Response Record, the Sacramento District should prepare a written proposed response to the Final IEPR Report in accordance with reference 1a. The proposed response should be coordinated with the Major Subordinate Command District Support Team and HQUSACE to ensure consistency with law, policy, project guidance, ongoing policy and legal compliance review, and other USACE or National considerations.

CONTRACT NO. W912HQ-10-D-0002
Task Order: 0068

Comment Response Record for the Final Panel Comments for the American River Common Features GRR IEPR

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LIST OF ACRONYMS

ADM	Agency Decision Milestone
AEP	annual exceedance probability
ARCF	American River Common Features
ATR	Agency Technical Review
BA	Biological Assessment
BMP	best management practices
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
COI	Conflict of Interest
CRPR	California Rare Plant Rank
CVFPB	Central Valley Flood Protection Board
CWRB	Civil Works Review Board
DrChecks	Design Review and Checking System
DWR	Department of Water Resources (CA)
EAD	expected annual damages
EC	Engineer Circular
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ER	Engineer Regulation
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FWOP	future without-project
GRR	General Re-evaluation Report
H&H	Hydrologic and Hydraulic
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
IEPR	Independent External Peer Review
IWR	Institute for Water Resources

JFP	Joint Federal Project
NED	National Economic Development
NEPA	National Environmental Policy Act
OEO	Outside Eligible Organization
OMB	Office of Management and Budget
PCX	Planning Center of Expertise
PDT	Project Delivery Team
SAFCA	Sacramento Area Flood Control Agency
SAR	Safety Assurance Review
SRA	Shaded Riverine Aquatic
TSP	Tentatively Selected Plan
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
VELB	valley elderberry longhorn beetle
WRDA	Water Resources Development Act

Final Panel Comment 1

It is not clear why the hydraulic profile for the future without-project condition is significantly higher than the profile for Alternative 1.

Basis for Comment

Based on Section 3.4 of the Hydraulic Appendix Executive Report (Appendix C, Attachment B of the GRR), the future without-project (FWOP) conditions "will serve as the baseline for alternative comparison" in this GRR and, based on Section 2.2 of the Hydraulic Appendix, the FWOP conditions include the change in operations at Folsom Dam due to the Joint Federal Project (JFP).

In Plate 44 of the Hydraulic Appendix, the 200-year water surface profile for the baseline condition (i.e., FWOP) appears to be significantly higher than the profile for Alternative 1. Based on the information above, it would seem that, hydraulically, Alternative 1 would only be affected by raised levee heights south of the American River confluence, which in turn would potentially cause Alternative 1 to be higher than the baseline condition. In addition, since the Natomas levees are not being raised for this analysis and therefore would have no effect on the baseline condition or Alternative 1, the baseline condition would not be expected to be higher than Alternative 1.

For the 10-year flood event, it is not clear why the baseline and Alternative 1 would be any different (see Plate 42 as an example) since the 10-year event would not be expected to overtop levees under either condition.

Plates 42 and 44 represent examples of the two profile issues noted above. These issues are apparent on several other profiles between Plates 31 to 56. Each profile represents a different reach of the rivers and canal systems for either the 10-year (Plates 31 to 43) or the 200-year (Plates 44 to 56) events.

Significance – High

If the baseline condition is not correct, there is a high risk that the flood damage estimates will be incorrect. If, on the other hand, Alternative 1 is incorrect, then there is a risk that the National Economic Development (NED) plan has not been identified.

Recommendation for Resolution

1. Verify the baseline conditions and Alternative 1 profiles on all Plates 31 to 56 in the Hydraulic Appendix Executive Report and adjust analysis as necessary.

PDT Final Evaluator Response (FPC#1):

Concur. The water surface profiles for Alternative 1 and the future without-project condition are identical. The differences observed in the plates were from a superseded and now out of date strategy to measure hydraulic effects of a combination of projects along the American River including the Joint Federal Project Auxiliary Spillway.

Recommendation #1: Adopt

Plates 31 to 56 in the Hydraulic Appendix Executive Report have been verified for baseline conditions and Alternative 1 profiles.

Panel Final BackCheck Response (FPC#1):

Concur. By replacing the plates in the Hydraulic Appendix Executive Report with up-to-date plates, the USACE response adequately addresses the FPC.

Final Panel Comment 2

Details as to why non-Federal agencies would not continue to undertake incremental improvements to the levee system in the future without-project condition are not included in the GRR.

Basis for Comment

The GRR describes work the non-Federal sponsors have done, and are currently doing, to improve the levee systems in the study area. However, the FWOP condition described in the report assumes that no additional improvements will be made to the levee system by USACE, the non-Federal sponsors, or other local agencies. It is not clear why local interests would not continue or even increase their efforts to make improvements to the levee system if no USACE project was anticipated. A clear understanding of the rationale supporting the projected FWOP condition is needed to provide confidence in the results of the evaluation and comparison of alternative plans.

Significance – Medium

If, in the future, non-Federal agencies would continue to make improvements to the levee system in the absence of a Federal project, then the flood risk management benefits of the action alternatives for the ARCF GRR may be overstated.

Recommendation for Resolution

1. Explain in the GRR and Economics Appendix why it is anticipated that local interests will not make improvements to the levee system in the FWOP condition.

PDT Final Evaluator Response (FPC#2):

Concur. The non-Federal sponsor, in addition to partnering with USACE on ongoing and completed flood risk management projects in the study area, has undertaken several large levee improvement projects on their own, including the Natomas Levee Improvement Program (NLIP). The sponsor has also indicated that they will be seeking both permission to alter the Federal Flood Management Project (Section 408) and Credit Consideration (Section 221) for levee improvement work they intend on constructing prior to implementation of the ARCF GRR recommended project. Section 221 of the Flood Control Act of 1970 as amended by Section 2003 of the Water Resources Development Act (WRDA) of 2007 (42 U.S.C. 1962d-5b) allows the sponsor to seek credit for the study, design and construction of Federally authorized water resources development projects that are carried out after the execution of an agreement with the ASA(CW). Where there is a cost sharing agreement, the sponsor may provide in-kind contributions in accordance with the terms of the applicable agreement. The sponsor has indicated that they intend to construct portions of the levee improvements recommended by the GRR that are considered the highest risk areas and seek credit for those improvements. These actions will not be considered part of the without project condition however, in order that the sponsor may receive credit consideration in the future.

With the construction of these multiple projects, SAFCA, the local cost sharing sponsor, had indicated that they are reaching the limit of their funding capabilities with the existing parcel assessments they use to fund flood risk management projects. The State of California, which is the direct cost sharing partner with

USACE, has a larger funding capability, but they would like to distribute funding to other underserved areas beyond the Sacramento Region.

Recommendation #1: Adopt
Additional language has been added to Section 2.8 (Future Without-Project Condition) of the GRR and the Economics Appendix to explain that the non-Federal sponsor will have future funding limitations that will hamper their ability to construct the project without the involvement of the Federal Government. It will also note that the sponsor will be seeking both permission to alter the Federal Flood Management Project (Section 408) and Credit Consideration (Section 221) for levee improvement work they intend on constructing prior to implementation of the ARCF GRR recommended project. These actions will not be considered part of the without project condition however, in order that the sponsor may receive credit consideration in the future.

Panel Final BackCheck Response (FPC#2):

Concur.

Final Panel Comment 3

Baseline conditions for invasive plants in the project area, and an effects analysis for invasive plant spread as a result of project construction, have not been presented.

Basis for Comment

The Draft EIS/EIR does not discuss the baseline conditions for invasive plants in the project area (e.g., their presence or potential to occur) and how project implementation could result in their introduction or spread. For example, invasive plants could be inadvertently introduced or spread in the project area during construction activities if nearby source populations passively colonize disturbed ground, or if construction and personnel equipment is transported to the site from an infested area. In addition, soil, vegetation, and other materials transported to the project area from off-site sources for best management practices (BMPs), revegetation, or fill for project construction could contain invasive plant seeds or plant material that could become established in the project area.

Executive Order 13112 (E.O.13112, 1999), which established a National Invasive Species Council, directs all Federal agencies to prevent the introduction and control the spread of invasive species in a cost-effective and environmentally sound manner to minimize their economic, ecological, and human health impacts. If significant impacts could occur, standard invasive plant management practices are available and should be considered as part of the project design or mitigation. However, the Draft EIS/EIR does not present an effects analysis of invasive plant spread as a result of project construction.

Significance – Medium

The Draft EIS/EIR is not clear whether the effects related to invasive plants have been adequately evaluated and, if needed, mitigated. The potential for construction-related introduction and spread of invasive species that is not addressed or mitigated would elevate the risk to native biological communities and may affect project approval/implementation.

Recommendations for Resolution

1. Discuss existing conditions for invasive plants/noxious weeds in the project area in Section 3.6 (Vegetation and Wildlife) of the Draft EIS/EIR. If recent field or other site-specific data to characterize invasive plant conditions in the study area are not available, then a summary of the expected or likely conditions there based on land cover types, levels of disturbance, and known invasive plant occurrences in nearby areas would be adequate.
2. Discuss construction-related impacts in the effects analysis and consider whether mitigation to prevent invasive plant spread during construction is needed.

PDT Final Evaluator Response (FPC#3):

Concur. The requested information will be added to the appropriate sections of the report.

Recommendation #1: Adopt
Will add invasive species discussion to vegetation and wildlife section.

Recommendation #2: Adopt
Will add discussion of invasive species introduction during construction and include mitigation measures to address this.

Panel Final BackCheck Response (FPC#3):

Concur.

Literature Cited:

E.O. 13112 (1999). Invasive Species. Executive Order 13112, 64 Federal Register 6183 (February 8, 1999). Available online at http://www.gpo.gov/fdsys/pkg/FR-1999-02-08/pdf/99-3184.pdf

Final Panel Comment 4

Some biological resources in the study area potentially affected by project implementation have not been analyzed or presented in sufficient detail to describe the existing conditions and support the Draft EIS/EIR analysis.

Basis for Comment

The Panel found that several biological resource issues were not addressed or presented clearly in the Draft EIS/EIR. The following points summarize the Panel's concerns:

- Although the Draft EIS/EIR discusses vegetation/habitat types within the study area, it does not include supporting figures/maps showing the distribution and types of land cover and other biological resources in the study area potentially affected by project implementation. Detailed representations of the distribution and types of land cover and other potentially affected biological resources, using graphics and/or tables, are important for describing the existing conditions and evaluating potential impacts. Also important would be a table that quantifies (in acres) and compares the amount of each land cover type, including waters of the U.S., assumed to be affected under each alternative.
- In Section 3.6 (Vegetation and Wildlife), it is not clear whether or how the vegetation variance to protect riparian vegetation on the waterside of improved levees was factored into the quantification of riparian vegetation impacts (locations, acreages). It is important to describe whether the estimate of riparian/Shaded Riverine Aquatic (SRA) habitat loss presented in the analysis already accounts for reduced impacts under the vegetation variance.
- Section 3.8 (Special-Status Species) does not address any special-status plant species, which include those considered by California Department of Fish and Wildlife (CDFW) to be "rare, threatened or endangered in California" and have a California Rare Plant Rank (CRPR); listed or designated as a candidate as threatened or endangered under the Federal Endangered Species Act (ESA) or California Endangered Species Act (CESA); etc. For projects subject to California Environmental Quality Act (CEQA), effects on special-status plant species must be considered. In addition, effects on special-status plant species are included in the "Basis of Significance" for evaluating impacts in the Draft EIS/EIR (p.127); however, they are not mentioned elsewhere in the environmental setting or impact analysis.
- Section 3.8 lacks discussion and analysis of several special-status species that could occur in the study area and be affected by project implementation, such as burrowing owl, tricolored blackbird, northern harrier, special-status bats, and others.
- The quantification of impacts on elderberry shrubs and valley elderberry longhorn beetle (VELB) is not clear. Tables 9, 10, and 11 of the Draft Biological Assessment (BA, p. 71) summarize the number of elderberry shrubs and stems that would be affected, observed exit holes, and proposed compensation for loss of shrubs. However, on page 65, the BA states: "The Corps conducted surveys in 2012 of the levee systems within the action area … The survey located elderberry clusters, however, actual shrubs, stem size, nor exit hole presence were determined." These two statements appear inconsistent. Because VELB is listed as threatened under ESA, and the U.S. Fish and Wildlife Service (USFWS) requires the implementation of specific mitigation requirements for impacts on VELB and its habitat (elderberry shrubs), clarifying how impacts on elderberry shrubs and VELB were estimated is important for evaluating the adequacy of the impact analysis and proposed mitigation.

- In the Draft EIS/EIR, tree removal is discussed in adequate detail. However, how it relates specifically to compliance or conflict with the American River Parkway Plan, the Sacramento County Tree Preservation Ordinance, or the City of Sacramento Protection of Trees Ordinance is not discussed. Conflict with these plans and ordinances is listed as a criterion for significance in the Draft EIS/EIR (p. 98). However, how the proposed mitigation would achieve compliance with these plans and ordinances is not described.
- Section 3.6 (Vegetation and Wildlife) does not fully discuss project-related impacts on Federally protected wetlands and other waters of the United States, and how those effects would be mitigated (e.g., completion of a wetland delineation and appropriate compensation, as needed). The effects on stream habitats protected under Section 1600 of the California Fish and Game Code (Streambed Alteration Agreements) and mitigation of those effects are also not addressed.
- The discussion of cumulative effects on special-status species in the Draft EIS/EIR (Section 4.2.4) is limited to only special-status fish and giant garter snake. However, other special-status species evaluated in Section 3.8 (Special-Status Species) (e.g., valley elderberry longhorn beetle, Swainson's hawk, etc.) belong in the cumulative effects analysis.

Significance – Medium

Some of the biological rationale and evidence to evaluate the magnitude of effects and support the conclusions are not clearly presented, which is a substantive issue for California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) review. Not addressing or mitigating (if needed) these potential project-related impacts would increase the risk to special-status species and other biological resources and may affect project approval/implementation.

Recommendations for Resolution

1. Prepare and add to the Draft EIS/EIR figures that depict biological resources within the study area, including vegetation/habitat types in relation to proposed project features.
2. Add a table in Section 3.6 that quantifies (in acres) and compares the amount of each land cover type, including waters of the U.S., assumed to be affected under each alternative.
3. Clarify in Section 3.6 whether the vegetation variance to protect riparian vegetation on the waterside of improved levees was factored into the quantification of riparian vegetation impacts (locations, acreages); describe whether the estimate of riparian/SRA habitat loss presented in the analysis already accounts for reduced impacts under the vegetation variance.
4. In Section 3.8, define which categories of special-species were evaluated (e.g., species listed as threatened or endangered under ESA or CESA, designated by CDFW as species of special concern, Fully Protected under the California Fish and Game Code, plant species with a CRPR rank [formerly California Native Plant Society list], etc.)
5. Add an analysis of special-status plant species to Section 3.8, including information on existing conditions, a table that summarizes special-status plant species with potential to occur in the study area (similar to Table 17 for wildlife), an analysis of potential effects, and proposed mitigation.
6. Expand the analysis in Section 3.8 to include all special-status animal species with potential to occur in the study area (e.g., add species such as tricolored blackbird, northern harrier, special-status bats, etc.). In Table 17, include all special-status animals initially considered or with

potential to occur. For any of those species that could occur and be affected, analyze potential effects of project implementation and, if needed, describe the proposed mitigation for any significant effects. For a more complete list and discussion of species in the area, refer to USACE's West Sacramento Project EIS/EIR.

7. In the Draft BA and the Draft EIS/EIR, clarify how impacts on elderberry shrubs and VELB were quantified from the survey data; resolve the inconsistency in survey information presented in pages 65 and 71 of the Draft BA.
8. In Section 3.6, add a discussion of tree removal as it relates to compliance or conflict with the American River Parkway Plan, the Sacramento County Tree Preservation Ordinance, or the City of Sacramento Protection of Trees Ordinance. Describe whether tree removal would conflict with these plans and ordinances, and how the proposed mitigation would achieve compliance with these plans and ordinances.
9. In Section 3.6, add a discussion of project-related impacts on Federally protected wetlands and other waters of the United States, and how those effects would be mitigated (e.g., completion of a wetland delineation and appropriate compensation, as needed). Also discuss the effects on stream habitats protected under Section 1600 of the California Fish and Game Code (Streambed Alteration Agreements) and mitigation for those effects.
10. In Section 4.2.4, expand the discussion of cumulative effects to include all special-status species addressed in Section 3.8 (e.g., VELB, Swainson's hawk, etc.).

PDT Final Evaluator Response (FPC#4):

Concur. Additional analysis will be conducted as noted below:

Recommendation #1: Adopt
Figures will be added to the EIS/EIR denoting the vegetation/habitat types within the study area.

Recommendation #2: Adopt
A table that quantifies habitat types affected by alternative will be included. .

Recommendation #3: Adopt
Will clarify language in the document to ensure that it is clear that the estimate of SRA habitat loss includes the reduced impacts under the vegetation variance.

Recommendation #4: Adopt
Will give designations to special status species listed in the table in Section 3.8 and describe which species were evaluated.

Recommendation #5: Adopt
Will add a section on special-status plant species affected by the project and will include those considered by CDFW, CNPS and USFWS.

Recommendation #6: Adopt
Will review the species lists generated by USFWS and CDFW to ensure all special status species that could occur in the project area are addressed in the document and will add them to the table.

Recommendation #7: Adopt
Will ensure that language and impacts regarding VELB are consistent between the BA and the EIS.

Recommendation #8: Adopt
Will add a discussion on how tree removal for the project relates specifically to the American River Parkway Plan, the Sacramento County Tree Preservation Ordinance, and the City of Sacramento Protection of Trees Ordinance. Will describe how the proposed mitigation would comply with the plans.

Recommendation #9: Adopt
Will clarify wetland impact discussion and mitigation as well as stream habitats protected under Section 1600. Wetland delineations will be conducted in PED.

Recommendation #10: Adopt
Will add discussion of all special status species to the cumulative effects section.

Panel Final BackCheck Response (FPC#4):

Concur.

Final Panel Comment 5

The justification to use a content-to-structure value ratio of 50% to calculate the value of contents of residential structures has not been explained and the reasonableness of this ratio is unknown.

Basis for Comment

The damageable value of the contents of residential structures is estimated to be over $12 billion. This is the second highest category of damageable property for structures or contents – only the damageable value of residential structures is higher. The Economics Appendix (Section 2.7) describes significant field investigation and analyses for estimating the damageable value of residential and non-residential structures.

Given the magnitude of the value of damageable contents of residential structures, it is important that the methodology or rationale for estimating the value be presented. The Economics Appendix (p. 29) states that a 50% content-to-structure ratio was used. The evidence provided to support this assumption is that it was used in prior American River Watershed studies. The GRR does not offer an explanation of why a 50% content-to-structure value ratio is reasonable for use in this study, or how it is specific to the study area and the period of analysis.

Significance – Medium/Low

The value of damageable contents of residential structures represents a significant portion of the total damageable property and requires an explanation of why use of a 50% content-to-value ratio is reasonable in order to provide confidence in the computed flood damages.

Recommendation for Resolution

1. Provide an explanation in the Economics Appendix of why use of a 50% content-to-structure value ratio is appropriate to calculate damageable property for this study.

PDT Final Evaluator Response (FPC#5):

Concur. The residential content-to-structure value ratio (CSVR) of 0.5 (50%) was used to derive an order of magnitude estimate of the value of damageable property (contents) for reporting purposes only; please note that the ratio was not used to estimate actual residential content values for use in the calculation of expected annual damages (EAD) or annual benefits. While it is understood that the 0.5 CSVR cannot realistically be applied broadly to all homes in the study area, it has been used in past District studies as a simple but adequate way to help derive an estimate of the total value of property in the study area and as a way to gage the magnitude of content damages should a flood event occur. The 0.5 CSVR, as used specifically and solely for reporting purposes in this study, does not have any effect on EAD, annual benefits, net benefits, or benefit-to-cost ratios (BCR).

The economic analysis used the generic depth-percent damage curves (contents) provided in the USACE Economic Guidance Memorandum (EGM) 01-03, *Generic Depth-Damage Relationships* (2000), so it was not necessary to explicitly estimate residential content values for use in the damage/benefit analyses. The EGM 01-03 curves for contents are adjusted curves that rely on structure values to derive content

damages; structure values were explicitly estimated for residential structures in the study area.

Recommendation #1: Adopt
The Economic Appendix will provide clarifying language which explains the primary purpose for using a residential 0.5 CSVR in this study.

Panel Final BackCheck Response (FPC#5):

Concur.

Final Panel Comment 6

The magnitude of impacts and level of significance for the effects of sedimentation and turbidity on fisheries resources are not easily determined.

Basis for Comment

The analysis presented in Section 3.7 (Fisheries) of the Draft EIS/EIR concludes that an increase in sedimentation and turbidity would result from project construction. In-stream effects such as suspended sediment, turbidity, and sediment deposition is mentioned generally, but the specific types and expected magnitude of these effects under each alternative are not described.

In terms of the specific significance criteria used for fisheries resources (Draft EIS/EIR, p.111), it is not clear how the level of significance was determined. For example, it is not certain what assumptions were made about the amount of increased sedimentation and turbidity that would be considered substantial and therefore significant.

Significance – Medium/Low

Without a discussion of the specific types and magnitude of impacts on fisheries resources relative to baseline conditions, the quality and completeness of the analysis are limited, and the biological rationale to support the conclusions and adequacy of proposed mitigation (e.g., BMPs) are not clear.

Recommendations for Resolution

1. Expand the discussion of anticipated project effects on fisheries resources. The discussion should describe impact mechanisms and the types and magnitude of biological effects. Any applicable modeling projections for project-generated in-stream effects (e.g., sediment and turbidity) and/or modeling of effects on fish habitat that may have been conducted for the project would be appropriate to reference in the fisheries analysis.
2. Discuss the assumptions made about the amount of project-related increased sedimentation and turbidity (relative to baseline conditions) that would result from project implementation, and the amount that would be considered substantial and therefore significant. If any amount of increase is considered significant, then clarify that point.

PDT Final Evaluator Response (FPC#6):

Concur. The Corps will update the EIS/EIR to include the recommendations discussed below.

Recommendation #1: Adopt
The Corps will ensure that the fisheries section includes impact mechanisms and the types and magnitude of biological effects. These analyses will be prepared and included in the final report.

Recommendation #2: Adopt
The Corps will ensure that the fisheries section includes a discussion regarding the assumptions made about project-related increased sedimentation and turbidity (relative to baseline conditions). The significance criteria will be clarified.

Panel Final BackCheck Response (FPC#6):
Concur.

Final Panel Comment 7

It is unclear why several of the planning objectives are required; some are redundant or not appropriate to fully evaluate alternatives.

Basis for Comment

Limiting the number of planning objectives (and associated metrics) to only those that are necessary to fully evaluate alternatives helps focus the planning process and helps clarify decision making. The GRR presents five planning objectives. The first two appear to be redundant: (1) reduce the probability of flooding, based on annual exceedance probability (AEP), and (2) reduce the consequences of flooding, based on expected annual damages (EAD). The probability of flooding (AEP) is only useful for comparing alternatives if the consequences of flooding are known. The EAD is a measure of both the probability and consequences of flooding. If EAD is used, evaluation of AEP provides no additional information that is useful to decision-making and should not be included.

Given that Sacramento is the state capital and is home to many agencies that are responsible for administering essential state programs, the third planning objective (to reduce impacts on critical infrastructure) provides important information to decision makers that is not addressed in the EAD (or the AEP) and should be retained.

The final two planning objectives identified in the GRR (to encourage wise use of the floodplain and to educate the public about residual risks) are non-structural management measures directed at the objective of reducing EAD. They are a means of achieving an objective. Furthermore, these measures are already in place as part of the existing flood risk management project for the American River. Since the final two planning objectives (to encourage wise use of the floodplain and to educate the public about residual risks) are management measures that should be part of the FWOP condition, they should be eliminated as planning objectives.

The five planning objectives established in the GRR could be reduced to two without losing any information that would be critical to decision making. The remaining planning objectives would be:

1. Reduce flood risk in the study area as measured by the EAD
2. Reduce impacts on critical infrastructure.

Significance – Medium/Low

Streamlining the planning objectives will focus the evaluation of alternatives on the most critical metrics and will simplify decision-making.

Recommendations for Resolution

1. Combine the first and second planning objectives into one: reduce the EAD in the study area. This captures both the frequency of flooding and the consequences of flooding in one metric.
2. Eliminate the final two planning objectives (to encourage wise use of the floodplain and to educate the public about residual risk) and add them to the FWOP condition.

PDT Final Evaluator Response (FPC#7):

Concur. As the commenter noted, Expected Annual Damages (EAD) are an effective metric for calculating the reduction of both probability and consequences of flooding and therefore a single objective can be used to articulate this goal. Therefore, the first two objectives have been combined to avoid redundancy. Planning objectives are used to formulate solutions by clarifying what a plan is desired to achieve which goes beyond just the evaluation of alternatives. Objectives can also be understood as a means to articulate a mission statement of the Federal and non-Federal planning partnership that further emphasizes the importance of including actions the sponsor would continue to implement. Maintaining focus on both the wise use of the floodplain and communication of residual risk are important outcomes for the GRR.

Recommendation #1: Adopt
The first and second planning objectives have been combined into one objective to reduce flood risk in the study area. Section 2.5 (Objectives) and Section 3.9 (Screening of measures) have been modified to reflect this change.

Recommendation #2: Not adopt
The two final planning objectives have not been eliminated. These objectives are needed to highlight the importance of addressing life safety and residual risk management and communication.

Panel Final BackCheck Response (FPC#7):

Concur. The Panel agrees that the last two objectives included in the report (to encourage wise use of the floodplain and to educate the public about residual risks) are important and should be emphasized. However, both are actions that can (and should) be taken to achieve an objective (e.g., reduce flood risk) and should be *considered management measures*. In the ARCF GRR, they are both included in the no action alternative and all action alternatives and as a result, their inclusion as objectives does not detract from the evaluation and comparison of alternatives. For this reason, the Panel is concurring with this Evaluator Response because, overall, including the last two objectives in the ARCF GRR, did not affect the planning process.

Final Panel Comment 8

The basis for the assumption that the project will receive total Federal and non-Federal funding for implementation at a rate of $44 million to $197 million per year over the entire 10-year implementation period has not been provided, and the construction period may be too short, which would result in an underestimate of the cost of interest during construction.

Basis for Comment

GRR Table 5-5 summarizes annual Federal and non-Federal funding for implementation of the project (e.g., design, land acquisition, construction) from 2018 through 2027: $29 million to $128 million per year in Federal funding and an additional $16 million to $91 million per year in non-Federal funding. The GRR assumes the project will receive Federal and non-Federal funding for implementation at a rate of $44 million to $197 million per year over the entire period. The Panel cannot determine whether this is a reasonable funding schedule since the GRR does not provide a rationale for the schedule. In addition, there are several concurrent Federal and non-Federal projects competing for the same funding. If funds are not available at the assumed schedule, the project will accrue additional interest costs that have not been considered in the economic analysis of the TSP.

Significance – Medium/Low

If funding is not available at the proposed schedule, additional interest costs may be incurred. However, given the high benefit-to-cost ratios, this should not affect the recommendation of the TSP or justification of the project.

Recommendations for Resolution

1. Add a description of the basis for the assumption that the project will receive $44 million to $197 million per year during the implementation of the project, including an explanation of why concurrent Sacramento District project funding requirements will not impact the availability of funds for this project.
2. Provide a revised funding schedule to evaluate the potential impact on the TSP benefit-to-cost ratio to account for additional interest costs if the project completion date is extended.

PDT Final Evaluator Response (FPC#8):

Concur. More clarity on the funding assumptions has been added to the GRR.

Recommendation #1: Adopt
Optimal funding from Federal and Non-Federal Sponsors was used as a baseline comparison between the final array of alternatives as a matter of policy. Standard practice for Corps civil works project is to reflect design and construction how it would be best to play out and assume that funding will be provided in time to support this schedule. The duration was determined based on a variety of factors including construction rates, air emissions, property acquisitions, and resource capacity to execute the design and construction of the features. The cost risk contingencies also considered the possibility of competition between flood risk projects in the same area. The description in the text will be expanded to clarify this.

In addition, Civil Works Transformation, which began in 2012, emphasizes the need to fund high-risk projects more efficiently. This funding assumption is consistent with Civil Works Transformation.

Recommendation #2: Not adopt
As stated above, standard practice is to assume optimal funding. If during construction, optimal funding does not keep pace, it will be reflected in the mandated Economic Updates which are required at least every three years. However, by policy, "interest during construction will only be calculated based on remaining construction costs and a schedule to complete that assumes adequate funding." Based on this guidance, a schedule delay will impact BCR updates less significantly than if all sund IDC was included. Additionally, with the nature of federal funding, as part of Civil Works Transformation, less projects are being funded, but they are being fully funded; the projects that are in the highest federal interest are the ones that are being fully funded. This project, because of the large population at risk and the strong economic justification, makes it a good contender to being one of these projects that are fully funded. Therefore, it is unlikely that the schedule will be significantly delayed causing a higher IDC cost.

Panel Final BackCheck Response (FPC#8):

Concur.

Final Panel Comment 9

The rationale and process for selecting the index points are not described or consistently listed in figures, making it difficult to assess whether the index points are representative of potential economic impacts.

Basis for Comment

The GRR does not discuss the relevance of the index points to the extent of flood plain inundation or land use/density. It is therefore unclear whether these index points provide a representative assessment of potential economic impacts. The GRR (and its supporting appendices) discusses the selection of index points used to calculate annual damages on the basis of hydraulic reaches defined by geotechnical conditions. The GRR (p. 3-31) states that index points "are located on the main flood sources, were chosen in order to be able to reasonably characterize the flood risk associated with each of the three main basins by accounting for the multiple sources of flooding in each basin." Appendix C, Attachment C Draft Geotechnical Report (also called Appendix F of the Geotechnical Report) provides the cross-sectional detail of the selected index points, while the Hydraulic Appendix Executive Report provides hydraulic inputs to the various index points.

The Economics Appendix states (p. 24) that 25 reaches were identified and five were selected by the project team for use in economic modeling and the associated without-project damage and with-project benefit analyses; however, no explanation is provided for why the 25 reaches were reduced to five or how the five were selected. Three additional points were added at locations where there are no levees. An additional index point ARS B was added, but only used to "estimate damages associated with emergency cost losses." The Economics Appendix references Figure 7 relative to the location of the index points used in the economics analysis; however, ARS B is not shown on the figure.

In addition, Figure 8 from the Hydraulic Appendix Executive Report also does not include all index points that were considered, and the Geotechnical Report references Plate 2 as showing the index point location; however Plate 2 was not included in the review materials.

Significance – Medium/Low

A concise explanation of the basis for index point selection will add clarity to the report and provide additional justification for the economic analysis.

Recommendations for Resolution

1. Explain the rationale for index point selection.
2. Include Index Point ARS B on Figure 7 of the Economics Appendix.
3. Confirm that all the figures showing index points in the various appendices are consistently listed.

PDT Final Evaluator Response (FPC#9):

Concur. Additional explanation has been included in the Economic Appendix that describes the rationale for choosing the representative index points used in the economic analysis.

Consistent with SMART planning principles, the PDT's intent was to balance rigor with practicality in choosing the number of index points to use in the analysis. Once the number of index points was determined for this GRR – essentially one index point to represent a major source of flooding (per bank side) plus several others to be able to check for residual damages (e.g., outflanking locations on the American River), the PDT then made a preliminary comparison of the chance of flooding and the consequences of flooding – in other words the overall flood risk associated with a levee breach at various locations – in selecting the representative index points. In order to make this comparison, the PDT used preliminary floodplains, geotechnical levee fragility curves showing probabilities of failure, and preliminary engineering performance results generated from HEC-FDA. During the course of the study, two of the index points that were originally selected (ARS B and ARS E) were replaced by alternate index points ARS A and ARS F (and their respective engineering data). The PDT believes that the index points used in the current analysis allows for a fair characterization of both the future without-project and with-project conditions.

Recommendation #1: Adopt
Additional language regarding the selection of representative index points has been included in the Economic Appendix.

Recommendation #2: Not adopt
Index point ARS B was originally selected but has been replaced with ARS A. Any reference to ARS B in the Economic Appendix was incorrect and has been replaced with a reference to ARS A.

Recommendation #3: Adopt
Cross check of appendices to ensure consistent presentation of index points will be performed.

Panel Final BackCheck Response (FPC#9):

Concur.

Final Panel Comment 10

The Geotechnical Report does not include interpretive cross-sections of the five index points chosen to represent critical surface and subsurface conditions in the selected reaches.

Basis for Comment

As summarized in Section 8.0 of Appendix C, Attachment C Draft Geotechnical Report (also called Appendix F of the Geotechnical Report), five index points were selected to represent the critical levee section throughout the project. While the sections are generally described, there are no interpretive cross-sections showing the surface and subsurface conditions, the water levels considered, proposed improvements, or failure mechanisms considered. The clarity of the geotechnical analysis would be greatly enhanced by the inclusion of interpretive cross-sections.

Significance – Medium/Low

Without cross-sections it is difficult to evaluate the reasonableness of the geotechnical analyses summarized in the appendix.

Recommendations for Resolution

1. Provide an illustrative, interpretive cross-section of each of the five index points where geotechnical analysis was conducted
2. Show topography, subsurface conditions, water levels, phreatic surfaces, and the failure modes considered.

PDT Final Evaluator Response (FPC#10):

Concur. The Geotechnical Attachment will be revised to include raw data associated with the geotechnical analysis organized into enclosures. The raw data, including the geotechnical cross sections showing stratigraphic interpretations, being provided as the response to this comment will be included in those enclosures.

Recommendation #1: Adopt
The geotechnical cross sections are being provided as recommended.

Recommendation #2: Adopt
The requested data included in raw format as part of the response to this comment, will also be crafted into formal enclosures to the geotechnical attachment.

Panel Final BackCheck Response (FPC#10):

Concur.

Final Panel Comment 11

The seismic vulnerability of the project has not been discussed in the GRR and a strategy to address earthquake-related damage to the project area has not been identified.

Basis for Comment

The GRR does not address the seismic vulnerability of the project levees. However, Appendix C, Attachment C Draft Geotechnical Report (also called Appendix F of the Geotechnical Report) indicates that the liquefaction potential is high at all of the reaches for Natomas Basin, Reach A of the American River, and Reaches C to G of the American River southern Basin. Furthermore, the Geotechnical Report (p. 21) states that post-earthquake deformation as a result of liquefaction is a "global or structural failure mode that is very likely to compromise the ability to provide flood protection at these critical locations."

While neither USACE (USACE, 2011) nor the local sponsor under California Department of Water Resources (DWR) guidance (URS, 2012) commonly undertakes levee improvements to address seismic stability, the typical practice is to evaluate the range of deformations that could be sustained during a 200-year earthquake. Once a range of deformations has been evaluated, a post-earthquake remediation plan is developed that addresses emergency preparations, mobilization, data gathering, actions, interim repairs, long-term repairs, and public notification. Costs will be associated with planning and post-earthquake response; however, the Panel cannot determine if these costs have been considered.

Significance – Medium/Low

USACE and the local sponsor will be responsible for earthquake preparedness and post-earthquake remediation; whether costs have been allocated to these activities cannot be determined.

Recommendations for Resolution

1. Describe seismic vulnerability and post-earthquake remediation strategies in the GRR.
2. Consider the cost of post-earthquake remediation in the economic analysis and allocate the cost among Federal and non-Federal interests.

PDT Final Evaluator Response (FPC#11):

Concur. As per the ULDC (DWR, 2012) and Sacramento District internal guidelines for seismic evaluation of levees (USACE, 2013), an intermittently-loaded levee is a levee that does not experience a WSE of 1 foot or higher above the elevation of the landside levee toe at least once a day for more than 36 days per year on average. The ARCF GRR Study Area has low frequencies of measurable channel flow, resulting in the Study Area levees to be considered intermittently loaded. This classification results in the determination that coincident flood and seismic events are not likely and do not need to be accounted for during the levee improvement design process (no seismic specific design measures). Therefore, seismic failure of levees does not significantly contribute to the levee performance curve when compared to seepage, stability, erosion, vegetation, utilities, encroachments, and animal activity.

The Sacramento District performed a seismic evaluation as part of the ARCF General Reevaluation Report (USACE, 2010). For the Study Area, liquefactions analyses and seismic vulnerability analyses

were performed for the most critical cross-section in each reach. Based on the seismic vulnerability analyses, the majority of reaches within the Study Area were classified as “Very Likely Compromised” with respect to post-seismic flood protection ability. As part of DWR’s ULE Project, URS also performed a seismic evaluation. The ULE study provides results of seismic vulnerability evaluations, including liquefaction potential analysis and post-seismic vulnerability analyses. Based on the ULE seismic evaluations, the levees were identified as having “low to medium seismic vulnerability”.

Therefore, for purposes of this study, it is assumed that if liquefaction of a segment of levee occurs as a result of an earthquake during the life of the project, agencies will perform the necessary inspections of the infrastructure for visible signs of damage. If there was a change in the structure’s ability to perform as intended, an emergency flood fight would be initiated by state and local agencies. If the flood fight in the area exceeded the state’s ability to respond, then PL 84-99 flood fight assistance could be requested through a governor’s letter. Following the flood event, if necessary the request for PL 84-99 rehabilitation assistance could be requested/sought to address the areas with damage. The USACE policy does not require consideration of PL 84-99 in the project economics.

Recommendation #1: Adopt
Language has been added to the GRR, Section 2.3, addressing the intermittent loading of levees in the study area, and the seismic vulnerability of the levees, and to Section 4.5 of the GRR addressing post earthquake remediation strategies.

Recommendation #2: Not adopt
The U.S. Army Corps of Engineers Policy does not require consideration of PL 84-99 in the project economics.

Panel Final BackCheck Response (FPC#11):

Concur.

Literature Cited:

USACE (2011). Guidelines for Seismic Stability Evaluation of USACE Levees. U.S. Army Corps of Engineers Sacramento District. December 2.

URS (2012). Development of a 200-year Return Period Seismic Hazard Map for the Urban Levee Evaluation Program. URS Corporation, California DWR Urban Levee Evaluation Program. February 24.

Final Panel Comment 12

It is not clear in the GRR whether a water control plan has been developed and will be adopted when construction of the Joint Federal Project auxiliary spillway at Folsom Dam is complete.

Basis for Comment

The GRR states that a new water control manual will be adopted when the Folsom Dam Joint Federal Project (JFP) is complete. This water control plan will specify an operating strategy that will govern future discharges from the dam, allowing larger discharges to be made when lake stages are at lower levels. The rate and frequency of discharges from Folsom Dam are important factors affecting the risk of flooding in the study area.

Although the water control plan is adequately defined in the Hydrology Appendix to the GRR, it is not clear in the GRR itself whether the plan defined in the Hydrology Appendix has been developed and will be adopted when the JFP is complete or whether the plan is under development. The likelihood that the operating strategy for the water control plan assumed in the GRR could change in the future is not made clear in the GRR.

Significance – Low

A description of the water control plan that is assumed to be in place for the future without- and with-project conditions will provide a better understanding of how the alternative plans were evaluated.

Recommendation for Resolution

1. Add a brief description to the GRR defining the Folsom Dam water control plan that is assumed in the GRR for the future without- and with-project conditions.

PDT Final Evaluator Response (FPC#12):

Concur. The ARCF GRR without-project condition assumed that the JFP is constructed and the update to the water control manual is complete. The ARCF GRR with-project conditions do not include any proposed changes in operation at Folsom Dam; therefore, the operations at Folsom would be the same for the with- and without-project conditions. This assumption includes a 400,000 acre-feet to 600,000 acre-feet (400/600) variable flood space operation that takes incidental storage space in upstream reservoirs into consideration when determining how much flood storage is needed at Folsom Dam during the flood season.

Recommendation #1: Adopt

The following additional detail has been added to the description of the JFP water control plan for the without project condition in Section 2.8.3 of the GRR. “In 2017, the Folsom Joint Federal Project (JFP) auxiliary spillway at Folsom Dam (Figure 2-10) will be completed and a new water control manual will be adopted (Folsom Dam Modifications). This includes a 400,000 acre-feet to 600,000 acre-feet (400/600) variable flood space operation that takes incidental storage space in upstream reservoirs into consideration when determining flood storage requirements at Folsom Dam during the flood season.

Panel Final BackCheck Response (FPC#12):
Concur.

Final Panel Comment 13

Several of the proposed non-structural management measures are already in place and should not be considered management measures in the GRR.

Basis for Comment

The GRR is evaluating the feasibility of modifying an existing flood risk management project that is being operated in accordance with laws, executive orders, policies, and regulations that are applicable to USACE flood risk management projects.

Executive Order 11988 (1977) directs Federal agencies to "… avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative." Accordingly, the terms of local cooperation for USACE flood risk management projects (including the existing American River Project) require non-Federal sponsors to (among other things):

- Prepare and implement a floodplain management plan designed to reduce the impact of future flood events in the project area (ER 1105-2-100; USACE, 2000).
- Not less than once each year, inform affected interests of the extent of protection afforded by the project.

The terms of local cooperation for USACE flood risk management projects require that the non-Federal sponsors implement several measures that are included as non-structural management measures considered for the GRR. Non-structural management measures identified in the GRR that are currently requirements of local cooperation are floodplain management, providing floodplain information to regulatory agencies, local building codes, annual publication of residual risks, and a Federal flood insurance program (USACE, Project Partnership Agreements website). Since these measures should be in place now and in the future, it is not appropriate to include them as management measures for consideration in the GRR. Including these non-structural management measures in the GRR implies that they are not currently in place or will not be in place in the future. Since these measures should be in place now and in the future, they should be part of the FWOP condition.

Significance – Low

Elimination of non-structural management measures that are currently in place as requirements of local cooperation for the existing flood risk management project will reduce the potential for confusion and improve the overall understanding of the proposed versus existing non-structural management measures for the project.

Recommendation for Resolution

1. Review the proposed set of non-structural management measures and eliminate those that are currently in place.

PDT Final Evaluator Response (FPC#13):

Concur. The non-structural management measures that are currently in place as requirements of local

cooperation for the existing flood risk management project have been removed to reduce the potential for confusion and improve the overall understanding of the proposed versus existing non-structural management measures.

Recommendation #1: Adopt
Tables 3-3 and 3-5 and Section 3.8 of the GRR have been modified to remove the non-structural measures that are currently in place (telemeter stream flow gages and modifications to the flood warning system) as well as the measures that are considered items of local cooperation. The following description has been added to explain how these measures are treated: "Other measures, including floodplain management, providing information to regulatory agencies, local building codes, annual publication of residual risk and participation in Federal flood insurance programs are all existing measures that are currently in place but these will also be items of local cooperation to be agreed to by the sponsor as part of implementation of the Recommended Plan".

Panel Final BackCheck Response (FPC#13):

Concur.

Literature Cited:

E.O. 11988 (1977). Executive Order 11988 – Flood Plain Management. 42 FR 26951, 3 CFR, 1977 Comp. Issued May 24, 1977. Available online at: https://www.fema.gov/executive-order-11988-floodplain-management.

USACE (2000). Planning – Planning Guidance Notebook. Engineer Regulation (ER) 1105-2-100. U.S. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. April 22.

USACE. Project Partnership Agreements. U.S. Army Corps of Engineers Headquarters website. Online at: http://www.usace.army.mil/Missions/CivilWorks/ProjectPartnershipAgreements.aspx

Final Panel Comment 14

The critical volume durations in the Hydrology Executive Report appear to be inconsistent, which makes the discussion of the hydrology difficult to understand.

Basis for Comment

Section A-3 (p. B2-2) of the Hydrology Executive Report (Appendix C, Attachment A of the GRR) first refers to Figure A-1 when discussing inflow hydrographs into the Folsom Reservoir. Figure A-1 appears to show flood waves composed of 4-day volumes. This section then notes that "The 3-day duration is considered the most critical within the American River Basin." The connection between the text and the figure is unclear.

Significance – Low

The discrepancy between Figure A-1 and the text of Section A-3 is confusing; if the analysis is based on the incorrect critical duration, the results of the hydrologic analyses may be different than documented.

Recommendations for Resolution

1. Verify the critical volume durations in the text vs. Figure A-1 and modify text or graph, as necessary.
2. If text and graph are correct, add text to Section A-3 to clarify the relationship between the stated 3-day critical duration and Figure A-1.

PDT Final Evaluator Response (FPC#14):

Concur. The description below will be added to clarify critical volume duration.

Section A-3 (which describes the critical duration volume as the 3-day duration) and the hydrographs shown in Figure A-1 are correct. There is no discrepancy. Each wave of inflow is composed of 4 to 5 days of runoff, but this does not negate the fact that critical duration is 3-days. Longer duration hydrographs (more than 3-days) are utilized in the modeling because a) atmospheric rivers tend to produce 3 - 5 day precipitation waves in this region b) after a levee break, the large, flat floodplain areas in the Sacramento area may take more than 3 days to fill c) More than 3 days must be simulated to account for timing between the larger Sacramento River and smaller American River.

Critical duration is the most challenging volume to the safe operation of the project to protect downstream. The maximum storage (filling of the reservoir) and maximum downstream discharge occurs during the maximum 3-day unregulated inflow, rather than after that period. While critical duration is described as the 3-day, the Folsom Dam inflow hydrographs are actually balanced to multiple durations (including the critical 3-day volume). The hydrograph is balanced to all durations shown in Table A-1 (page B2-4) which includes the peak, 1-, 3-, 7-, 15-, and 30-day durations.

Recommendation #1: Adopt
The critical duration has been verified, and was determined to be correct in the appendix. The text given

above will be added to clarify the ambiguity regarding the critical volume duration in Figure A-1.

Recommendation #2: Adopt
The text above will be added to clarify critical volume duration.

Panel Final BackCheck Response (FPC#14):

Concur. The USACE response clarified that the hypothetical inflow hydrographs were not the basis for the 3-day critical volume, but serve to cover the critical 3-day duration of the inflow for the analysis. It is therefore reasonable for these hydrographs to be longer than three days. The balanced hydrograph (runoff) approach also seems reasonable given similar approaches used with rainfall patterns for smaller watersheds across the country. Based on the explanation above, USACE has adequately addressed the FPC.

Final Panel Comment 15

The reason for updating the flow record with additional data for Arcade Creek but not Dry Creek is unclear.

Basis for Comment

Sections 5.2 (p. B3-11) and 6.2 (p. B3-14) of the Hydrology Executive Report (Appendix C, Attachment A of the GRR) both state that updating the flow record with additional data did not seem to make much difference in the frequency curves. However, while the data for Dry Creek were not updated (Section 5.2), the data for Arcade Creek were updated with Peer Review statistics (Section 6.2). The Panel did not find any explanation for these decisions.

Significance – Low

The two different responses to updating the flow record without a rationale for the decisions is confusing and/or may suggest bias in the frequency curves.

Recommendation for Resolution

1. Provide additional text in Section 6.2 or both sections (Sections 5.2 and 6.2), as needed, to clarify the decision to update one set of data and not the other.

PDT Final Evaluator Response (FPC#15):

Concur. We agree that there is ambiguity in the way that the hydrologic periods of record were presented for the two creeks in question. Our review however confirms that both creeks (Dry and Arcade) rely on the statistics for the Peer Review Findings (Adjusted Gage Measurement) which was a study conducted in 1996. These statistics are shown in Table 3, column 2. The statistics are based on the hydrologic data set from 1962 to 1995, rather than updated statistics based on data from 1950 - 2009. The reasoning to use the 1996 analysis are as follows: a) the curve did not change significantly; and b) multiple agencies had worked together to analyze the data and results for the Peer Review Study which gave it importance.

Recommendation #1: Adopt
Text has been added to sections 5.2 and 6.2 to clarify that both creeks use the same hydrologic period of record and the reasons why the updated information was not used.

Panel Final BackCheck Response (FPC#15):

Concur. The PDT response and reasons used to support the response clarified that neither gage was updated to add data to the period of record, and that adding data to the period of record at either gage did not change the statistical mean at that particular gage. Based on this information, USACE has adequately addressed the FPC.

Final Panel Comment 16

The use of the 1-year event stage data has not been described in sufficient detail to understand how it was derived.

Basis for Comment

Section 6.2 of the Hydraulic Appendix Executive Report (Appendix C, Attachment B of the GRR) states (p. 24) that "1-year and 2-year event stage data was derived via a different process using gage data." A "1-year event" is a statistical impossibility, indicating that it has a 100% chance of being equaled or exceeded in any given year.

The Panel also noted that Section 5 of the Memorandum for the Hydrologic Engineering Center's Flood Damage Reduction Analysis (HEC-FDA) Inputs (USACE, 2013) references use of the 99% event. It may be that this is what is meant by a "1-year event." Plates 2 through 9 of the same memorandum indicate that "1yr = .999" (or 99.9% ACE)

Significance – Low

The reference to a "1-year event" is confusing and affects the understanding of how stage data were derived.

Recommendation for Resolution

1. Add a brief description of the meaning of "1-year event" for clarification, since a 1-year event cannot be statistically quantified.

PDT Final Evaluator Response (FPC#16):

Concur. The reviewer is correct that a 1-yr stage is a statistical impossibility and correctly noted that is meant to be a frequent event that approaches a 1-yr stage. The language will be updated to be consistent with the FDA Inputs Technical Memorandum, using Annual Chance Exceedance and a value that approaches a 1-yr event (now to be called a 99% (1/1.01) ACE). The frequent stages of the 1-yr and 2-yr are needed to produce for a full range of the stage frequency curve for HEC-FDA.

Recommendation #1: Adopt
The language will be updated to be consistent with the FDA Inputs Technical Memorandum, using Annual Chance Exceedance and a value that approaches a 1-yr event (now to be called a 99% (1/1.01) ACE).

Panel Final BackCheck Response (FPC#16):

Concur.

Literature Cited:

USACE (2013). Memorandum for File: American River Common Features GRR Feasibility Study. HEC-FDA Inputs. U.S. Army Corps of Engineers, Hydraulic Analysis Section, Sacramento District, Sacramento, CA. 15 May.

Final Panel Comment 17

The level of significance of impacts on biological resources after mitigation is not presented in sufficient detail.

Basis for Comment

In the Draft EIS/EIR, Table ES-3 summarizes environmental effects, mitigation, and levels of significance for each alternative. Under the "Vegetation and Wildlife" category (p. ES-11), the effects are listed as "significant" (with mitigation incorporated). At the mid-review of the IEPR, the Panel asked USACE if that means the conclusion is "significant and unavoidable," even with mitigation incorporated; and, if so, whether that was because permanent loss of riparian vegetation is assumed despite compensatory mitigation. In response, USACE clarified that long-term effects on vegetation would be less than significant with the compensatory mitigation; however, the short-term effect would be significant and unavoidable due to the temporal loss of habitat (because of the amount of time it takes for the new habitat to reach the same quality). The Panel agrees with USACE that addressing both short- and long-term effects of project implementation on vegetation is a good approach for this project. However, if separate significance findings are concluded and presented for short- and long-term effects, then those should be clarified and stated in the appropriate sections of the EIS/EIR (i.e., Executive Summary and Section 3.6) for clarity. Clarifying this would make the link between the specific impact and proposed mitigation more transparent.

For biological resources impacts discussed in Sections 3.6 (Vegetation and Wildlife), 3.7 (Fisheries), and 3.8 (Special-Status Species), the level of significance after mitigation is not clearly presented. These sections lack a conclusion about which potentially significant effects have been reduced to a less-than-significant level and why, and which have not.

Significance – Low

The biological rationale and evidence to support the conclusions of the analysis of impacts on biological resources are not consistent or clearly presented, which limits the completeness and technical quality of the Draft EIS/EIR. The nexus between the context, intensity, and significance (per NEPA and CEQA requirements) is important for supporting the analysis, conclusions, and whether proposed mitigation is adequate.

Recommendations for Resolution

1. For the biological resources impact discussions presented in Sections 3.6, 3.7, and 3.8 of the Draft EIS/EIR, add a conclusion statement about which potentially significant effects have been reduced to a less-than-significant level and why, and which (if any) have not. (For consistency, this revision could be made to all of the resource sections.)
2. Review and, if needed, revise Table ES-3 to make it consistent with the analysis conclusions for biological resources.

PDT Final Evaluator Response (FPC#17):

Concur. Will state in Section 3.6 and in the Executive Summary table that short term impacts to vegetation are significant but that in the long term those effects will be less that significant with mitigation.

Will add or clarify conclusion statements in Sections 3.6, 3.7, and 3.8 to ensure they state the level of significance and whether or not it's reduced with mitigation

Recommendation #1: Adopt
Will add conclusion statements to the resource sections clarifying whether effects are potentially significant and whether they are reduced to less-than-significant with mitigation or not.

Recommendation #2: Adopt
Will update table ES-3 to make it consistent with the conclusions in the analysis sections.

Panel Final BackCheck Response (FPC#17):

Concur.

6. For further information, please contact me at (415) 503-6852 or Ms. Anastasiya Hernandez, PCX IEPR Lead for this effort, at (410) 962-2558.

Encl

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American River Common Features, California, Flood Risk Management Project
General Reevaluation Report and Impact Statement\ Environmental Impact Report

DRAFT

U.S. Army Corps of Engineers Response to
Independent External Peer Review
September 2015

Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Section 2034 of WRDA 2007, EC 1165-2-209, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review (2004).

The goal of the U.S. Army Corps of Engineers (USACE) Civil Works program is to always provide scientifically sound, sustainable water resources solutions for the nation. The USACE review processes are essential to ensuring project safety and quality of the products USACE provides to the American people. Battelle Memorial Institute (Battelle), a non-profit science and technology organization with experience in establishing and administering peer review panels for the USACE, was engaged to conduct the IEPR of the American River Common Features, California Flood Risk Management Project General Reevaluation Report and Environmental Impact Statement and Environmental Impact Report (EIS\EIR).

The Battelle IEPR panel reviewed the Draft General Reevaluation Report (GRR) and Draft EIS/EIR, as well as supporting documentation. The Final IEPR Battelle Report was issued in June 2015.

Overall, 17 comments were identified and documented; one was identified as having high significance, three were identified as having medium significance, seven had medium/low significance, and six were identified as having low significance. The following discussions present the Final Response to the 17 comments.

Based on the technical content of the study documents and the overall scope of the project, Battelle identified candidates for the panel in the field of Civil Works Planning, National Environmental Policy Act (NEPA) and Biology, Hydrology and Hydraulics Engineering, and Geotechnical Engineering. Four panel members were selected for the IEPR.

1. IEPR Comment – *High Significance*. It is not clear why the hydraulic profile for the future without-project condition is significantly higher than the profile for Alternative 1. If the baseline condition is not correct, there is a high risk that the flood damage estimates will be incorrect. If, on the other hand, Alternative 1 is incorrect, then there is a risk that the National Economic Development (NED) plan has not been identified.

The comment includes one recommendation for resolution which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended verifying the profiles and adjusting the analysis as necessary. In response, plates 31 to 56 in the Hydraulic Appendix Executive Report were verified for baseline conditions and Alternative 1 profiles. The water surface profiles for Alternative 1 and the future without-project condition are identical. The differences observed in the plates were from a superseded and now out of date strategy to measure hydraulic effects of a combination of projects along the American River including the Joint Federal Project Auxiliary Spillway.

2. IEPR Comment – *Medium Significance*. Details as to why non-Federal agencies would not continue to undertake incremental improvements to the levee system in the future without-project condition are not included in the GRR.

The comment includes one recommendation for resolution which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended explaining in the GRR and Economics Appendix why it is anticipated that local interests will not make improvements to the levee system in the FWOP condition. Additional language has been added to Section 2.8 (Future Without-Project Condition) of the GRR and the Economics Appendix to explain that the non-Federal sponsor will have future funding limitations that will hamper their ability to construct the project without the involvement of the Federal Government. It will also note that the sponsor will be seeking both permission to alter the Federal Flood Management Project (Section 408) and Credit Consideration (Section 221) for levee improvement work they intend on constructing prior to implementation of the ARCF GRR recommended project. These actions will not be considered part of the without project condition however, in order that the sponsor may receive credit consideration in the future.

3. IEPR Comment – *Medium Significance*. Baseline conditions for invasive plants in the project area, and an effects analysis for invasive plant spread as a result of project construction, have not been presented.

The comment includes two recommendations for resolution which were both adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended discussing existing conditions for invasive plants/noxious weeds in the project area in Section 3.6 (Vegetation and Wildlife) of the Draft EIS/EIR. If recent field or other site-specific data to characterize invasive plant conditions in the study area are not available, then a summary of the expected or likely conditions there based on land cover types, levels of disturbance, and known invasive plant occurrences in nearby areas would be adequate.

USACE Response (#2): Adopted

Action Taken: The IEPR panel recommended discussing construction-related impacts in the effects analysis and to consider whether mitigation to prevent invasive plant spread during construction is needed. This discussion was added.

4. IEPR Comment – *Medium Significance*. Some biological resources in the study area potentially affected by project implementation have not been analyzed or presented in sufficient detail to describe the existing conditions and support the Draft EIS/EIR analysis.

The comment includes ten recommendations for resolution which were all adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended adding figures that depict biological resources within the study area, including vegetation/habitat types in relation to proposed project features.

USACE Response (#2): Adopted

Action Taken: The IEPR panel recommended adding a table in Section 3.6 that quantifies (in acres) and compares the amount of each land cover type, including waters of the U.S., assumed to be affected under each alternative.

USACE Response (#3): Adopted

Action Taken: The IEPR panel recommended clarifying in Section 3.6 whether the vegetation variance to protect riparian vegetation on the waterside of improved levees was factored into the quantification of riparian vegetation impacts (locations, acreages) and describing whether the

estimate of riparian/SRA habitat loss presented in the analysis already accounts for reduced impacts under the vegetation variance.

USACE Response (#4): Adopted

Action Taken: The IEPR panel recommended defining in Section 3.8 which categories of special-species were evaluated (e.g., species listed as threatened or endangered under the Endangered Species Act or California Endangered Species Act, designated by California Department of Fish and Wildlife as species of special concern, Fully Protected under the California Fish and Game Code, etc.).

USACE Response (#5): Adopted

Action Taken: The IEPR panel recommended adding an analysis of special-status plant species to Section 3.8, including information on existing conditions, a table that summarizes special-status plant species with potential to occur in the study area, an analysis of potential effects, and proposed mitigation.

USACE Response (#6): Adopted

Action Taken: The IEPR panel recommended expanding the analysis in Section 3.8 to include all special-status animal species with potential to occur in the study area. In Table 17, include all special-status animals initially considered or with potential to occur. For any of those species that could occur and be affected, analyze potential effects of project implementation and, if needed, describe the proposed mitigation for any significant effects. For a more complete list and discussion of species in the area, refer to USACE's West Sacramento Project EIS/EIR.

USACE Response (#7): Adopted

Action Taken: The IEPR panel recommended clarifying in the Draft Biological Assessment (BA) and the Draft EIS/EIR how impacts on elderberry shrubs and the Valley Elderberry Longhorn Beetle (VELB, special status species) were quantified from the survey data; resolve the inconsistency in survey information presented in pages 65 and 71 of the Draft BA.

USACE Response (#8): Adopted

Action Taken: The IEPR panel recommended adding, in Section 3.6, a discussion of tree removal as it relates to compliance or conflict with the American River Parkway Plan, the Sacramento County Tree Preservation Ordinance, or the City of Sacramento Protection of Trees Ordinance. Describe whether tree removal would conflict with these plans and ordinances, and how the proposed mitigation would achieve compliance with these plans and ordinances.

USACE Response (#9): Adopted

Action Taken: The IEPR panel recommended, in Section 3.6, adding a discussion of project-related impacts on Federally protected wetlands and other waters of the United States, and how

those effects would be mitigated (e.g., completion of a wetland delineation and appropriate compensation, as needed). Also discuss the effects on stream habitats protected under Section 1600 of the California Fish and Game Code (Streambed Alteration Agreements) and mitigation for those effects.

USACE Response (#10): Adopted

Action Taken: The IEPR panel recommended, in Section 4.2.4, expanding the discussion of cumulative effects to include all special-status species addressed in Section 3.8 (e.g., VELB, Swainson's hawk, etc.).

5. IEPR Comment – *Medium/Low Significance*. The justification to use a content-to-structure value ratio of 50% to calculate the value of contents of residential structures has not been explained and the reasonableness of this ratio is unknown.

The comment includes one recommendation for resolution which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended providing an explanation in the Economics Appendix of why use of a 50% content-to-structure value ratio is appropriate to calculate damageable property for this study.

6. IEPR Comment – *Medium/Low Significance*. The magnitude of impacts and level of significance for the effects of sedimentation and turbidity on fisheries resources are not easily determined.

The comment includes two recommendations for resolution which were both adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended expanding the discussion of anticipated project effects on fisheries resources. The discussion should describe impact mechanisms and the types and magnitude of biological effects. Any applicable modeling projections for project-generated in-stream effects (e.g., sediment and turbidity) and/or modeling of effects on fish habitat that may have been conducted for the project would be appropriate to reference in the fisheries analysis.

USACE Response (#2): Adopted

Action Taken: The IEPR panel recommended discussing the assumptions made about the amount of project-related increased sedimentation and turbidity (relative to baseline conditions) that would result from project implementation, and the amount that would be considered

substantial and therefore significant. If any amount of increase is considered significant, then clarify that point.

7. IEPR Comment – *Medium/Low Significance*. It is unclear why several of the planning objectives are required; some are redundant or not appropriate to fully evaluate alternatives.

The comment includes two recommendations for resolution, one of which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended combining the first and second planning objectives into one: reduce the Expected Annual Damages in the study area. This captures both the frequency of flooding and the consequences of flooding in one metric.

USACE Response (#2): Not Adopted

Action Taken: The IEPR panel recommended eliminating the final two planning objectives (to encourage wise use of the floodplain and to educate the public about residual risk) and adding them to the future without-project condition. The two final planning objectives have not been eliminated, as these objectives are needed to highlight the importance of addressing life safety and residual risk management and communication.

8. IEPR Comment – *Medium/Low Significance*. The basis for the assumption that the project will receive total Federal and non-Federal funding for implementation at a rate of $44 million to $197 million per year over the entire 10-year implementation period has not been provided, and the construction period may be too short, which would result in an underestimate of the cost of interest during construction.

The comment includes two recommendations for resolution, one of which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended adding a description of the basis for the assumption that the project will receive $44 million to $197 million per year during the implementation of the project, including an explanation of why concurrent Sacramento District project funding requirements will not impact the availability of funds for this project.

USACE Response (#2): Not Adopted

Action Taken: The IEPR panel recommended providing a revised funding schedule to evaluate the potential impact on the Tentatively Selected Plan benefit-to-cost ratio to account for additional interest costs if the project completion date is extended. Standard practice is to assume optimal funding. If during construction, optimal funding does not keep pace, it will be

reflected in the mandated Economic Updates which are required at least every three years. However, by policy, "interest during construction will only be calculated based on remaining construction costs and a schedule to complete that assumes adequate funding." Based on this guidance, a schedule delay will impact BCR updates less significantly than if all sund IDC was included. Additionally, with the nature of federal funding, as part of Civil Works Transformation, less projects are being funded, but they are being fully funded; the projects that are in the highest federal interest are the ones that are being fully funded. This project, because of the large population at risk and the strong economic justification, makes it a good contender to being one of these projects that are fully funded. Therefore, it is unlikely that the schedule will be significantly delayed causing a higher IDC cost.

9. IEPR Comment – *Medium/Low Significance*. The rationale and process for selecting the index points are not described or consistently listed in figures, making it difficult to assess whether the index points are representative of potential economic impacts.

The comment includes three recommendations for resolution, two of which were adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended explaining the rationale for index point selection.

USACE Response (#2): Not Adopted

Action Taken: The IEPR panel recommended including Index Point ARS B on Figure 7 of the Economics Appendix; however, index point ARS B was originally selected but has been replaced with ARS A. Any reference to ARS B in the Economic Appendix was incorrect and has been replaced with a reference to ARS A.

USACE Response (#3): Adopted

Action Taken: The IEPR panel recommended confirming that all the figures showing index points in the various appendices are consistently listed.

10. IEPR Comment – *Medium/Low Significance*. The Geotechnical Report does not include interpretive cross-sections of the five index points chosen to represent critical surface and subsurface conditions in the selected reaches.

The comment includes two recommendations for resolution, both which were adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended providing an illustrative, interpretive cross-section of each of the five index points where geotechnical analysis was conducted.

USACE Response (#2): Adopted

Action Taken: The IEPR panel recommended showing topography, subsurface conditions, water levels, phreatic surfaces, and the failure modes considered.

11. IEPR Comment – *Medium/Low Significance*. The seismic vulnerability of the project has not been discussed in the GRR and a strategy to address earthquake-related damage to the project area has not been identified.

The comment includes two recommendations for resolution, one of which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended describing seismic vulnerability and post-earthquake remediation strategies in the GRR.

USACE Response (#2): Not Adopted

Action Taken: The IEPR panel recommended considering the cost of post-earthquake remediation in the economic analysis and allocating the cost among Federal and non-Federal interests; however, the U.S. Army Corps of Engineers Policy does not require consideration of PL 84-99 in the project economics.

12. IEPR Comment – *Low Significance*. It is not clear in the GRR whether a water control plan has been developed and will be adopted when construction of the Joint Federal Project auxiliary spillway at Folsom Dam is complete.

The comment includes one recommendation for resolution, which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended adding a brief description to the GRR defining the Folsom Dam water control plan that is assumed in the GRR for the future without- and with-project conditions.

13. IEPR Comment – *Low Significance*. Several of the proposed non-structural management measures are already in place and should not be considered management measures in the GRR.

The comment includes one recommendation for resolution, which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended reviewing the proposed set of non-structural management measures and eliminating those that are currently in place.

14. IEPR Comment – *Low Significance*. The critical volume durations in the Hydrology Executive Report appear to be inconsistent, which makes the discussion of the hydrology difficult to understand.

The comment includes two recommendations for resolution, both of which were adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended verifying the critical volume durations in the text vs. Figure A-1 and modifying text or graph, as necessary.

USACE Response (#2): Adopted

Action Taken: The IEPR panel recommended adding text to Section A-3 to clarify the relationship between the stated 3-day critical duration and Figure A-1.

15. IEPR Comment – *Low Significance*. The reason for updating the flow record with additional data for Arcade Creek but not Dry Creek is unclear.

The comment includes one recommendation for resolution, which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended providing additional text in Section 6.2 or both sections (Sections 5.2 and 6.2), as needed, to clarify the decision to update one set of data and not the other.

16. IEPR Comment – *Low Significance*. The use of the 1-year event stage data has not been described in sufficient detail to understand how it was derived.

The comment includes one recommendation for resolution, which was adopted as discussed below.

USACE Response (#1): Adopted

Action Taken: The IEPR panel recommended adding a brief description of the meaning of "1-year event" for clarification, since a 1-year event cannot be statistically quantified.

17. IEPR Comment – *Low Significance*. The level of significance of impacts on biological resources after mitigation is not presented in sufficient detail.

The comment includes two recommendations for resolution, both which were adopted as discussed below.

USACE Response (#1): Adopted

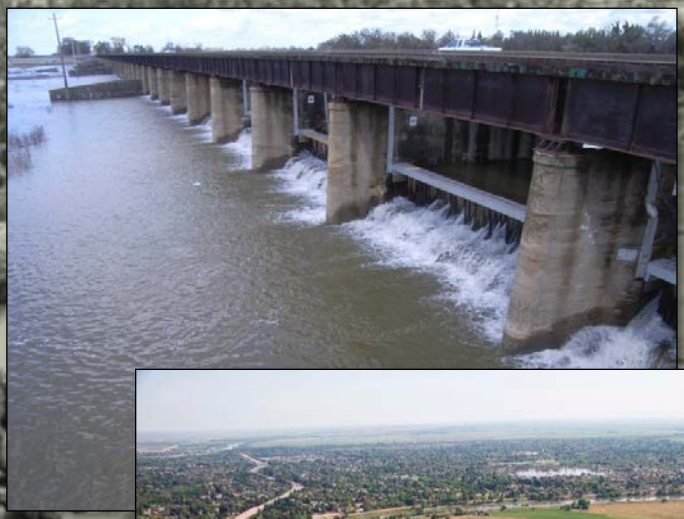
Action Taken: The IEPR panel recommended, for the biological resources impact discussions presented in Sections 3.6, 3.7, and 3.8 of the Draft EIS/EIR, adding a conclusion statement about which potentially significant effects have been reduced to a less-than-significant level and why, and which (if any) have not. For consistency, this revision could be made to all of the resource sections.

USACE Response (#2): Adopted

Action Taken: The IEPR panel recommended reviewing and, if needed, revising Table ES-3 to make it consistent with the analysis conclusions for biological resources.

American River Watershed

Common Features
General Reevaluation Report



Engineering Appendix

December 2015

Sacramento Area Flood Control Agency

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:
Sacramento Weir during operation
Sacramento River facing south near the Pocket and Little Pocket neighborhoods
High flows on the American River at the Highway 160 overcrossing
Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Engineering Appendix

U.S. Army Corps of Engineers
Sacramento District

December 2015

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CHAPTER 1 – INTRODUCTION

1.1 Introduction

This engineering appendix documents the design for the American River Common Features General Reevaluation Report (ARCF GRR). The purpose of the ARCF GRR is to evaluate the level of Federal interest in measures needed to reduce the flood risk to the City of Sacramento and surrounding areas. The study area includes the American River Watershed with several tributaries, the Sacramento River, and the Yolo and Sacramento Bypasses. This appendix summarizes the existing conditions, proposed alternatives, design considerations, costs, and schedule for the alternatives retained in the final array of alternatives leading up to the identification of the National Economic Development (NED) plan and Tentatively Selected Plan (TSP). Information and analysis for other alternatives in the preliminary array of alternatives were developed by various sources including previous USACE and sponsor provided reports. The detail provided by these sources varies but were considered adequate for screening alternatives and were adapted for use in the final array.

1.2 Project Location and Background

The ARCF GRR analyzed over 90 miles of levee and associated features in Sacramento, Sutter, and Yolo Counties that reduced flood risk in the greater Sacramento Area. Many of these levees were initially constructed by local interests. The levees were generally built close to the rivers to use as much land as possible for agricultural production and flush out hydraulic mining debris which had contributed to flooding in the past. The historic floods of 1907 and 1909 initiated a new comprehensive approach to flood management within the area. Since then, the United States Army Corps of Engineers (USACE) along with the State of California have managed flood risk in the Sacramento Area using an integrated system of levees, overflow bypasses, and dams known as the Sacramento River Flood Control Project (SRFCP).

The study area includes portions of the Sacramento and American River Watersheds. The flood plain includes most of the developed portions of the City of Sacramento, the Natomas basin, and portions of Sacramento and Sutter Counties. The study area also includes other flood facilities including the Fremont and Sacramento Weirs and Yolo Bypass. The Natomas Post Authorization Change Report (NPACR) and resulting Chief's Report were completed in December 2010. The remaining portion of the project, including potential Natomas Basin levee raises, is being addressed in this report.

1.3 Reach Delineation

The ARCF GRR study area, shown in Figure 1, has been divided into three basins; Natomas (NAT), American River North (ARN), and American River South (ARS), which were further subdivided into study reaches. In addition, the Sacramento Bypass was also included within the project study area. This report covers the approximate areas:

- 12 miles of the north and south banks of the American River immediately upstream of the confluence with the Sacramento River
- 18 miles of the east bank of the Sacramento River, downstream of the NCC down to the American River

- 5 miles of the south bank of the Natomas Cross Canal (NCC)
- 3 miles of the Pleasant Grove Creek Canal (PGCC)
- 26 miles of the Natomas East Main Drainage Canal and tributaries (NEMDC)
- 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek
- 1.8 miles of the Sacramento Bypass upstream from confluence with American River

For the purposes of the feasibility planning process, the three study area basins were further subdivided into reaches based on common elements, such as geographic features. In general, this report presents information either by basin or reach. However, in some cases the report structure deviates from basin or reach based organization. For instance, geology and geomorphology, construction history, and past performance are better related to channel features than basin related reaches. Therefore, for those topics, the information has been presented in the following groups: American River (both banks), Sacramento River (south of the American River confluence), East Side tributaries (Dry and Robla Creeks, NEMDC east, and Arcade Creek), and Natomas Basin.

The American River North Basin (ARN) includes levees on the north (right) bank of the American River upstream of NEMDC, the east (left) bank of NEMDC from the American River to Arcade Creek and from Arcade Creek up to Dry/Robla Creeks, both banks of Arcade Creek from NEMDC up to Marysville Blvd, both banks of Dry/Robla Creek from NEMDC up to Marysville Blvd, and Magpie Creek between Vinci Ave and Raley Blvd. The levees in the American River North Basin have been divided into nine planning reaches; ARN A, B, C, D, E, F, G, H, and I.

The American River South Basin (ARS) includes levees on the south bank (left) bank of the American River upstream of the Sacramento River and the east (left) bank of the Sacramento River from the American River down to Morrison Creek. The levees in the American River South Basin have been divided into seven planning reaches; ARS A, B, C, D, E, F, and G.

The Natomas Basin (NAT) includes levees on the east (left) bank of the Sacramento River from Verona to the American River, the south (left) bank of the NCC, the west (left) bank of the PGCC, west (right) bank of the NEMDC, and the north (right) bank of the American River from the NEMDC to the Sacramento River. The levees in the Natomas Basin have been divided into nine planning reaches; NAT A, B, C, D, E, F, G, H, and I.

The Sacramento Bypass includes the northern (right) bank levee of the bypass from the Sacramento River into the Yolo Bypass. The area also includes the existing Sacramento Weir structure.

1.4 Coordination

The Project Delivery Team, consisting of U.S. Army Corps of Engineers (USACE), the State of California Department of Water Resources (DWR), the Central Valley Flood Protection Board (CVFPB), and Sacramento Area Flood Control Agency (SAFCA), coordinated in the preparation of this appendix. The designs for the identified alternatives were developed by the Sacramento District Corps of Engineers using assumptions and guidance as described in this Appendix.

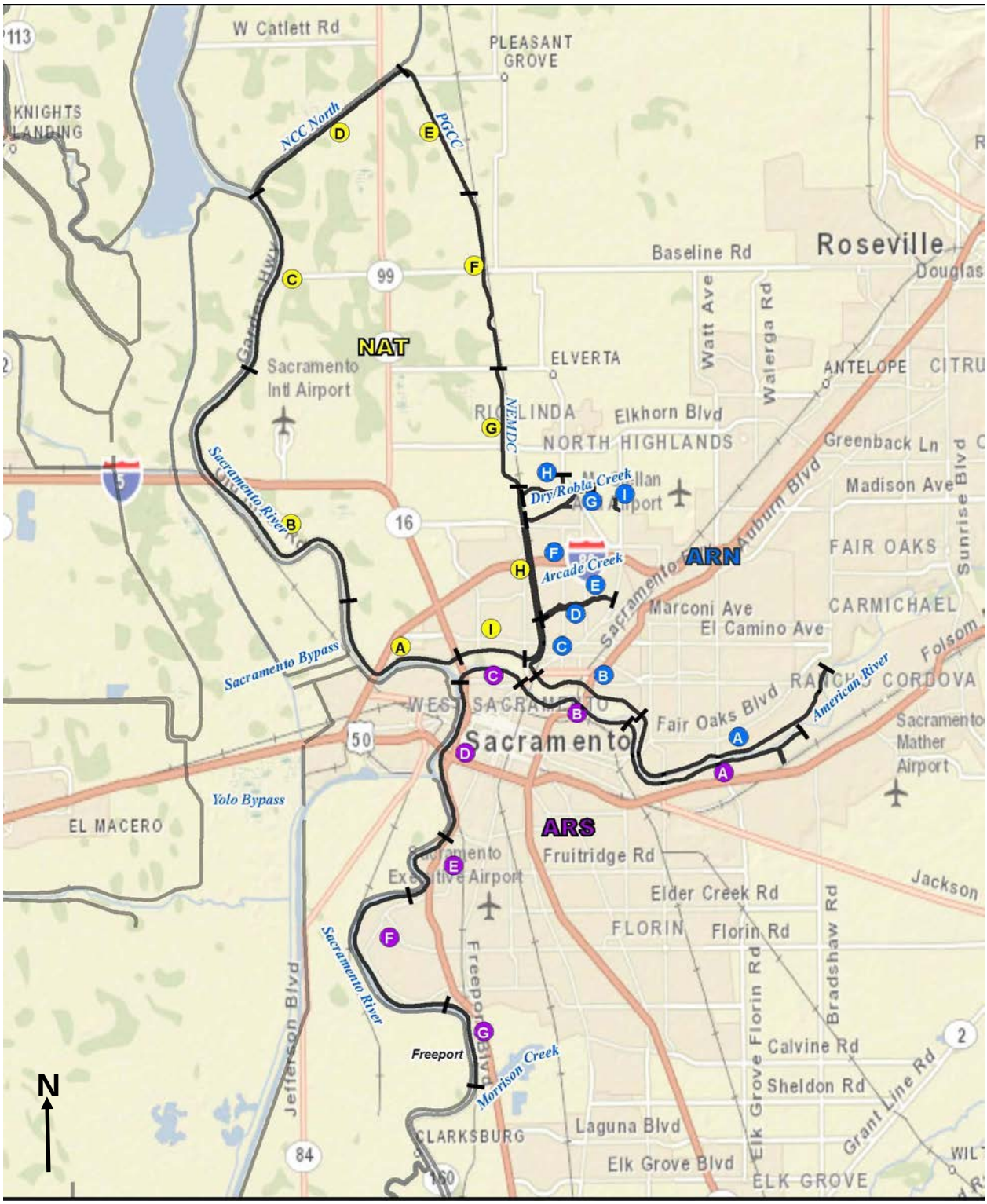

Figure 1 – Study Area Map

CHAPTER 2 – GENERAL DESIGN CONSIDERATIONS

2.1 General

The GRR includes a discussion of the full array of measures and alternatives. The technical appendices only include the Final Alternatives for which qualitative analysis was conducted. The Final Alternatives consist of three alternatives including the No Action Plan. This chapter summarizes the design considerations necessary for evaluation of the without-project condition and for development of the alternatives.

2.2 Hydrology

The hydrologic information used in support of this study is presented in *Synthetic Hydrology Technical Documentation* (USACE 2009) which completed ATR certification in January 2009. For details about the boundary conditions, calibration, data verification, and other topics related to the hydraulic modeling See Attachment A – Hydrology Executive Report for information.

2.3 Hydraulic Design

For alternative selection, the water surface for a median 200-year Annual Chance of Exceedance (ACE) event plus 3 feet was chosen as the top of levee (TOL) design profile. The profiles generated were used in quantitative development for final array and feasibility level costs. This approach is supported by an economic analysis of levee raises above existing TOL discussed within the economic appendix. The design profile also aligns with the sponsor's Urban Levee Design Criteria and the intent of Folsom Dam JFP to control releases up to a 200-year event. Raises beyond the 200-yr event were determined infeasible because the American River system could not contain the releases from Folsom Dam JFP to within the channel and both ARN and ARS basins would be inundated by water outflanking the levee system. In areas where the existing top of levee was higher than the criteria, the top of levee was used for the design profile.

The water surfaces were developed using hydraulic modeling by the Sacramento District Hydraulic Design Section. Much of the hydraulic data used to calibrate this data came from the Comp Study UNET model and flow/stage data from the 1997 flood event. See Attachment B – Hydraulic Executive Report for more information.

2.4 Geotechnical Design

This section summarizes the geotechnical analysis and resulting recommendations. See Attachment C – Geotechnical Report for additional detail.

2.4.1 Geotechnical Analysis

For the purposes of problem identification and alternatives analysis, several different failure modes have been evaluated for the without project condition. The failure modes included seepage (under and through), slope stability, erosion, overtopping and seismic. The details of the analysis and full report are included in Attachment C – Geotechnical Report.

Where levee height, geometry, erosion, access, vegetation, seepage, and slope stability deficiencies were identified (criteria not met) improvement measures consisting of cutoff walls, seepage berms, relief wells, stability berms, geotextile reinforcement, flattened embankment slopes, flood walls, retaining walls, sliver fills, and various other measures were included in development of conceptual alternative cross-sections.

2.4.2 Vegetation Variance

The majority of the Sacramento River levee within the study area, requires seepage, slope stability, height, and erosion improvements in order to meet USACE criteria. In areas requiring levee raising, construction of the levee improvements will require complete vegetation removal on the levee from approximately 15 feet landward of the landside toe to approximately 1/2 the height of the levee on the waterside slope. On the waterside, where construction does not remove vegetation, Army Corps ETL 1110-2-583, *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures,* would require a vegetation free zone on the levee slope to 15 feet waterward of the waterside levee toe. The Sacramento District will instead seek a Vegetation Variance Request (VVR) which will keep the remaining vegetation left in place.

To show that the safety, structural integrity, and functionality of the levee would be retained, an evaluation of underseepage and waterside embankment slope stability was performed using a realistic vegetation scenario. The scenario analyzed the effects of a tree falling during a flood event and the resulting scouring of the root ball area based on tree species and size.

The analyses section/index point at LM 5.92 was chosen for the VVR analyses because it was considered to be representative of the most critical channel and levee geometry and the without project analyses showed the section does not meet underseepage and slope stability criteria. The cross-section geometry of the index point incorporated tree fall and scour by using a maximum depth of scour for cottonwoods as approximately 11.0ft; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of Cottonwoods (12.0ft) projected horizontally at a depth of 11.0ft below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets USACE seepage and slope stability criteria considering the seepage and stability improvement measures are in place ("with project" conditions). Therefore, it is a reasonable conclusion that with a VVR to allow vegetation to remain, the safety, structural integrity, and functionality of the levees within the study area would be retained. More information on the VVR and graphical representation can be found in the draft EIS/EIR under chapters 1 and 2 respectively.

2.4.3 Borrow and Stockpile Sites

It is anticipated that significant quantities of material will be required for construction of the proposed project. Several different improvement measures such as seepage berms, cutoff walls, embankment construction/reconstruction, and erosion protection are proposed. The Sacramento District Geotechnical Engineering Branch, SOP-003 *Geotechnical Levee Practice*, (SOP-003)

established the requirements of engineered fill to be used for the construction of the levee embankments.

The material is expected to be sourced from several sites including; newly identified borrow sites within approximately 25 miles of the study area, existing borrow sites identified for the Natomas Basin by SAFCA, the Deep Water Ship Channel dredge disposal area, the existing levees, and existing commercial sources. Test pits and laboratory testing on materials collected from test pits were provided by SAFCA as part of the Natomas Levee Improvement Program (NLIP) for borrow sites established for the Natomas Basin. Additionally, the Sacramento District has studied the Deep Water Ship Channel spoil areas as a borrow source several times in the past. Typically projects constructed by the Sacramento District utilize commercial borrow sites near the project area.

It is anticipated that the required soil fill import for the proposed project will exceed the capacities of the already identified borrow sites in the Natomas Basin, and obtaining significant quantities of material from commercial sites may be cost prohibitive. Therefore, a desktop regional borrow study was performed to identify potential borrow sites, within 25 miles of the study area, where enough soil could be sourced to satisfy the project needs. This study was performed by obtaining National Resources Conservation Service (NRCS) National Cooperative Soil Survey (NCSS) data, sorting the NCSS data based on material classification and engineering properties, using aerial photographs to identify areas of open or agricultural land, and then merging the sorted NCSS data with the open or agricultural land areas to obtain locations, acreage, and volume of potential borrow sites. Results of the desktop regional borrow study indicate adequate materials available within the assumed 25 mile area. A map which indicates these areas is included in the Geotechnical Appendix – Attachment C.

Depending on the selected improvement measure, it is possible that existing levee material could be used as a source of borrow material. Typically, the existing levee is composed of poorly graded sands, silty sands, and sandy silts on the rivers and streams, while the bypass levees were constructed of fat clays. This material can be considered suitable for use in the construction of some stability berms, seepage berms, and for reconstructing the levee embankment where a cutoff wall with an impervious clay cap is proposed. Additionally, the widening of the Sacramento Bypass in Alternative 2 may provide another borrow opportunity from levee degrade and grading efforts within the new floodway channel.

Levee materials such as impervious fill, sand filter, and topsoil are largely expected to be import materials. These materials will be stockpiled or delivered and placed at the same time to construct the proposed levee improvements.

2.5 Civil Design

2.5.1 General

This section describes the civil design and site considerations required for construction of project features, access roads, contractor staging areas, real estate requirements, relocations, and quantities developed for the alternatives analyzed for the GRR. Design consideration

information includes floodwall and levee construction guidance, EM 1110-2-1913 *Design and Construction of Levees*, and ER 1110-2-1150 *Engineering and Design for Civil Works Projects*.

2.5.2 Alignment and Stationing

For purposes of this report, river miles were used for figures and display purposes as they were a common reference between hydraulics and geotechnical disciplines. Levee stationing in feet was developed for each feature for design and quantity take-offs. Alignments for fix in-place levee improvements were determined by the existing levee features such as existing landside or waterside toe, waterside crest, etc.

The landside toe was determined using the Light Detection and Ranging (LiDAR) data along with recent aerial photos and was visually located by Civil Design. Most of the access-related improvements were developed using offsets of this approximation.

2.5.3 Topographic Data

The topographic data used for civil design alternative quantity estimates were based on LiDAR surveys conducted in 2007. The surveyed area consisted of a larger survey contract through the DWR in support of its Urban Levee Evaluation (ULE) geotechnical evaluations. Bathymetry data along the Sacramento and portion of American River was also used in conjunction with the LiDAR surveys under the same DWR geotechnical evaluations. Additional bathymetry was used to complete the rest of the American River study area from an updated 2006 Ayres model.

2.5.4 Datum/Units

The North American Datum of 1983 (NAD83) was used throughout the project area for horizontal control. For vertical control, some of the older datasets used were developed using the National Geodetic Datum of 1929 (NGVD29). These datasets were converted to the National American Vertical Datum of 1988 (NAVD88). English units have been used on this project as preferred by the Non-Federal Sponsor (NFS).

2.5.5 Relocations and Utilities

Utilities and various encroachments were researched and identified using a variety of sources including: State DWR Levee Logs, USACE Periodic Inspection data, and Central Valley Flood Protection Board (CVFPB) permitting data. All of these sources were compiled into a central spreadsheet for organization and priority identification purposes. Field surveys followed the research, attempting to identify both public and non public encroachments as well as verifying existing descriptions, materials, and sizes. The surveys were conducted for the ARS and ARN basins due to the higher risk associated with utilities near urban areas and the proposed levee improvement features within the area. The Natomas basin was not included because the NPACR was assumed authorized and built which included utility relocations.

The field survey and spreadsheet data were combined into a final document recording basic descriptions, owner, and permit number as applicable. Typical fixes were created to reflect

existing conditions and proposed improvements to accommodate levee construction features and USACE policy compliance. Features like replacement/relocation of pipe, impervious fill around pipes, and positive closure represented a majority of the reoccurring items requiring relocation. Larger pumping stations were not assigned a typical fix; instead they were estimated by comparing to similar fixes identified in the NPACR and pro-rating. The pro-rate was related by pipe size and quantity of pipes penetrating the levee, assuming that all of the pipes would require relocation, positive closure, and new pumping equipment to meet USACE policies. The typical fixes and pumping plant pro-rates were then assigned to the utilities outlined in the document and evaluated for compensability.

Private encroachments identified in the field surveys were tabulated separately from the utilities and recorded for the NFS. These were items such as fence intersections, landscaping, pools and stairs along the landside of the levee which are included into the total project cost for alternative selection. ARS Reaches E-G were chosen as the best representation of NFS estimated costs for private encroachments as these reaches contained a majority of the private encroachments. The impact of the encroachments will vary between the alternatives due to the differences in levee raise which requires additional easement to construct and maintain, beyond that which is covered by the System Wide Implementation Framework (SWIF).

2.5.6 Construction Access, Haul Routes, and Staging Areas

Permanent access along most of the project is currently available using existing levee access roads. For scour protection, sites along the Sacramento River are anticipated to be constructed using barges. For the American River, additional waterside access roads will be constructed for the bank protection sites.

Access for constructing cutoff walls will be accomplished using existing levee access roads and public roads. For levee raising, access will be needed along the landside toe for construction and maintenance. Relocations will be accessed through the routes already mentioned. Further refinement of access requirements will be analyzed during the Preconstruction, Engineering and Design (PED) phase.

Haul routes will generally use existing public roadways that connect to the existing project. As borrow sources were not specifically identified, exact haul routes were not identified.

Since there have been many projects along the levees in this study, it is expected that previously used staging areas will be the primary location for staging for this project. There are other available sites such as parks, levee ramps, widened levee areas, and vacant land along the levees that may serve as staging areas. Refinements of staging requirements and identification of staging areas will be completed during the PED phase. For feasibility level cost estimates, it is estimated that approximately one acre of staging area will be needed per mile along the project features.

2.5.7 Real Estate Requirements

Real estate requirements for the study area consist of Flowage Easements (FE), Flood Protection Levee Easements (FPLE), Temporary Work Area Easement (TWAE), and Bank Protection Easement (BPE). These easements were needed to provide adequate construction room to build proposed flood risk management features and secure lands needed for Operations and Maintenance (O&M). The easements are described in Engineering Circular (EC) 405-1-11, and summarized below as they apply to the project.

Bank Protection Easement (BPE) – Easement needed for construction and maintenance of erosion protection features. Included are the rights to trim and cut vegetation, shape and grade slope, and place riprap. The easement includes all area required to construct and maintain erosion protection features that are outside of the FPLE.

Flowage Easement (FE) – Lands that will be subject to permanent and occasional flooding as a result of levee setbacks and degrading of existing levees within the project. This easement will be used for the widened Sacramento Bypass and Magpie floodplain detention features.

Temporary Work Area Easement (TWAE) – Easements needed for a limited duration such as during construction. These include areas needed for access roads and staging areas.

Flood Protection Levee Easement (FPLE) – Needed for levee setback areas and in locations where the local maintaining agency does not have sufficient rights on the levee. These include the right to construct, maintain, repair, operate and patrol the flood protection features. This easement includes all area from landside toe to waterside toe of the existing and/or proposed levee.

In areas where levees will be raised, a FPLE is needed for construction and maintenance for the expanded levee footprint. The easement needed for the expanded footprint is estimated to be 15 feet landward from the existing landside levee toe. Only levee raise areas will require the additional landward FPLE, with remaining areas to be included under the SWIF. See the GRR chapter 2 paragraph 6.6 for discussion of without project future conditions.

During PED, slope flattening will be analyzed further and it is expected that areas with proposed construction improvements will require slopes to be flattened. It is anticipated the slope flattening will not have impacts on permanent easements but will require a TWAE for construction when not coincident with levee raise. The slope flattening work will require approximately 10 feet extending from the toe of the levee towards the landside or waterside for construction. The work does not alter the project footprint for either alternative; instead it reestablishes design slopes with the sloughed material at the toe of the levee. The areas for slope flattening were not defined in this study along the Sacramento River due to the extensive analysis required to define these areas. However, it is estimated that slope flattening could occur on 15% of the levee lengths (9,300 feet) to allow estimation of Real Estate costs for this study. The qualitative estimate came from reviewing levee LiDAR data using slope shading techniques to indicate potential areas where levee slopes were over steepened. The real estate requirement will not be needed in areas of levee raising so it primarily affects the cost for Alternative 2. There is potential for slope flattening for Alternative 1 but it has been reduced to 5,300 feet for estimation of Real Estate costs. In ARN, both sides of Arcade Creek appear to require slope

flattening. On the north side of Arcade, the TWAE extends to the landside as there appears to be minimal impact to existing homes and it is preferable to extend towards the landside to avoid hydraulic impacts to the creek. On the south side, the TWAE extends towards the waterside to avoid impact to existing residential property.

The project does not include work or real estate requirements to bring levees in compliance with Engineering Technical Letter (ETL) 1110-2-583. For areas along the Sacramento River with vegetation that doesn't meet the ETL, this report assumes the Sponsor has sufficient rights to meet requirements of the variance described in paragraph 2.4.2 Vegetation Variance. All work and real estate needs related to vegetation removal or access requirements on the landside of the levee will be covered under a System Wide Improvement Framework (SWIF).

More information on the types of easements, relocations, and estimates can be found in Appendix D – Real Estate.

2.6 Scour Protection Analysis

This section summarizes the erosion protection analysis and resulting recommendations. See Attachment E – Erosion Protection Report for additional detail.

Two erosion protection measures have been proposed that could be implemented in combination along the levee alignment depending on factors such as bank/bench geometry, existing habitat, and existing land use among other considerations. The location of these fixes relied heavily on the existing ground constraints and whether the waterside bench was large enough for the buried trench.

From engineering design perspective and initial environmental input, the Launchable Rock Trench method was preferred and used wherever physically possible and bank protection only when necessary. Because of the differences between the American River and Sacramento Rivers within the study area, this approach led to the majority of the erosion fixes on the American River as Launchable Rock Trench and the majority on the Sacramento River as Bank Protection. However, after impact analysis it was later determined that bank protection would be preferred because of the reduced impacts to vegetation requiring removal during the trench construction. A sensitivity analysis between the two designs was evaluated and costs were determined to be similar with regards to construction and real estate. Therefore, prior to the planning feasibility report milestone (FRM), updates to the plates and quantities will be performed to capture the preferred erosion protection method.

Both erosion designs used the same rock revetment gradations which were calculated using the CHANLPRO software and hydraulic inputs. Section design thicknesses, launching distances, and quantities were dictated by the revetment size and guidance from EM 1110-2-1601, *Hydraulic Design of Flood Control Channels*. The amount of launchable rock needed for both designs was close to 10 cubic yards per lineal foot to account for scour and will potentially allow launching distances up to 25 feet with 3 feet design thickness. Depending on site conditions, sand filters and geotextiles would be used accordingly.

Both erosion protection measures propose planting areas within the design. Plantings are not considered detrimental to the erosion protection features if, at a minimum, they are not within the vegetation free zone and the roots will not penetrate into the launchable rock trench. As shown in Figures 2, 3, and 4, the erosion protection includes 1) a sand filter (minimum 1-foot thick) to prevent migration of material, 2) rock sized as described in paragraph above, 3) cut slopes are no steeper than 1.5H:1V but should also match the waterside levee slope angle when excavating against the levee, and 4) the base of the launchable rock trench should correspond to the elevation of the summer mean water surface elevation to limit the vertical distance the rock must launch to during an event.

2.7 Environmental Impact Assessment

The waterside and landside areas of levees provide a large amount of habitat for the Sacramento Area. These areas are important for nesting and roosting habitats for a variety of wildlife species, some of which are special-status. The waterside wooded areas are especially valuable because of the Shaded Riverine Aquatic (SRA) habitat which creates nutrient rich areas and cooler temperatures for fish to take shelter.

The harmful effects that construction could have within the project area were considered during alternative evaluation. The affected areas are described in the Environmental Impact Statement along with any options that may reduce or mitigate for the proposed flood features.

2.7.1 Hazardous, Toxic, and Radioactive Wastes (HTRW)

A Phase 1 Environmental Site Assessment (ESA) was performed in accordance with the scope and limitations of ASTM E 1527-05 and USACE ER 1165-2-132 for the American River Common Features GRR study. There are many contaminated properties adjacent to the landside of the levees that should be avoided due to the nature of the contamination or the nature of the work proposed on the levees. The ESA has identified sites with recognized and probably unavoidable environmental conditions at the locations shown in Table 1 below.

Table 1 - Sites with Recognized Environmental Conditions

Site Name	Reach	Issue
Old North Sacramento	ARN Reach C NEMDC	CVOC, TPH Groundwater Plumes adjacent to levee, multiple properties
Full Stop Mini Mart	ARN Reach D Arcade Creek	TPHg plume at levee bridge crossing with air sparging
Robertson/Harbor Sand & Gravel	ARS Reach B American River	Levee Encroachment, recycled pavement
TOSCO Corp. Conoco-Phillips Sacramento Terminal	ARS Reach D Sacramento River	Petroleum release site on water side of the levee
TOSCO Corp./ Conoco-Phillips	ARS Reach D Sacramento River	Petroleum release site on land side of the levee. Petroleum

Sacramento Terminal		pipelines pass through the levee.
Southern Pacific Rail Yard	ARS Reach D Sacramento River	CVOC, TPH Groundwater Plume, land use restrictions
Old Bryte Landfill	Sacramento Bypass	Lead in soil

The historical land uses of the region may also contribute to residual contamination of the entire project area with agricultural fertilizers, herbicides, and pesticides as well as arsenic and mercury from mining operations in the region. Additional sampling will be required during subsequent investigations to determine if project areas have been impacted by these historical contaminants.

On-line records are limited. For contaminated sites identified as unavoidable under the alternatives considered by the American River Common Features GRR, a public records review is recommended at the Central Valley Regional Water Quality Control Board office and the Sacramento Regional Office of the Department of Toxic Substances Control as the next step to determine if additional investigation is required to determine the impact of these sites on the proposed project. Current groundwater plume maps and environmental liens / deed restrictions incorporating land use controls are particularly needed. Emphasis is needed on the Sacramento Terminal Bulk Fuel Handling Facility, the Old Southern Pacific Rail Yard, and the Old Bryte Landfill.

A follow on Phase 1 ESA will need to be performed at the beginning of Preconstruction Engineering and Design (PED). The subsequent Phase 1 ESA(s) will investigate if new sites have emerged and if existing sites still need to be addressed prior to construction.

2.7.2 Environmental Commitments

The summaries below discuss environmental impacts and mitigation values for vegetation and wildlife. More information on these impacts including fisheries, water quality, special status species, and cultural resources can be found in the EIS/EIR Chapter 3, Affected Environment and Environmental Consequences.

American River

During the PED phase, plans will be evaluated to reduce the impact on vegetation and wildlife. Refinements that could be implemented to reduce the loss of riparian habitat are; reduced footprint and replacing the trench cross section with bank protection and planting berm cross section where large riparian habitat areas exist adjacent to the levee toe (when no hydraulic impacts would occur).

Where the bank protection cross section and planting berm can be constructed, trees would remain in the area that is 15 feet from the levee toe and complies with the Corps vegetation policy. Trees would be protected in place to the extent practical along the natural channel during the placement of rock. The rock would anchor the trees in place and reduce the risk of them falling over during a high flow event. Additional plantings would be installed on the newly constructed berm to provide habitat for fish and avian species. The planting berm would be used

to minimize impacts to fish and wildlife species; however, the impact to riparian habitat would still be significant.

To compensate for the removal of 65 acres of riparian habitat on the American River, approximately 130 acres of replacement habitat will be created. Species selected to compensate for the riparian corridor removal will be consistent with the approved list of trees, shrubs, and herbaceous plants native to the American River Parkway. The 130 acres will create habitat connectivity and wildlife migratory corridors that provide for the habitat needs of important native wildlife species, without compromising the integrity of the flood management facilities, the flood conveyance capacity of the Parkway, and Parkway management goals in the Parkway Plan (See EIS for more information on the Parkway Plan). Some of the 130 acres of riparian would be planted on top of the rock trench. Corps vegetation policy allows for trees to be planted 15 feet from the levee toe. In order to comply with this policy and reduce the amount of maintenance on the compensation lands, trees could be planted on top of the rock trench starting at 15 feet from the waterside toe. In other words if the trench is 70 feet wide the outer 55 feet could be planted with riparian habitat. Additionally, to comply with the Parkway Plan, lands within the Parkway will be evaluated for compensation opportunities. The exact location of the compensation lands in the Parkway will be coordinated in the PED phase of the project with Sacramento County Parks Department and comply with the Parkway Plan objectives and goals. It is assumed that sufficient lands will be available within the Parkway, however, if there is not sufficient land, other locations within Sacramento County will be identified and public coordination will occur.

East Side Tributaries

Compensation for the removal of approximately 200 trees in the Arcade Creek and NEMDC areas will be done in compliance with the Sacramento City tree ordinance. It is estimated that 2 acres will be required to accommodate the planting of approximately 450 trees. There are multiple locations that are suitable for planting the compensation trees within the City of Sacramento Parks land.

Sacramento River

Avoidance and minimization measures incorporated as part of the Sacramento River design include compliance with the Corps vegetation policy through a vegetation variance, and installation of a planting berm where erosion protection is required.

The vegetation variance would allow waterside trees on the lower 1/2 of the waterside slope to remain in place. This allows approximately 930 trees along 10 miles of the Sacramento River from the American River confluence to Freeport to continue to provide habitat for fish and wildlife species. Along with retaining the trees, additional plantings of small vegetation will be done on the newly constructed berm. Species of plants will be coordinated with the National Marine Fisheries Service, Fish and Wildlife Service, and State and local partners.

Within the half levee degrade portion of the levee, there are approximately 750 trees of various sizes and species that will be removed to facilitate construction. On the landside area, where the

footprint cannot be reduced, approximately 1300 trees will be removed to construct the levee features and provide access in accordance with Corps and State policy. These trees are considered to be riparian habitat because of the close proximately to the waterside riparian corridor. Compensation for the tree removal was evaluated based on other projects in the Central Valley where riparian trees were removed, coordination with FWS, and local tree ordinances. Based on this evaluation and the lack of riparian habitat in the urban area, up to 95 acres could be required to compensate for the loss of these trees. There are parcels of land within a short distance that could be planted, however, further evaluation on availability of these lands and coordination with the resource agencies will be needed. Lands within the extended Sacramento Bypass could be used to compensate for some of the landside trees being removed. A hydraulic analysis would need to be done to determine what extent planting could occur. If sufficient compensation lands cannot be located, credits in a FWS approved mitigation bank will be purchased to meet the requirement of 95 acres.

Sacramento Weir and Bypass

Impacts associated with the Sacramento Weir and Bypass are related to the construction of Alternative 2 (See Section 4.3 Alternative 2 – Sacramento Bypass and Weir Widening**)** only. Avoidance, minimization, and mitigation measures discussed in this section would only be implemented if Alternative 2 is constructed.

It is estimated that 8-acres of riparian vegetation will be removed to construct the 1,500 foot long weir. Compensation was determined by evaluating other projects with similar impacts in the Central Valley, coordination with resource agencies, and evaluation of compensation plantings ability to provide similar wildlife habitat. Because new plantings will take many years to establish a temporal loss was considered in the calculation for compensation acreage. A total of 20 acres would be needed to compensate for the removal of the vegetation along the Sacramento River and within the new weir footprint. Plantings could be accomplished within the expanded bypass if hydraulic analysis determines that it would result in no reduction in conveyance capacity. Specific lands for compensation have not been identified; however, lands considered will provide similar habitat to that being impacted. If appropriate lands cannot be located, a FWS approved mitigation bank may be used to offset the impacts.

2.8 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R)

The Non-Federal Sponsor (NFS) is responsible for project Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) for project features. The costs of OMRR&R are represented as the averaged annualized cost to maintain the flood control features over the project lifespan. The regulation which governs this work is under the provisions of Title 33, Flood Control Regulation, Maintenance and Operation of Flood Control Work approved by the Secretary of the Army, published 17 August 1944 Federal Register.

The GRR evaluates the additional effort required by the local maintaining agency (LMA's) to Operate, Maintain, Repair, Replace, and Rehabilitate (OMRR&R) for the added features of the alternatives. The following paragraphs provide a general description of additional features

proposed as part of the GRR study and describe the Corps understanding of increases/decreases in OMRR&R effort as a result.

USACE worked with staff from the LMA's to develop the differential costs associated with the project features. Costs associated with OMRR&R are presented in section 5.4.1 Cost Engineering Data & Results.

Cutoff Walls

Cutoff walls are proposed in levees along the Sacramento River, NEMDC, and Arcade Creek. The cutoff wall will be within the subsurface of the levee and therefore no additional maintenance cost is needed for the cutoff wall features. However, in the future, features or natural events which disturb the wall will require additional costs to repair and replace portions of the wall.

Construction Access for Operations and Maintenance

Construction access to the levee toe will be provided in areas where the levee is being raised or slopes are flattened to allow for OMRR&R. The access requirements include a 10 foot wide easement on the landside of the levee. Generally, the local sponsor will need to increase mowing, rodent control, and encroachment removal to include this additional area. For purposes of this GRR, the Corps has included costs equivalent to increasing the current budgets for vegetation control, rodent control, and mowing by 15 and 5 percent to account for the additional area for alternatives 1 and 2, respectively.

Floodwalls and Retaining Walls

The required maintenance for the floodwalls and retaining walls includes caulking and graffiti removal. The exposed area for the proposed floodwalls and retaining walls is minimal and impact on OMRR&R is considered negligible. Therefore, no cost increase is included.

Erosion Protection

There is new erosion protection proposed for most areas along the American and Sacramento Rivers that are not currently protected with modern bank protection. The erosion protection along the Sacramento River is mainly bank protection type similar to existing Sacramento River Bank Protection Project sites. The maintenance required for these areas includes replacing rock damaged by floods or other means. The bank protection will offset the need to repair levees with erosion damage after flood events.

The maintenance required for the launchable rock trench includes vegetation control and mowing from levee crown to 15' waterside of the toe. The vegetation and mowing are typically already included in existing OMRR&R operations. The required efforts are considered offsetting and no additional costs were calculated.

There will also be vegetation (mainly trees) planted in designated areas for both bank protection and launchable rock trench control types. The vegetation will be outside the 15' waterside of the levee toe boundary. The proposed plantings are native plants and should regenerate and require no maintenance. Additional costs for establishment period have been included into the construction costs and are not part of O&M. No additional costs were calculated for additional plantings.

2.9 Cost Engineering

2.9.1 General

The project cost estimates were prepared by Cost Engineering Section, Sacramento District, and based on quantities and data furnished by the Civil Design Section A, Environmental Planning, and Real Estate sections. Each project delivery team (PDT) member was responsible for defining confidence/risk levels associated with their products. During preliminary alternative development an abbreviated cost risk analysis was prepared by the PDT leading up to the TSP milestone. Following that milestone, a formal cost risk and schedule analysis was prepared for feasibility level design leading to the final report milestone (FRM). Project cost related items that were considered in the analysis included but was not limited to:

- Project Scope Growth
- Construction Schedule
- Contract Acquisition Strategy
- Construction Elements
- Construction Quantities
- Specialty Fabrication or Equipment
- External Project Risks

During the course of the feasibility study, the cost estimate level progressed from a class 5 to a class 3. The basis of the estimates goes from very little design definition (plan formulation - alternatives screening) to a refined design (refinement of the NED and LPP plans for authorization). The estimate class definition and progression is explained under ASTM E 2516-06 *Standard Classification for Cost Estimate Classification System*. The evaluation and summary of the initial array of alternatives through to the final array of alternatives can be found in Chapter 3 of the GRR. For the FRM, the Total Project Cost Summaries (TPCS) and Cost and Schedule Risk Analysis (CSRA) were prepared for the NED and LPP plans and are provided under Attachment D – Cost Estimates.

Additionally, real estate estimates were based on footprint requirements for project construction. Operation and maintenance estimates were provided by Civil Design Branch. Alternative level estimates were prepared based on refinements to the preliminary layouts, features, and measures as determined by screening analysis done by Planning Division, and input from the potential non-Federal sponsors.. Design guidance came from ER 1110-2-1302, *Civil Works Cost Engineering*. Detailed preparation and the format of all estimates follow the guidance in Engineer Technical Letter (ETL) 1110-2-573.

A combined Value Engineering study for this project and the West Sacramento study was completed in November 2013. The study had the following objectives: validate alternatives, facilitate communication, manage risk, and improve value. It analyzed an array of alternatives and provided a comparison of value between alternatives. Results indicate Alternative 1 has the highest value with Alternative 2 as the second highest value.

CHAPTER 3 – EXISTING CONDITIONS

3.1 General

The purpose of this chapter is to provide an overview of the existing levee system in the study areas. The discussion will focus on describing the existing features. Hydraulic and geotechnical analyses of the existing condition and performance of the levee system are discussed in paragraphs 2.3 and 2.4 of this report. Refer to the Attachment B – Hydraulic Executive Report and Attachment C – Geotechnical Report for more detail.

The levees providing flood risk management to the ARCF GRR study area are susceptible to through seepage, underseepage, slope stability, overtopping, and erosion. In addition to these problems there are instances of utility facilities, existing drainage ditches and irrigation structures and other encroachments landside of the levee which compromise levee integrity. This section presents the problems that remain for the levees within the ARCF GRR study area.

3.2 American River

On the American River (both banks, Reaches ARN A and B and ARS A, B, and C) seepage and stability improvements have been accomplished as authorized by WRDA 1996 and 1999. Geotechnical seepage and slope stability analyses performed for the ARCF GRR confirmed that at the critical cross-sections, the improvements constructed for WRDA 1996 and 1999 negate need for additional seepage and stability improvements as part of the ARCF GRR. The WRDA improvements also have addressed height issues by designing the TOL design profile to convey 160,000cfs with 3 feet of freeboard.

The American River levees were originally intended to convey a release from Folsom Dam of 115,000 cfs. During several events since the construction of Folsom Dam, flows have exceeded design capacity and caused significant erosion distress. Additionally, the objective release from Folsom Dam is for 160,000 cfs. Due to the past performance and future without project conditions, erosion is the driving potential failure mode along the American River requiring additional improvements to convey design flows.

3.3 Sacramento River South

On the Sacramento River east levee south of the confluence with American River (Reaches ARS D through G), the need for further seepage and slope stability improvements has been identified through geotechnical analyses. Although the majority of the levee embankments contain a through seepage cutoff wall from the Sacramento Urban Area Levee Reconstruction Project of the early 1990s, analyses and past performance indicate a deeper underseepage and underseepage induced slope stability deficiency exists. In these areas, the low permeable confining layers are typically found deep below the levee and may require deep cutoff wall construction methods. Additionally, the levee at Pioneer Reservoir was improved by the Sacramento District with relief wells and a landside seepage berm in 2006 to meet criteria at the 100 year flood event.

Levee and existing floodwall height deficiencies have been identified along the Sacramento River levee for the 200-year event. Deficiencies ranged from 1 to 2 feet with a majority beginning at the end Reach E and carried through Reach G. Some of the existing improvements in the area had already built up the levees which would not require any further height improvements.

At several locations the typical design levee section criteria is not applicable due to geometric configuration, historic encroachments, roadways adjacent to the levee, or high ground adjacent to the embankment. These locations include several segments of high ground (typically man-made such as the Sacramento Railyards or the Interstate-5 embankment) downstream of the confluence with the American River and adjacent to the levee embankment. Through portions of Old Sacramento the "Boat Section" of Interstate-5 parallels the floodwall and levee alignment. The "Boat Section" consists of a deep cut for the roadway supported by two retaining walls that buttress I-5 off ramp embankments. At this location, a system of floodwalls, retaining walls and pumped wells operate for the interstate and City of Sacramento waterfront. The features mentioned are expected to handle any seepage and stability issues.

Slope stability issues have been identified for certain areas along the Sacramento River. Over steepened slopes combined with loadings from adjacent roads, railroads, and structures may result in stability issues which need to be addressed.

The Sacramento River levees also have erosion problems similar to the American River. Analysis performed under programs such as the DWR Urban Levee Geotechnical Evaluations (ULE) and the USACE levee screening tool indicate that there is medium to high risk of breach due to erosion. Additional information can be obtained under Attachment E – Erosion Protection Report.

3.4 East Side Tributaries

Based on hydraulic modeling, areas of the East Side Tributaries have been identified with overtopping issues for the 200-year Annual Chance of Exceedance (ACE) design event. The existing top of levee for NEMDC is above the mean 200 year ACE event with varying degrees of assurance. There are also existing levee crown floodwalls within Arcade Reaches D and E starting approximately halfway through the reach terminating at the upstream terminus of the study area. The floodwalls were built up to several feet high by SAFCA under the Arcade Creek Levee Improvements project in 1996 which targeted the FEMA 100-year design surface.

The NEMDC, Arcade Creek north, Dry Creek, and Robla Creek levees sections were improved in the 1990's to early 2000's by SAFCA, and although they did not include internal seepage improvements, the levees meet geotechnical analyses criteria for seepage and slope stability, except in limited segments. The NEMDC segment south of the Arden-Garden Connector Bridge is also currently finishing up WRDA 1999 improvements which have installed cutoff walls to address seepage/stability related issues. Portions that did not meet criteria were limited to a portion of NEMDC in the vicinity and north of the Arden-Garden Connector Bridge, both banks of Arcade Creek, and a section of NEMDC north where the historic Magpie Creek intersects the levee foundation. These areas have been identified as having underseepage and underseepage

induced slope stability problems. NEMDC segments also have an active railroad operated by Union Pacific Railroad (UPR) running parallel and within close proximity of the levee. This railroad cannot be relocated or temporarily shut down, therefore design of the seepage mitigation features will need to consider the most appropriate construction methods. Seepage and stability improvements were also recently constructed in Reach C under the WRDA 99 authorization. These improvements extend from the downstream end of Reach C upstream near the Arden-Garden Connector Bridge.

Dry Creek, Reach H and Dry/Robla Creek, Reach G were evaluated and were determined to have low probability of failure with regards to seepage and stability issues and there were no overtopping or erosion improvements needed. The driving factors for levee fragility were judgment based and were tied primarily to encroachments and utilities. The SWIF will address these issues and therefore the reaches will no longer be considered for project features.

The Arcade Creek north bank has a large open channel landside ditch used to collect stormwaters and deliver them to nearby City Sump No. 158. There are seepage and stability concerns for this particular area which will need to be addressed.

3.5 Natomas Basin

Levee improvements to address seepage, stability, and erosion problems in the Natomas Basin were addressed in the 2010 Natomas PACR and authorized in WRRDA 2014. Additional improvements, consisting of levee raises, were analyzed as part of this study but are not included in the recommendation in light of other ongoing work by local interests which could render these improvements unnecessary. See Chapter 3 of the GRR document for additional information.

3.6 Magpie Creek

The existing Magpie Creek Diversion Channel (MCDC) was constructed as a 1950's era flood control project. The diversion channel intercepts upstream flows near Raley Boulevard at the confluence of Don Julio and Magpie Creeks. Flow is diverted northwestward to Robla (also known as Rio Linda) Creek, rather than through the original Magpie Creek channel. Downstream of the diversion point, the original Magpie Creek channel still carries local runoff. Magpie and Robla Creeks both discharge into the NEMDC about 2.5 miles west of Raley Boulevard.

In the early 1990’s, the Sacramento District and SAFCA began studying the Magpie Creek and MCDC flood control project after the realization that the system was overtopped during frequent events. In the late 1990’s and early 2000’s, both the Sacramento District and SAFCA developed various improvement alternatives for the project. No construction occurred as a result of these studies. While the alternatives varied slightly, they included similar measures such as, levee raises (either embankment or floodwall), new levee construction, channel improvements (deepening or widening), and construction of detention basins.

There are no seepage and stability issues noted for this area. Design of features will focus on the hydraulic conveyance of the 200-year event.

3.7 Sacramento Bypass

The existing Sacramento Weir structure and bypass were completed by 1916. The geotechnical performance of the north levee is relatively unknown, with no significant exploratory data to conduct an evaluation. However, there have been some instances where the north and south levees experienced underseepage and slope stability related distresses. Therefore seepage and stability issues should be implemented within the design. The weir structure also has no known deficiencies or performance issues.

In summary, the project area has erosion, stability, seepage, and height issues which require flood risk mitigation. The following table summarizes the existing issues by reach:

Table 2 - Reach Issues

BASIN/ AREA	REACH	REACH LENGTH (MI)	EXISTING ISSUES
ARS	A	6.9	EROSION
	B	3.3	EROSION
	C	1.9	EROSION
	D	4.3	SEEPAGE, STABILITY, HEIGHT, EROSION
	E	2.4	SEEPAGE, STABILITY, HEIGHT, EROSION
	F	5.4	SEEPAGE, STABILITY, HEIGHT, EROSION
	G	2.5	SEEPAGE, STABILITY, HEIGHT, EROSION
ARN	A	7.5	EROSION
	B	3.1	EROSION
	C	1.5	SEEPAGE, STABILITY, HEIGHT
	D	2.1	SEEPAGE, STABILITY, HEIGHT
	E	2.1	SEEPAGE, STABILITY, HEIGHT
	F	2.6	SEEPAGE, STABILITY, HEIGHT
	G	2.2	HEIGHT
	H	1.6	-
SWB	I	0.6	HEIGHT
	-	1.8	SEEPAGE, STABILITY

CHAPTER 4 – ALTERNATIVE DESCRIPTIONS

4.1 General

The project final array of alternatives consisted of: no-action, fix in-place (Alternative 1), fix in-place with bypass widening (Alternative 2). These alternatives were carried through for economic analysis and into the selection of the Tentatively Selected Plan (TSP) milestone.

The no-action alternative does not include any additional features for this project. As such, there is no cost estimate or additional description for the no action alternative provided in this Appendix.

4.2 Alternative 1 – Fix In Place

The fix in-place method would combine a variety of flood risk management improvements and keep the project features within the existing levee footprint as much as possible. This method is a traditional approach to providing flood protection without the use of various structures, detention basins or bypasses. It is also a widely utilized flood protection fix in the Sacramento region in general and a prominent existing feature along the American River levees within the project area. The following table summarizes the features for Alternative 1:

Table 3 – Alternative 1 Improvements

FEATURES GRR - ALTERNATIVE 1						
WATER-COURSE	**BASIN**	**REACH**	**REACH LENGTH (FEET)**	**FEATURE LENGTH (FEET)**	**IMPROVEMENT**	**FEATURES**
NEMDC	ARN	C	8,330	1,250	SEEPAGE/ STABILITY	80' CUTOFF WALL
Arcade Creek (S. Bank)		D	10,965	10,965	HEIGHT	1 - 4' FLOODWALL
				10,965	SEEPAGE/ STABILITY	45' CUTOFF WALL WITH GEOTEXTILE REINFORCED SLOPE
Arcade Creek (N. Bank)		E	11,155	11,155	HEIGHT	1 - 4' FLOODWALL
				11,155	SEEPAGE/ STABILITY	45' CUTOFF WALL
				2,900	DRAINAGE CHANNEL	REPLACE EXISTING DITCH W/CLOSED BOX CULVERT
NEMDC		F	13,710	5,700	SEEPAGE/ STABILITY	80' CUTOFF WALL
Robla/ Dry Creek Left Bank		G	11,725	0	NONE	-
Dry Creek Right Bank		H	8,420	0	NONE	-
Magpie Creek		I	-	3,100	HEIGHT	NEW LEVEE WITH FLOODGATES, LEVEE RAISE, FLOODPLAIN PRESERVATION, CULVERT IMPROVEMENTS

Table 3 – Alternative 1 Improvements (Continued)

COMMON FEATURES GRR - ALTERNATIVE 1 (CONTINUED)						
WATER-COURSE	BASIN	REACH	REACH LENGTH (FEET)	FEATURE LENGTH (FEET)	IMPROVEMENT	FEATURES
AMERICAN RIVER	ARS	A	36,190	6,850	EROSION PROTECTION	BANK PROTECTION
				17,750		ROCK TRENCH
		B	17,405	850	EROSION PROTECTION	BANK PROTECTION
				6,400		ROCK TRENCH
		C	9,895	3,800	EROSION PROTECTION	BANK PROTECTION
				2,150		ROCK TRENCH
	ARN	A	36,400	18,150	EROSION PROTECTION	ROCK TRENCH
		B	1,100	950	EROSION PROTECTION	ROCK TRENCH
SACRAMENTO RIVER	ARS	D	22,825	9,200	EROSION PROTECTION	BANK PROTECTION
				2,100		ROCK TRENCH
				3,000	HEIGHT	2 - 4' FLOODWALL
				4,500		1 - 2' RAISE EXISTING FLOODWALL
				600	SEEPAGE/ STABILITY	~3' SEEPAGE BERM AT PIONEER RESERVOIR
				2,500		80' CONVENTIONAL CUTOFF WALL
				6,500		120' DSM CUTOFF WALL
		E	12,560	8,850	EROSION PROTECTION	BANK PROTECTION
				3,200	HEIGHT	LEVEE RAISE
				8,400	SEEPAGE/ STABILITY	95 - 135' DSM CUTOFF WALL
		F	28,635	21,100	EROSION PROTECTION	BANK PROTECTION
				1,000		ROCK TRENCH
				20,700	HEIGHT	LEVEE RAISE
				2,300	SEEPAGE/ STABILITY	80' CONVENTIONAL CUTOFF WALL
				24,250	SEEPAGE/ STABILITY	95 - 145' DSM CUTOFF WALL
		G	13,105	11,150	EROSION PROTECTION	BANK PROTECTION
				1,000	SEEPAGE	95' DSM CUTOFF WALL
				11,500	STABILITY	GEOTEXTILE STABILIZED SLOPE
				11,700	HEIGHT	LEVEE RAISE
		ALL	62,000	5,300	STABILITY	SLOPE FLATTENING

4.3 Alternative 2 – Sacramento Bypass and Weir Widening

Alternative 2 includes expanding the Sacramento Weir and Bypass (SWB) which will allow more water to be released upstream of ARS sub-basin, Reaches D-G; therefore, reducing the need for height improvements in these areas. However, this alternative does not reduce the need for seepage, stability and erosion improvements within those reaches. Alternative 2 includes all of the fix-in-place methods proposed in Alternative 1, with the exception of levee raising on the Sacramento River. The following table summarizes the features in Alternative 2:

Table 4 – Alternative 2 Improvements

COMMON FEATURES GRR - ALTERNATIVE 2						
WATER-COURSE	**BASIN**	**REACH**	**REACH LENGTH (FEET)**	**FEATURE LENGTH (FEET)**	**IMPROVEMENT**	**FEATURES**
NEMDC	ARN	C	8,330	1,250	SEEPAGE/ STABILITY	80' CUTOFF WALL
Arcade Creek (S. Bank)		D	10,965	10,965	HEIGHT	1 - 4' FLOODWALL
				10,965	SEEPAGE/ STABILITY	45' CUTOFF WALL WITH GEOTEXTILE REINFORCED SLOPE
Arcade Creek (N. Bank)		E	11,155	11,155	HEIGHT	1 - 4' FLOODWALL
				11,155	SEEPAGE/ STABILITY	45' CUTOFF WALL
				2,900	DRAINAGE CHANNEL	REPLACE EXISTING DITCH W/CLOSED BOX CULVERT
NEMDC		F	13,710	5,700	SEEPAGE/ STABILITY	80' CUTOFF WALL
Robla/ Dry Creek Left Bank		G	11,725	0	NONE	-
Dry Creek Right Bank		H	8,420	0	NONE	-
Magpie Creek		I	-	3,100	HEIGHT	NEW LEVEE WITH FLOODGATES, LEVEE RAISE, FLOODPLAIN PRESERVATION, CULVERT IMPROVEMENTS

Table 4 – Alternative 2 Improvements (Continued)

COMMON FEATURES GRR - ALTERNATIVE 2						
WATER-COURSE	**BASIN**	**REACH**	**REACH LENGTH (FEET)**	**FEATURE LENGTH (FEET)**	**IMPROVEMENT**	**FEATURES**
AMERICAN RIVER	ARS	A	36,190	6,850	EROSION PROTECTION	BANK PROTECTION
				17,750		ROCK TRENCH
		B	17,405	850	EROSION PROTECTION	BANK PROTECTION
				6,400		ROCK TRENCH
		C	9,895	3,800	EROSION PROTECTION	BANK PROTECTION
				2,150		ROCK TRENCH
	ARN	A	36,400	18,150	EROSION PROTECTION	ROCK TRENCH
		B	1,100	950	EROSION PROTECTION	ROCK TRENCH
SACRAMENTO RIVER	ARS	D	22,825	9,200	EROSION PROTECTION	BANK PROTECTION
				2,100		ROCK TRENCH
				800	HEIGHT	2 - 4' FLOODWALL
				600	SEEPAGE/ STABILITY	~3' SEEPAGE BERM AT PIONEER RESERVOIR
				2,500		80' CONVENTIONAL CUTOFF WALL
				6,500		120' DSM CUTOFF WALL
		E	12,560	8,850	EROSION PROTECTION	BANK PROTECTION
				8,400	SEEPAGE/ STABILITY	95 - 135' DSM CUTOFF WALL
		F	28,635	21,100	EROSION PROTECTION	BANK PROTECTION
				1,000		ROCK TRENCH
				1,200	HEIGHT	LEVEE RAISE
				2,300	SEEPAGE/ STABILITY	80' CONVENTIONAL CUTOFF WALL
				24,250	SEEPAGE/ STABILITY	95 - 145' DSM CUTOFF WALL
		G	13,105	1,000	SEEPAGE	95' DSM CUTOFF WALL
				1,600	HEIGHT	RAISE EXISTING FLOODWALL
				11,500	STABILITY	GEOTEXTILE STABILIZED SLOPE
		ALL	62,000	9,300	STABILITY	SLOPE FLATTENING
	SWB	-	-	1,500	HEIGHT	SACRAMENTO WEIR AND BYPASS WIDENING

4.4 Feature Descriptions

4.4.1 Erosion Protection Improvements

For both Alternatives, erosion protection extents are the same as shown in the above tables. Two erosion protection measures have been proposed that could be implemented in combination along the levee alignment depending on factors such as, bank/bench geometry, existing habitat, and existing land use among other considerations.

Bank Protection

The Bank Protection fix will include placing revetment on the existing levee waterside and project the revetment to a finished surface slope of 2H:1V or 3H:1V. The revetment will begin at the existing levee waterside hinge (when no bench exists) or waterside bench hinge depending on site conditions. Revetment will be placed on existing slope with little to no engineered slope reconstruction. Layer thickness will be approximately 1.5 feet deep and continue down to the Summer Mean Water Surface Elevation (SMWSE). At the SMWSE, there will be a riparian bench formed with a soil trench wrapped in geotextile within the design section. After the bench, the slope continues to project down to channel bottom at an increased slope of 1:1 (see Figure 2).

Existing large vegetation will be allowed as described in section 2.4.2 Vegetation Variance and to the extent practical during construction. Plantings and woody vegetation will be established within the design to create a self mitigating design, as acceptable. Factors which affected the design and quantity of revetment needed within the design were: the amount of launchable rock needed, the location of the SMWSE, and existing ground and channel geometry.

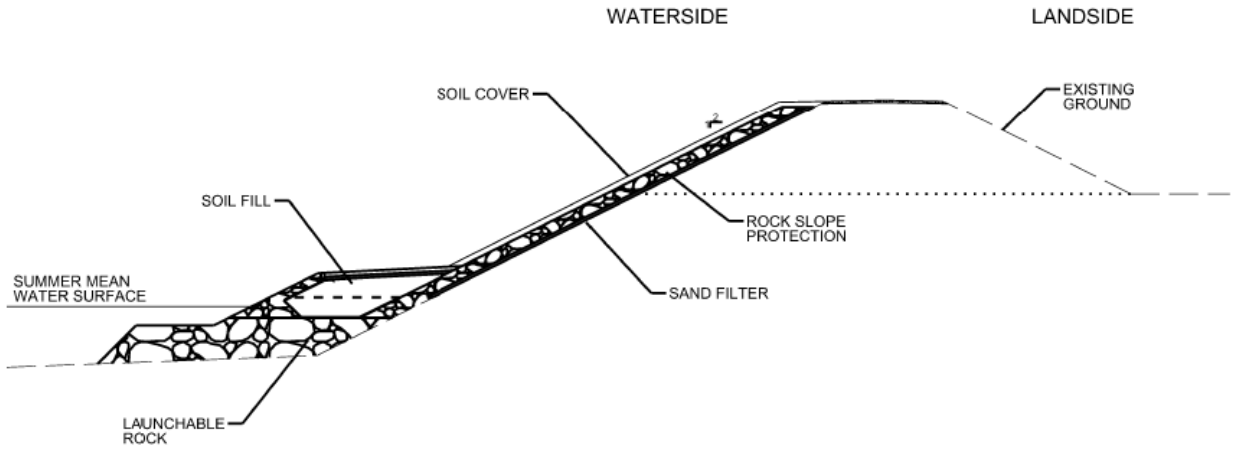

Figure 2 - Bank Protection Erosion Protection (insufficient bench)

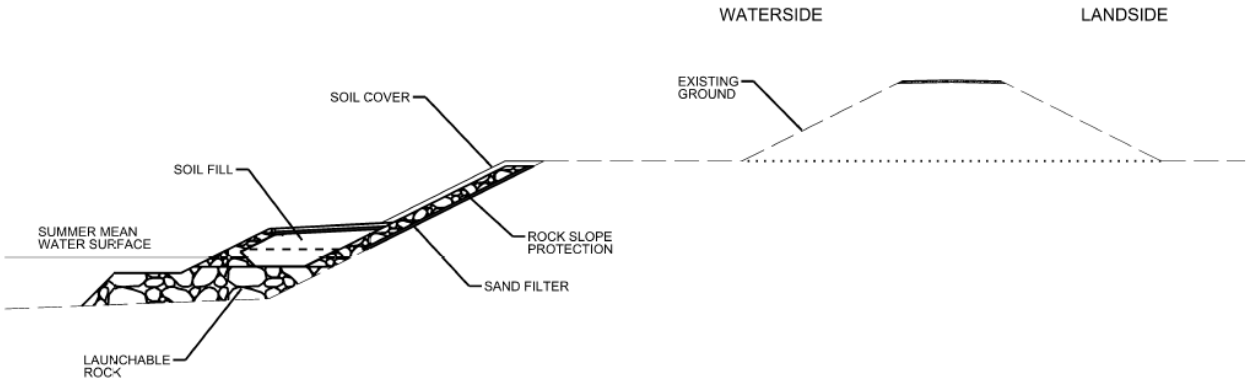

Figure 3 - Bank Protection Erosion Protection (sufficient bench)

Launchable Rock Trench

The Launchable Rock Trench fix provides the same protection to the levee as the bank protection by allowing the existing berm to be sacrificial. In order to be considered, the waterside berm width needed to be at least 50 feet wide for construction. The construction methodology would follow the trenchfill methods widely used on the Arkansas and Mississippi Rivers. The rock trench is constructed at the waterside toe of the levee and is excavated to a level that reduces the revetment launching distance and increases the reliability of design. The trench then is backfilled with rock revetment to provide enough quantity for launching. The typical design trench was approximately 10 feet wide at bottom, 40 feet wide at top, and 10 feet deep (see Figure 4). The trench would then be covered with native fill at a minimum of 3 feet thickness to allow for mitigation features such as vegetation and woody plantings to be replanted above the trench but outside the vegetation free zone.

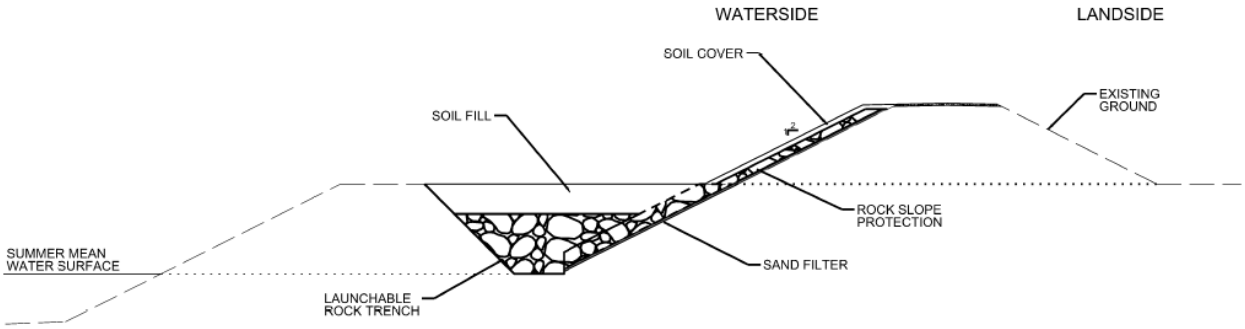

Figure 4 – Launchable Rock Trench Erosion Protection

4.4.2 Seepage/Stability Improvements

For both Alternatives, there are seepage and stability improvements proposed. Cutoff walls, seepage berms, geotextile stabilized slopes, and slope flattening are features proposed for seepage and stability improvements.

To address seepage and seepage related slope stability problems, the predominant recommendation is cutoff walls. Due to several factors, including constraints on expanding the levee footprint restricted by urban development, seepage berms, relief wells, and the majority of other seepage improvement measures were considered infeasible by the PDT.

Sacramento River

Figure 5 shows a typical seepage and stability fix for the Reaches D through F on the Sacramento River. Based on the seepage cutoff wall depths, a combination of conventional open trench and Deep Soil Mixing (DSM) cutoff wall construction methods is anticipated. Both Soil Bentonite (SB) and Soil Cement Bentonite (SCB) cutoff walls are appropriate in these reaches. The conventional method is used for wall depths of up to 85 feet and the DSM method was used for walls deeper than 85 feet. Both methods provide a barrier of low-permeable material within the levees which typically consist of sandy material. The depths of wall were determined by

geotechnical analysis and typically tie into a confining low permeable layer. The levee will be degraded by approximately half its height in order to establish a working platform as well as provide levee stability during construction.

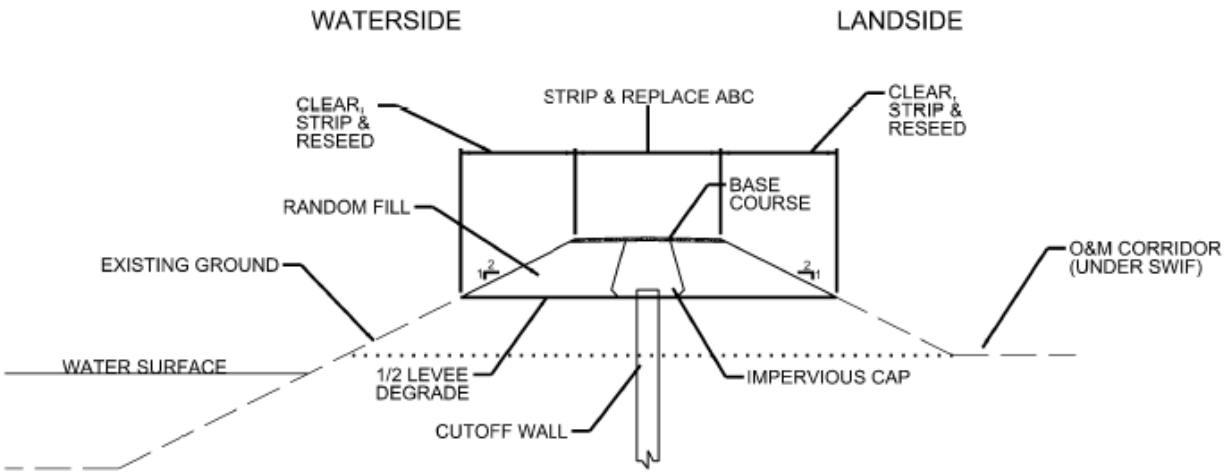

Figure 5 - Sacramento River Reaches D through F Cutoff Wall Typical Section

Levee reconstruction includes placement of random fill with an impervious cap above the cutoff wall. The levee fill will have side slopes graded to a minimum of 2H:1V slopes or existing slope if greater. The levee crown will be constructed to a minimum width of 20 feet and surfaced with aggregate base for the levee road.

Through portions of Old Sacramento and the "Boat Section" of Interstate-5 no improvement are recommended due to system of floodwalls, retaining walls and pumped wells operated for the interstate and City of Sacramento. In the same vicinity, the past Pioneer Reservoir improvements by the Sacramento District (berm and relief wells) targeted the 100-year event for design criteria. At this location additional thickness should be added to the seepage berm to increase the level of protection.

There are areas along the Sacramento River that will require slope flattening. Slope flattening will reestablish existing design slopes primarily by reusing existing levee material and mechanically strengthening. The areas are intermittently dispersed along most of these reaches and will be influenced by proposed fixes. It is estimated the total length will be approximately 15% of the existing levee lengths (not including Reach G or areas for levee raising) or approximately 9,300 lineal feet for Alternative 2. Alternative 1 has a greater amount of raise within the reaches D – G therefore additional slope flattening will be less, approximately 5,300 lineal feet. It is assumed the slope flattening can be completed without any additional permanent real estate easements but will require temporary easements during construction. A typical slope flattening section is shown below in Figure 6.

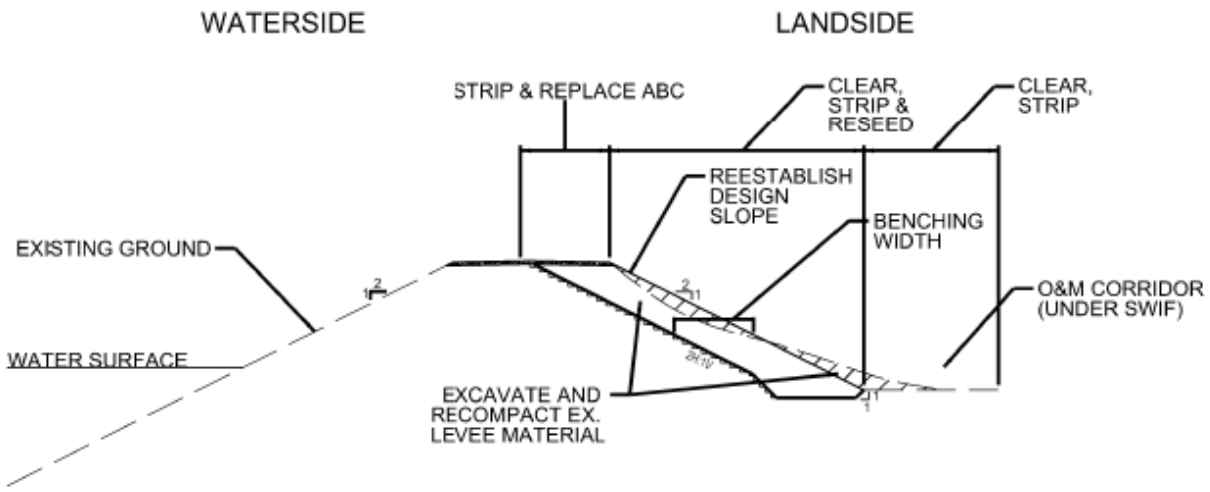

Figure 6 - Sacramento River Slope Flattening Typical Section

In ARS Reach G a slope stability deficiency has been identified. Due to adjacent roadways, railroad embankments, and structures, more common slope stability improvements, such as stability berms, were deemed not feasible. Therefore, to address the slope stability deficiency, a partial levee degrade and placement of geotextile within the reconstructed levee embankment spaced approximately 3 feet vertically is recommended. A typical geotextile section is shown in Figure 7 below.

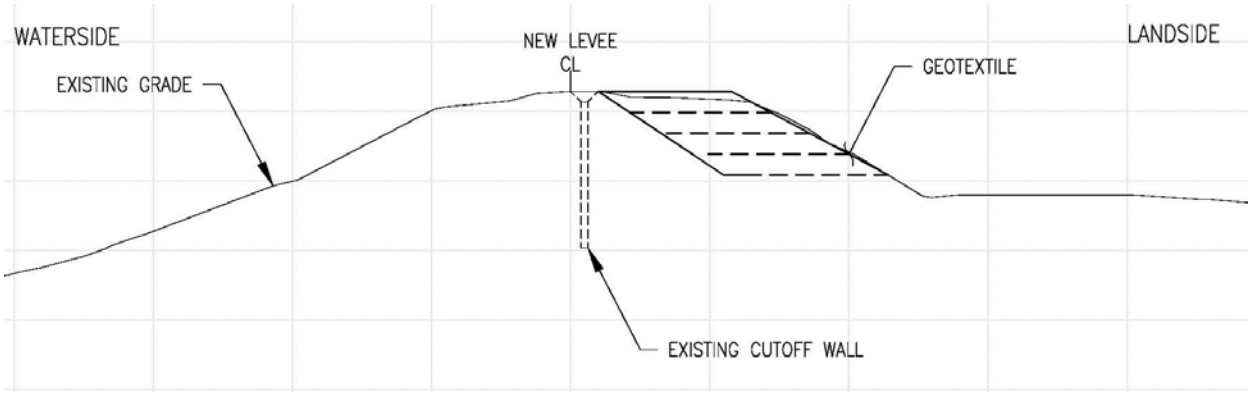

Figure 7 - Sacramento River Reach G Typical Section

Tributaries - NEMDC

A typical NEMDC levee improvement cross-section is shown in Figure 8. The measure includes a cutoff wall that will be constructed by conventional open trench methods (SB or SCB). For levee segments which run parallel and in close proximity of the active UPR railroad, SCB methods should be considered in order to mitigate the risk of trench collapse from the railroad surcharge and dynamic vibrations during construction.

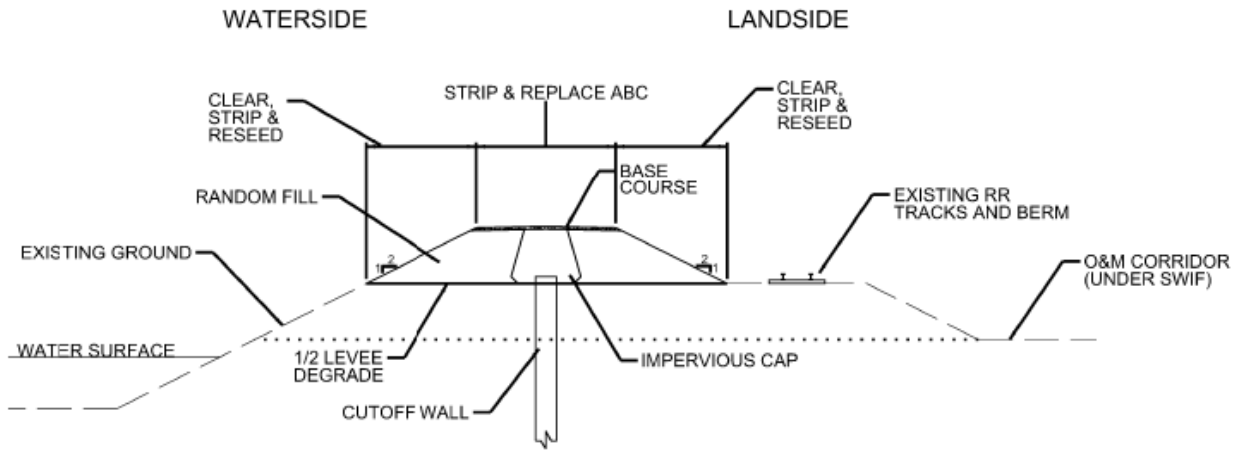

Figure 8 – NEMDC Cutoff Wall Typical Section

Tributaries – Arcade Creek

The Arcade Creek south bank cutoff wall is proposed in conjunction with a full levee height degrade and incorporation of geotextile. The improvements are proposed from the confluence of NEMDC upstream to Rio Linda Blvd. The geotextile is placed within the reconstructed levee embankment spaced approximately 3 feet vertically allowing for the existing levee slopes (steeper in some locations than 2H:1V) to remain and allow for landside access under the SWIF (see Figure 9).

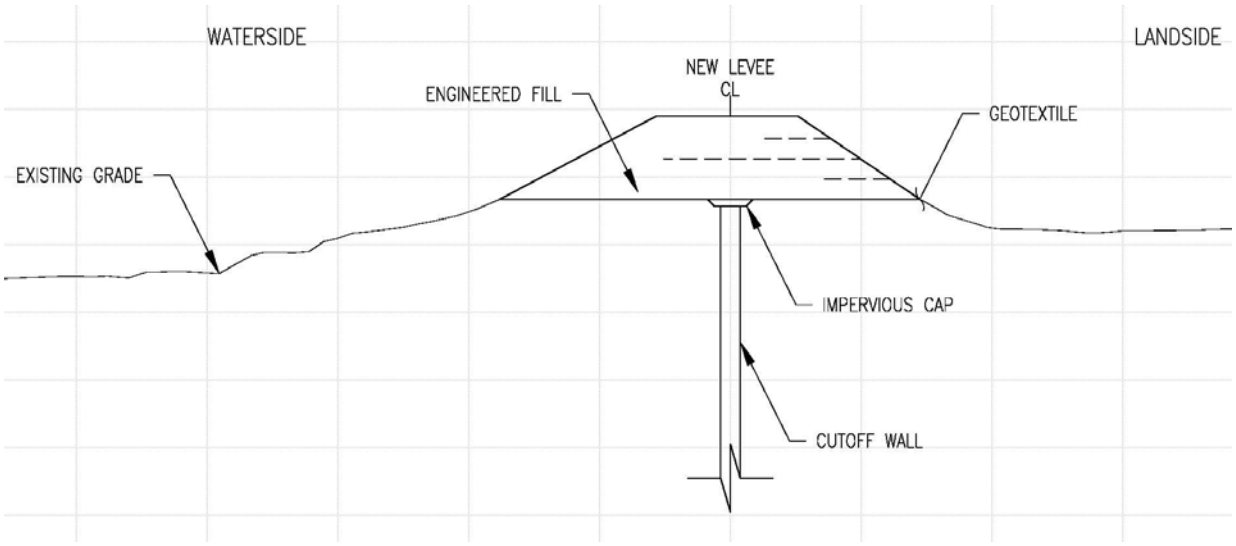

Figure 9 - Arcade Creek South Cutoff Wall Typical Section

The Arcade Creek north bank cutoff wall is proposed from the confluence of NEMDC upstream to Rio Linda Blvd. In addition, a landside ditch from the confluence to Sump Station 158 will be replaced with a box culvert or buried conduits as shown in Figure 10.

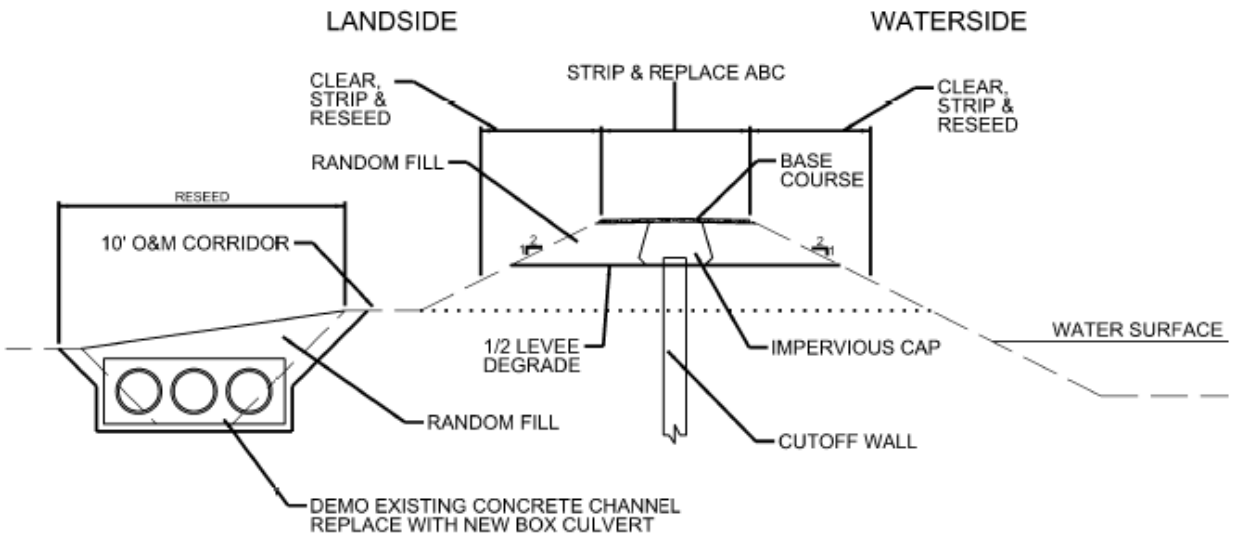

Figure 10 - Arcade Creek North Cutoff Wall Typical Section

4.4.3 Height Improvements

There are height improvements proposed for both Alternatives. The height improvements include levee raising, floodwalls, height improvements to existing floodwalls, and bypass and weir widening. During PED, other feasible methods to address height may be considered such as landside/waterside levee raising, or retaining walls.

Sacramento River

Height fixes are proposed in some segments of the Sacramento River levee which consist of a levee embankment raise, sliver fills, raising existing floodwalls, or a floodwall constructed at the levee crest. Parts of Reach D and Reach G will require new floodwalls or raising and bolstering of existing floodwalls to meet the design profile with required assurance. Figure 11 shows a typical Sacramento River levee section with the proposed levee raise improvement measures. Additional FPLE and TWAE easements will be required where levee raising occurs.

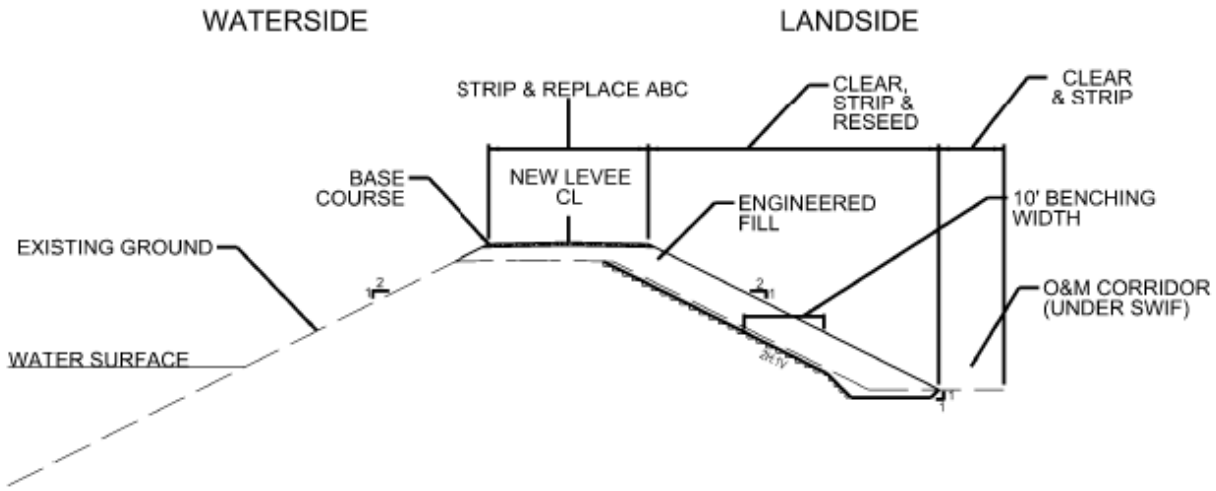

Figure 11 - Sacramento River Reaches D through F Levee Raise Typical Section

Tributaries – NEMDC, Robla/Dry Creek, Arcade Creek

Height improvements are proposed in Arcade Creek segments and will typically consist of floodwalls (see Figure 12). Within these areas, the 1 -2' raises recommended would provide assurance of containing the 200 ACE event for the American River North Basin. Additionally, there may be minor low spots within the levee profile which would be re-graded during construction. The recommended levee raises would bring the east side tributary levees to a consistent level of performance. Existing floodwalls on Arcade Creek will be removed during seepage and stability improvements and new floodwalls designed to the 200 ACE event will be constructed in those reaches.

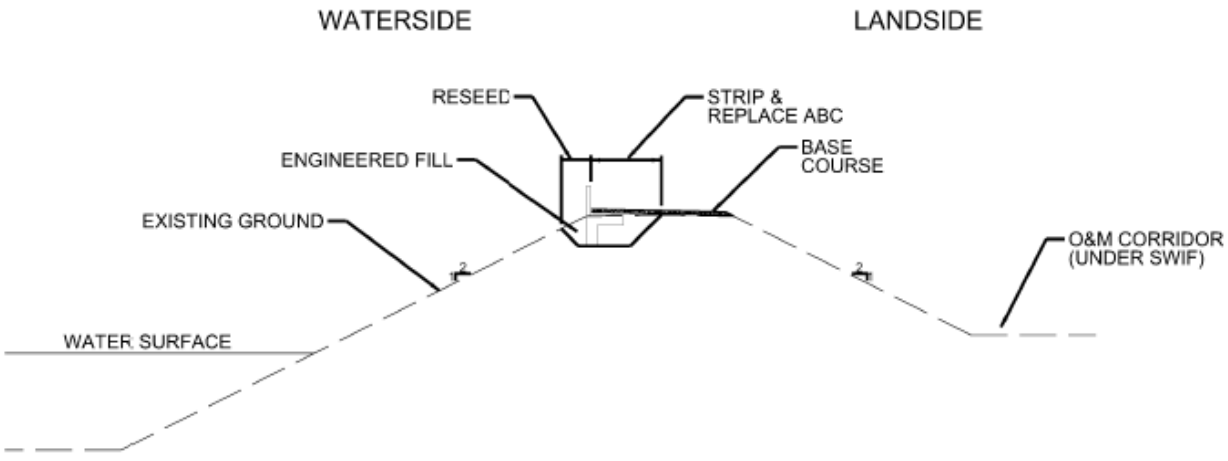

Figure 12 - Floodwall on Levee Crest

Tributaries – Magpie Creek

A number of features are proposed for the Magpie Creek Diversion Canal (MCDC) under Alternative 1 and 2. The features are consistent with the 2003 USACE Magpie Creek project report. The project includes raising the existing left bank levee (looking downstream, see Figure 13) of the MCDC for a distance of approximately 2,100 feet. The levee raise would begin just downstream from Raley Boulevard and continue to about 100 feet south of Vinci Avenue Bridge. In addition, a new 10-foot-wide maintenance road will be graded at the landside base of the new raised MCDC levee. A new levee would be constructed along the west side of Raley Boulevard south from the bridge down to Santa Ana Avenue for a distance of approximately 1,000 feet. The new levee would prevent floodwaters upstream of Raley Blvd from outflanking the existing levee.

A 5-foot high floodgate will be installed across the driveway of the Kelly-Moore paint store. An additional 4-foot high floodgate will be required at the driveway of a new development just south of the Kelly-Moore Paint Store property. A new aggregate base maintenance road will be constructed between Vinci Avenue and Dry Creek Road adjacent to the left bank (looking downstream) of the MCDC for a distance of approximately 2,700 feet.

A new culvert is also proposed under the Sacramento Northern Railway Bike Trail embankment. During high water events, this area has been a hydraulic pinch point and the additional culvert will help convey waters past this structure reducing stage further upstream. The culvert will be a triple 5-foot by 5-foot reinforced concrete box. A new channel would be excavated upstream and downstream from the culvert, connecting the culvert with Robla Creek. The new channel would be slightly above the existing channel invert to allow low flows to continue through the existing bridge. Stone protection would be placed in the bed and sides of the new channel to minimize erosion.

The area inundated east of Raley Blvd by a design event without the project in place is estimated to be 76 acres (excluding roadways and channels, the inundated land would be 73 acres). Construction of the proposed improvements would slightly increase the water surface elevation during all flood events greater than a 5-year frequency. The project would seek a total of 79 acres of land to preserve the existing floodplain in perpetuity and mitigate for proposed project features.

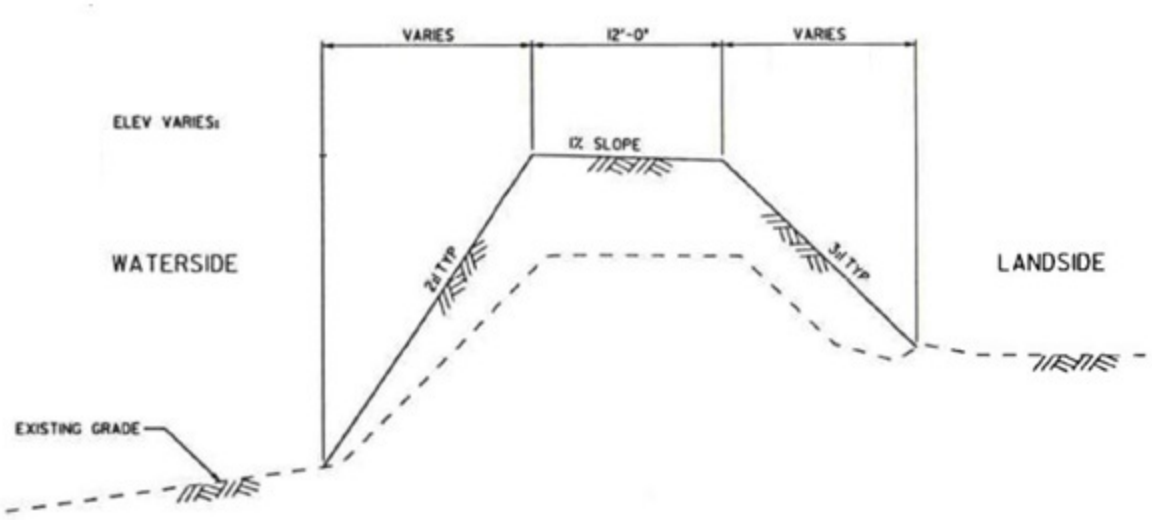

Figure 13 - Typical MCDC Levee Embankment Improvement Cross-Section

Sacramento Bypass and Weir Expansion

The Sacramento Bypass and Weir currently allows excess flood waters to spill out of the leveed river system into the Yolo Bypass thereby reducing the loading on the levees downstream. Alternative 2 expands capacity for the weir and bypass by constructing a new weir structure and relocating the bypass levee. Based on preliminary hydraulic analysis, to meet objective flows the proposed weir expansion and levee offset is approximately 1,500 feet and would be located to the north of the existing bypass. The weir operations will be tied to Folsom Dam releases which exceed 115,000cfs. This currently happens beyond a 1% and 0.5% ACE event. More detail can be found in the Hydraulic Appendix under Attachment B.

For this alternative, the existing north levee of the Sacramento Bypass would be degraded and a new levee constructed approximately 1,500 feet to the north. A new weir would also be extended approximately 1,500 feet north of the existing Sacramento Weir without impacting the existing structure. The weir will be similar to the existing structure which also includes an elevated roadway deck and railroad bridge. The extended alignment will include both of these features and will also be constructed with a seepage cutoff wall below. The alignment will be offset from existing railroad alignment so that there will be minimal interference with the railroad during construction and only temporary closure when the existing alignment is tied into the new weir structure. See Figure 14 for proposed weir structure cross section.

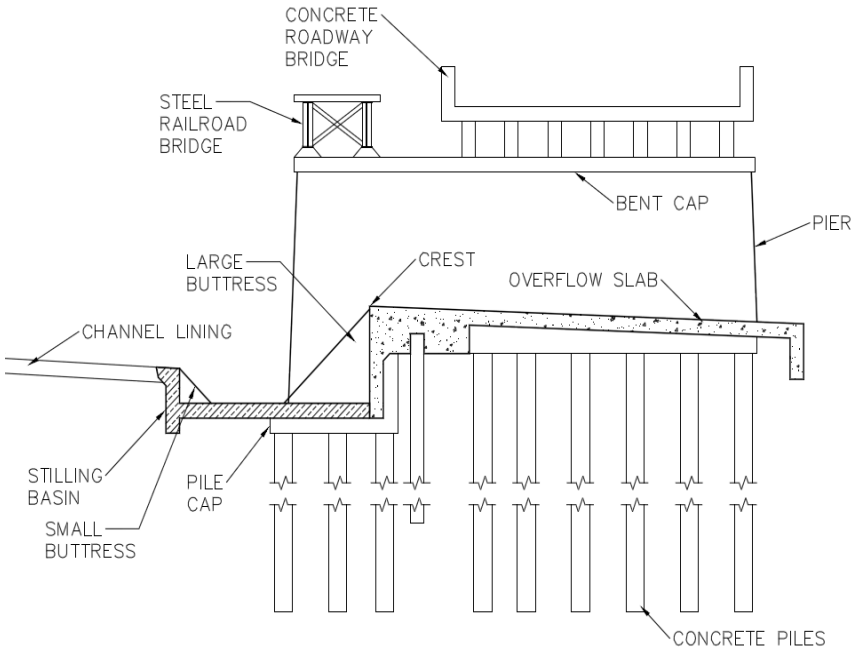

Figure 14 – Sacramento Weir Extension

The new north levee of the Sacramento Bypass would be constructed per the standard levee section for new construction which includes 3H:1V waterside and landside slopes, and a minimum crest width of 20 feet. The new north levee would include a 300-foot wide drained landside seepage berm ranging from 5 feet thick at the landside levee toe tapering to 3 feet thick at the berm toe and constructed of random fill with a 1.5-foot thick drainage and filter layer at the base. In addition to the seepage berm, a system of relief wells spaced at 200-foot intervals with a connecting drainage channel is proposed 15 feet landward from the berm toe. See Figure 15 below for a typical section of the bypass levee.

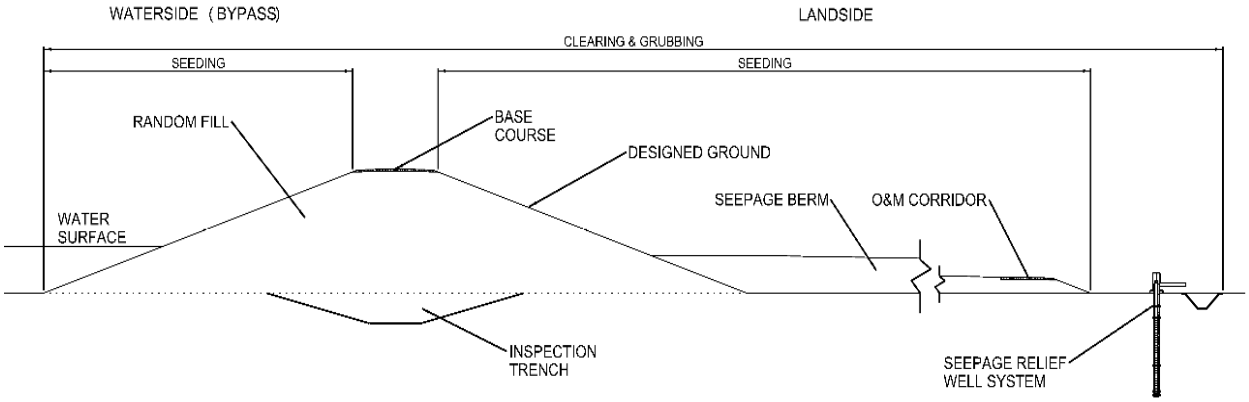

Figure 15 – Sacramento Bypass Levee

Existing infrastructure, including roads, railways, canals, and pump stations will be relocated to maintain current operation. Construction phasing will be important when coordinating these features along with the degrading of existing levees in order to maintain the integrity of the flood

works system. Refinements to this feature in PED include optimizing width of weir and bypass, possible environmental corridor alternatives, the need for operable gates, and system operation.

CHAPTER 5 – QUANTITY DEVELOPMENT, CONSTRUCTION SCHEDULE, AND COST ENGINEERING

5.1 General

The combination of improvements were quantified for the alternatives and estimated at a preliminary design level for the project area. Quantities were determined with cross sections of typical fixes to develop a civil cost estimate. These estimates would then have additional costs added to them like: Storm Water Pollution Prevention Plan (SWPPP), cultural resource preservation, Preconstruction Engineering and Design (PED), construction management costs, real estate and relocation costs, and fish and wildlife facilities. Cost risk contingencies were also assigned to these estimates to determine the initial cost for the alternative.

5.2 Preliminary Design and Quantity Development for Alternatives

Preliminary design for the alternatives were based on information developed for previous studies and engineering reports as well as new information developed for this study. For Magpie Creek features, the previous Corps Continuing Authorities Program (CAP) study features were used from the 2003 report. For the Sacramento Bypass and Weir widening, the design and cost engineering information was partially derived from previous work by Parsons Brinkerhoff (Parsons Brinkerhoff, 2008) and supplemented with information by the PDT.

Preliminary design for the erosion control features were based on typical cross sections that were based on previous erosion protection projects on the American River. A channel stability analysis (Ayres Associates, 2010) was used to determine areas requiring revetment with the assumption that all areas without modern revetment will be protected. Modern protection was determined by field inspection of areas having rock riprap with overall condition of good or very good. Additional analysis and supporting data are discussed under Attachment E – Erosion Protection Report.

Quantities were calculated for the proposed types of features and tabulated per reach, and by basin. Typical cross sections were generated to capture the types of fixes needed along the levee as well as the existing geometry of the levee. These sections were then referenced into a dynamic spreadsheet where the type of fix, hydraulic data, and existing levee geometry would be identified. By developing many fixes with varying levee geometry, the spreadsheet would calculate civil quantities using average end area method and generate better quantities than standard typical section methods allow. These quantities were then delivered to cost engineering where unit costs, site specific factors, and risk assessment were evaluated to determine initial alternative costs.

Quantities for construction of the proposed features were developed by District Civil Design staff. The engineering design and quantity development was in accordance with ETL 1110-2-573 *Construction Cost Estimating Guide for Civil Works* and ER 1110-2-1302 *Civil Works Cost Engineering*. Quantities do not include shrinkage and bulking factors or loss and waste factors for handling and hauling. For Preliminary Cost Estimates, design features focused on the cost drivers (i.e. Pareto Principle) such as cutoff wall, rip rap, levee excavation, and backfill quantities, etc.

5.3 Preliminary Construction Schedules

For economic and construction assessment, it was assumed that after authorization, the project would receive optimal annual funding appropriations and would be accomplished without resource limitations. When generating the schedule the PDT also considered a variety of factors such as: construction production rates, contractor capacity and availability, air emissions, sponsor capability, and design complexity. Considering these factors, both Alternatives 1 and 2 were estimated to take approximately 10 years. Annual appropriations under both Alternatives would vary because of phasing and feature differences, however, typical annual appropriations ranged between $100 – 200M..

A construction priority analysis was performed using levee fragility curves, hydraulic stage-frequency data, and economic data for the without project condition. The results determined which reaches had the highest risk of failure as a function of their economic consequences (see tables below). For Alternative 2, the Sacramento Bypass and Weir (SBW) widening is shown as starting after most of the levee fixes since it has no impact on the damages for more frequent events.

Table 5 - Reach Construction Priority

BASIN	INDEX POINT	HYDRAULIC STAGE (NAVD 88)		PR (FAILURE)		CONSEQ-UENCE	IMPACT	CONSTRUCTION PRIORITY
		100-YR	200-YR	100-YR	200-YR			
ARS	F	29.29	30.99	0.32	0.399	13600	5426	1
ARS	E	32.46	34.26	0.327	0.398	13600	5413	2
ARS	A	48.03	53.08	0.066	0.458	9800	4488	3
ARS	G	28.21	29.85	0.254	0.33	13600	4488	4
ARS	D	33.28	35.11	0.148	0.229	13600	3114	5
ARS	B	38.15	41.35	0.221	0.315	9800	3087	6
ARN	A	46.26	51.1	0.1179	0.463	4500	2084	7
ARS	C	35.86	38.23	0.092	0.14	9800	1372	8
ARN	B	37.01	39.89	0.102	0.145	4500	653	9
ARN	D	39.03	41.3	0.514	0.72	733	528	10
ARN	F	40.1	42.18	0.578	0.686	733	503	11
ARN	E	39.09	41.35	0.451	0.663	733	486	12
ARN	C	38.79	41.21	0.124	0.448	733	329	13
ARN	G	41.49	43.24	0.088	0.152	733	111	14
ARN	I	-	-	-	-	-	*	15
SBW	-	-	-	-	-	-	*	16

* Not included in evaluation priority, will be refined in PED

The following tables were generated using the reach priorities and cost estimates to form rudimentary diagrammatic construction schedules for the alternatives (see tables below).

Table 6 - Alternative 1 Preliminary Construction Schedule

AMERICAN RIVER COMMON FEATURES CONSTRUCTION SCHEDULE - ALTERNATIVE 1												
PRIORITY	BASIN	REACH	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
1	ARS	F										
2	ARS	E										
3	ARS	A										
4	ARS	G										
5	ARS	D										
6	ARS	B										
7	ARN	A										
8	ARS	C										
9	ARN	B										
10	ARN	D										
11	ARN	F										
12	ARN	E										
13	ARN	C										
14	ARN	I										

Table 7 - Alternative 2 Preliminary Construction Schedule

AMERICAN RIVER COMMON FEATURES CONSTRUCTION SCHEDULE - ALTERNATIVE 2												
PRIORITY	BASIN	REACH	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
1	ARS	F										
2	ARS	E										
3	ARS	A										
4	ARS	G										
5	ARS	D										
6	ARS	B										
7	ARN	A										
8	ARS	C										
9	ARN	B										
10	SBW											
11	ARN	D										
12	ARN	F										
13	ARN	E										
14	ARN	C										
15	ARN	I										

These tables do not represent the final project schedules and were instead used as a guide and to convey a prioritization strategy. The final project schedules are contained within the Cost Engineering Appendix – Attachment D.

5.4 Cost Engineering

5.4.1 Cost Engineering Data & Results

Quantity Takeoffs

Quantities for most project items were provided by the Civil Design Section, primarily using typical cross sections of levee improvements or utility penetrations. See Section 5.2 – Preliminary Design and Quantity Development for Alternatives for more information.

General Methodology in Cost Estimate Preparation

Preliminary level cost estimates (Class 4) were used in the evaluation of the final array of alternatives and the identification of the tentatively selected plan. The Cost Engineering team utilized a number of different methods to determine project costs, including the following:

Generic/parametric/characteristic unit construction costs for typical levee improvements were developed using pro-rated unit costs from the estimating software MII (MCACES, 2nd Generation). During the final array and selection of the TSP, MII was not used exclusively to develop costs or add refinement. For a typical task such as slurry wall placement or borrow material acquisition and placement, a unit cost was established based on a 'typical' crew, production rate, material cost, assumed/typical haul distance, etc. Current Davis Bacon labor rates, MII Equipment rates, current fuel prices and generic/typical Contractor markups were utilized to establish unit costs.

Historical cost data for some items have been utilized based on past projects in the vicinity of Sacramento, such as the Sacramento Bank Protection Project. Pump station costs were based on costs for similar pump stations from the Natomas PACR.

Cost Data from previous studies in the Sacramento area, specifically, those developed for SAFCA by Parsons-Brinckerhoff for the Sacramento Bypass Expansion (March 2009) were utilized to develop costs for the proposed Sacramento Bypass Expansion for Alternative 2. These costs were escalated to October 2014 for the purposes of the TSP milestone.

Cost Data supplied by other Disciplines, specifically Real Estate Division and Environmental Resources Branch (Mitigation and SWPP/Storm Water Pollution Prevention).

Cost Engineering judgment and experience was used to base some costs on a percentage of construction costs (e.g. Cultural Resources, Traffic Control, PED cost, Construction Management cost). The percentages are based on historical data and typical rates used by SPK Cost Engineers in the past.

The estimated project cost summaries (first cost) follow the Civil Works Work Breakdown Structure (CWWBS) code of accounts. Feature codes typically involved in this estimate are:

01-Lands and Damages (Real Estate)
02-Relocations
06-Fish and Wildlife Facilities
11-Levees and Floodwalls
13-Pumping Plants
15-Floodway Control Diversion Structures
18-Cultural Resource Preservation
30-Preconstruction Engineering and Design
31-Construction Management

The 30 and 31 accounts involve any costs associated with USACE staffing on the project for the federal share and anticipated costs associated with local sponsor costs for the non-federal share. The cost estimate for each Alternative is the summation of the costs from the major cost categories. The costs do not account for life cycle costs.

OMRR&R Costs

Sacramento District Civil Design Section developed OMRR&R costs associated with the project features. The costs were developed with input and review from two of the local maintaining agencies (LMA). Specifically, several meetings and conversations between the Corps, the Department of Water Resource's Maintenance Area 9 (MA-9), and American River Flood Control District (ARFCD) staff resulted in a mutual understanding of the increased efforts as a result of new project features and the impact on costs. Some of the OMRR&R costs considered related to inspection, mowing, rodent control, mechanical maintenance, and graffiti removal.

A few of the OMRR&R feature costs were developed quantitatively, however, many of the costs were developed using qualitative judgment by Corps and LMA staff. The following Table 8 shows the increased OMRR&R Costs for each alternative:

Table 8 – Annual Increase in OMRR&R Costs

ANNUAL INCREASE IN OMRR&R COSTS			
LMA	**Description**	**Alternative 1 Cost**	**Alternative 2 Cost**
MA-9	WEIR WIDENING	$ -	$ 56,250
	NORTH BYPASS LEVEE	$ -	$ 137,400
	BYPASS CHANNEL	$ -	$ 15,000
	LEVEE MAINTENANCE	$ 49,400	$ 49,400
ARFCD	GENERAL MAINTENANCE	$ 235,900	$ 235,900
OMRR&R Total		**$ 286,000**	**$ 494,000**

Total Project Schedule

A formal construction schedule coordinated with an MII cost estimate has been developed at this stage. Based on the assumption of optimal funding and resources, the yearly federal monetary allotment for the project will be approximately $100-200M. The initial PED portion and real estate efforts are assumed to take between 1-3 years prior to construction depending on the reach and types of features. These durations were evaluated on a reach by reach basis and are incorporated in Tables Table 6 and Table 7. For the purposes of alternative selection and economic analysis, the construction durations for both Alternative 1 and 2 were estimated to be 10 years. For more information, see section 5.3.

Cost Uncertainties and Cost Risk Analysis

There are inherent uncertainties in the costs at this preliminary level of design (screening alternatives) since there are no detailed designs, plans or specifications. There are also inherent uncertainties as the construction contractor(s) are responsible for obtaining the construction materials, accomplishing the work in a timely manner as per the project due date, using overtime and/or multiple crews to accomplish the same, etc. Funding appropriations are uncertain. The Central Valley of California is home to many threatened/endangered species that require much of the work to be done within certain construction windows, typically May-October.

More than 50% of the costs for this project are directly related to levee improvements. A large percentage of these costs come from obtaining and hauling materials for levee protection (stone) and placement of levee fill or impervious fill material (clay cap). For the purposes of the cost estimates, the assumption has been made that stone material will be placed from the waterside (via barge) for work along the Sacramento River and from the landside (trucked) for work along the American River. Stone materials are expected to come from either the Bay Area (via barge) or the Sierra Nevada mountains (via trucks). In either case, haul distance is approximately 75-100 miles (one-way). Much of the existing levee material can be re-used but still must be hauled to/from stockpiles. Impervious fill (clay) is assumed to come from within 25 miles (one-way haul). The potential contractors are free to obtain borrow from wherever they see fit, as long as it meets specifications. Haul costs in general have some uncertainty as material supply locations are up to the contractor and there is inherent risk that fuel prices may increase during the long construction duration anticipated for the project. The PDT acknowledges the risk of not specifically identifying borrow sites, and for the purposes of this study, have instead performed a regional borrow study which indicated more than enough suitable impervious material exists within 25 miles of the project. See paragraph 2.4.3 for more information. Another work feature of high risk/costs are the cutoff walls, which have large quantities of deep cutoff walls along the Sacramento River, requiring use of the deep soil mixing method (DSM), or some comparable method. DSM will require significant placement time.

Risk analysis results are intended to provide project leadership with contingency information in order to support decision making and risk management as the project progresses from planning through implementation. For the final array of alternatives, an abbreviated Cost Risk Analysis (CRA), using the Cost MCX Abbreviated Risk Analysis Template (spreadsheet), was performed

for each alternative. The risk analysis process involved dividing project costs into typical risk elements and placing them into a Risk Register, then holding discussions among the PDT members to identify the risks/concerns relative to those risk elements and then justify the likelihood and impact. A Risk Matrix utilizing weighted likelihood/impacts is used to establish the cost contingency to use for each risk element (work feature) for use in alternatives comparisons. To fully recognize its benefits, cost and schedule risk analysis must be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, budgeting and scheduling.

The CRA workshop was held in January 2013 with participation from most PDT members. The workshop focused primarily on risk identification using the CRA template and brainstorming techniques. Project risks were identified and were added to the risk register portion of the spreadsheet. The likelihood of and impact on each risk element was assessed by the PDT and after the meeting, the draft risk register and results were forwarded to the PDT for review. The results of the CRA were considered adequate for establishing contingencies for alternatives comparison.

Risk elements were identified for each alternative based on work feature. Prime features identified were categorized to allow relatively easy comparison of the different alternatives. The prime feature items typically accounted for 70 percent or more of the costs. The remaining work features are lumped together in a category for 'Remaining Construction Items'. The items are typically low-level risks but remain within the risk register for historical purposes as well as to support follow-on risk studies as the project and its accompanying risks evolve.

.A formal Cost and Schedule Risk Analysis (CSRA), supporting the feasibility level design refinements, was held during December 2015. Members of the PDT including Sponsors and construction field personnel were in attendance. The CSRA was similar to the CRA, however, was more detailed in identifying the risks associated with the project. The materials and results are presented within the Cost Engineering Appendix - Attachment D, for the NED and TSP (LPP), Alternatives 1 and 2 respectively.

Feasibility Level Costs

Total Project Costs have been prepared for the FRM and the cost summaries, including contingencies and escalation (per the construction schedule) and are under Attachment D – Cost Engineering. The cost summaries are presented for the NED and TSP plans. These costs include refinements to the design and feasibility level details (by Civil Design) and Cost Engineering data. This includes creation of feasibility level quantities, development of a detailed MII estimate, a Total Project Schedule (including Construction), PDT estimates for Planning, Engineering and Design, an updated Cost and Schedule Risk Analysis and a Total Project Cost Summary (TPCS) extending costs out through the life of the Project. The MII estimate includes detailed information indicating labor, equipment and materials with accompanying production rates.

Review

The cost estimates from screening level up through alternative selection have been reviewed for quality control at the Sacramento District and have also been through agency technical review (ATR). The costs currently shown in the Cost Engineering Appendix have been prepared for the FRM and are in the process of seeking cost certification from the cost center of expertise in Walla Walla District. These costs include refinements to the design where applicable including any changes from real estate and environmental disciplines.

REFERENCES

U.S. Army Corps of Engineers (USACE), *American River Common Features Project General Reevaluation Report, Placer, Sacramento, Sutter Counties, California, Synthetic Hydrology Technical Documentation, Sacramento District, United States Army Corps of Engineers*, USACE Sacramento District, September 2008. Revised January 2009.

Parsons Brinckerhoff, *Lower Sacramento River Regional Project, Conceptual Design and Cost Estimates,* prepared for SAFCA, November 2008.

U.S. Army Corps of Engineers (USACE), *Draft Supplemental Report to the Section 205 Final Detailed Project Report and Environmental Assessment on Magpie Creek, California, Sacramento District, United States Army Corps of Engineers*, USACE Sacramento District, January 2004.

PLATES

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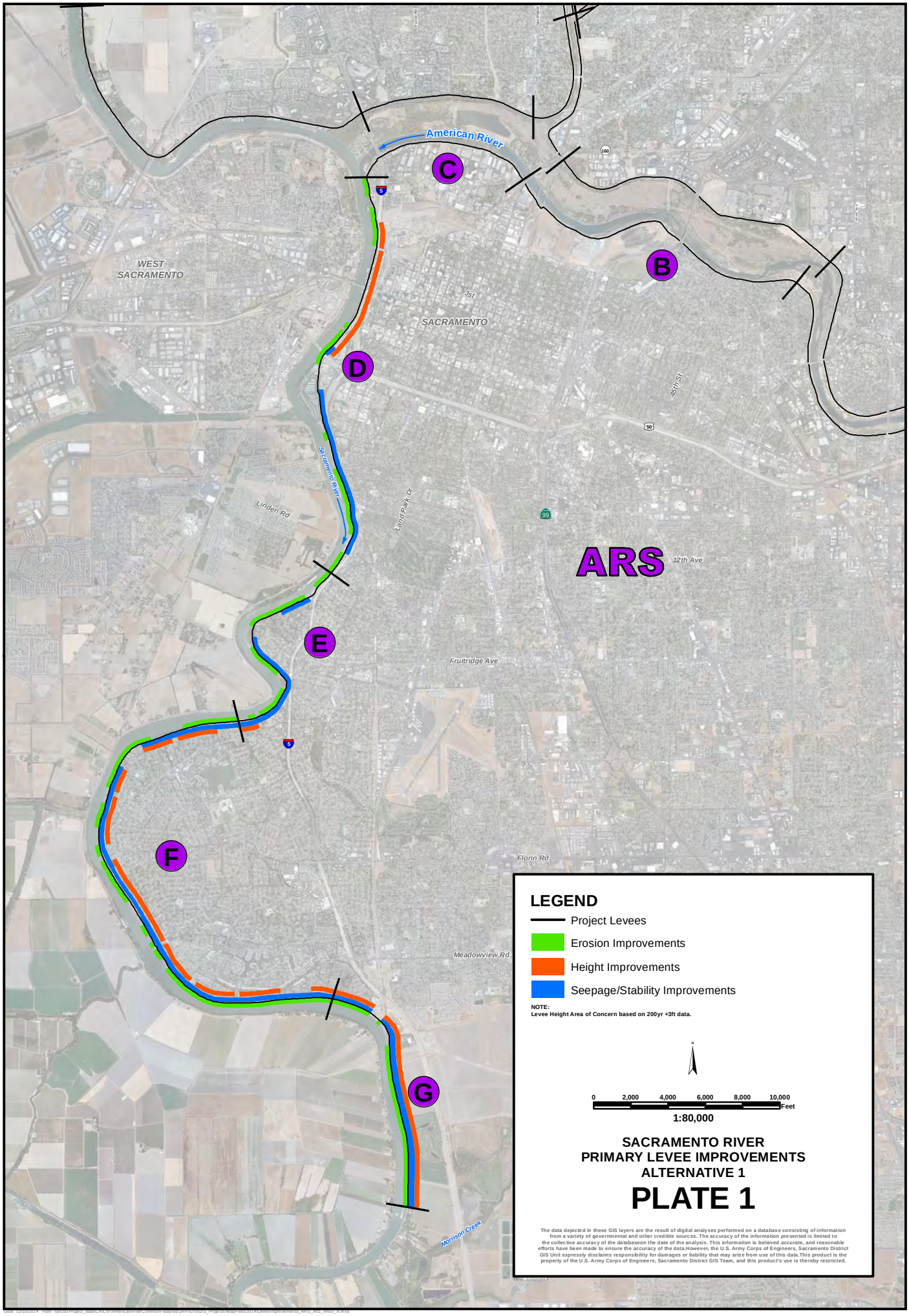
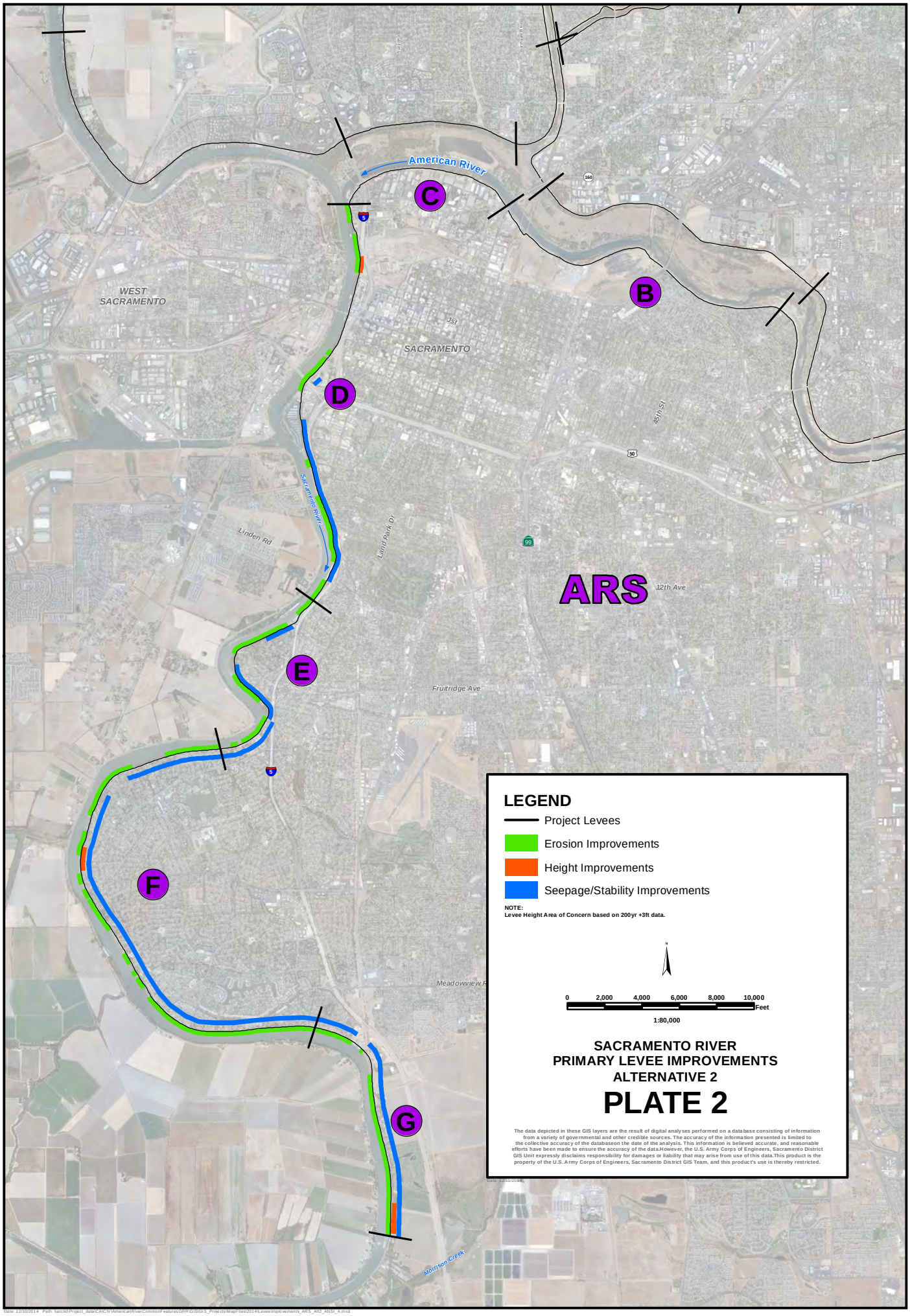

American River
C
B
D
E
F
G
ARS
WEST SACRAMENTO
SACRAMENTO
Sacramento River
Linden Rd
Lenri Park Dr
Fruitridge Ave
Florin Rd
Meadowview Rd
Morrison Creek
12th Ave
45th St
LEGEND
Project Levees
Erosion Improvements
Height Improvements
Seepage/Stability Improvements
NOTE:
Levee Height Area of Concern based on 200yr +3ft data.
0 2,000 4,000 6,000 8,000 10,000
Feet
1:80,000
SACRAMENTO RIVER
PRIMARY LEVEE IMPROVEMENTS
ALTERNATIVE 1
PLATE 1
The data depicted in these GIS layers are the result of digital analyses performed on a database consisting of information from a variety of governmental and other credible sources. The accuracy of the information presented is limited to the collective accuracy of the databaseon the date of the analysis. This information is believed accurate, and reasonable efforts have been made to ensure the accuracy of the data.However, the U.S. Army Corps of Engineers, Sacramento District GIS Unit expressly disclaims responsibility for damages or liability that may arise from use of this data.This product is the property of the U.S. Army Corps of Engineers, Sacramento District GIS Team, and this product's use is thereby restricted.


American River
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ARS
WEST SACRAMENTO
SACRAMENTO
Sacramento River
Linden Rd
Land Park Dr
12th Ave
Fruitridge Ave
Meadowview R
Morrison Creek
45th St
Jsr
LEGEND
Project Levees
Erosion Improvements
Height Improvements
Seepage/Stability Improvements
NOTE:
Levee Height Area of Concern based on 200yr +3ft data.
N
0 2,000 4,000 6,000 8,000 10,000
Feet
1:80,000
SACRAMENTO RIVER
PRIMARY LEVEE IMPROVEMENTS
ALTERNATIVE 2
PLATE 2
The data depicted in these GIS layers are the result of digital analyses performed on a database consisting of information from a variety of governmental and other credible sources. The accuracy of the information presented is limited to the collective accuracy of the databaseon the date of the analysis. This information is believed accurate, and reasonable efforts have been made to ensure the accuracy of the data.However, the U.S. Army Corps of Engineers, Sacramento District GIS Unit expressly disclaims responsibility for damages or liability that may arise from use of this data.This product is the property of the U.S. Army Corps of Engineers, Sacramento District GIS Team, and this product's use is thereby restricted.
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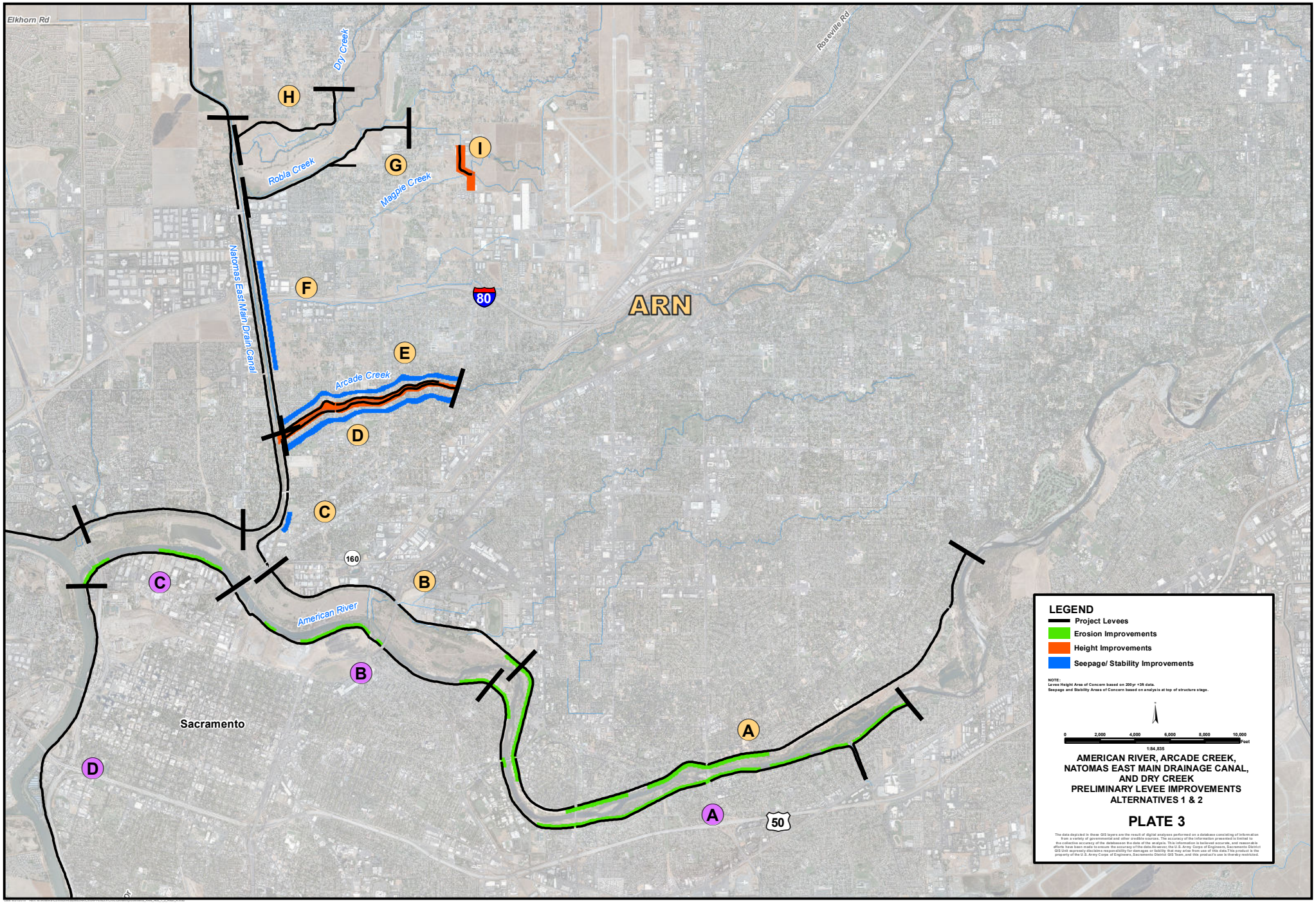
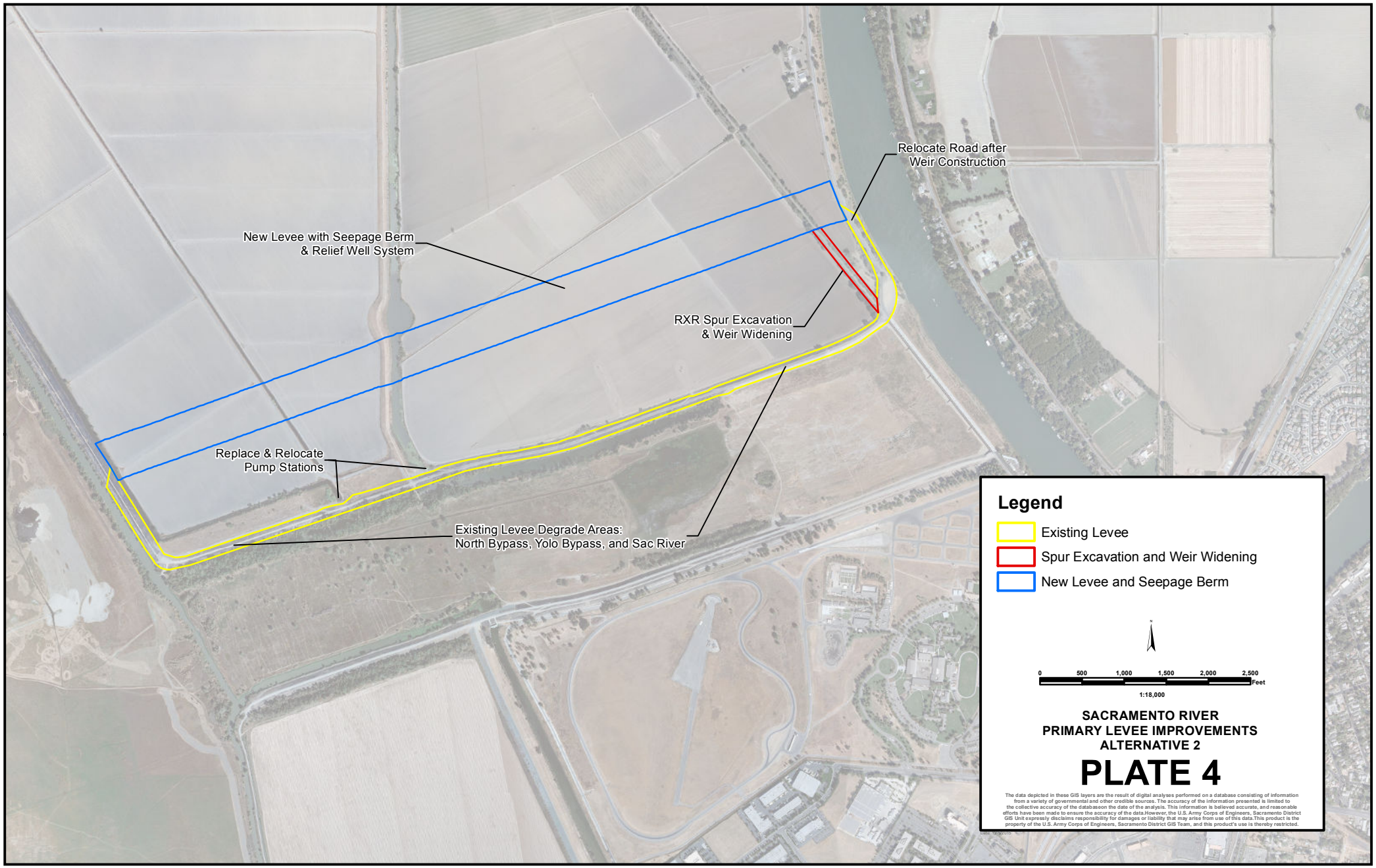

Elkhorn Rd
Dry Creek
Roseville Rd
H
Robla Creek
G
Magpie Creek
I
Natomas East Main Drain Canal
F
80
ARN
E
Arcade Creek
D
C
160
C
B
American River
B
Sacramento
D
A
A
50
LEGEND
Project Levees
Erosion Improvements
Height Improvements
Seepage/ Stability Improvements
NOTE:
Levee Height Area of Concern based on 200yr +3ft data.
Seepage and Stability Areas of Concern based on analysis at top of structure stage.
0 2,000 4,000 6,000 8,000 10,000 Feet
1:84,835
AMERICAN RIVER, ARCADE CREEK,
NATOMAS EAST MAIN DRAINAGE CANAL,
AND DRY CREEK
PRELIMINARY LEVEE IMPROVEMENTS
ALTERNATIVES 1 & 2
PLATE 3


Relocate Road after
Weir Construction
New Levee with Seepage Berm
& Relief Well System
RXR Spur Excavation
& Weir Widening
Replace & Relocate
Pump Stations
Existing Levee Degrade Areas:
North Bypass, Yolo Bypass, and Sac River
Legend
Existing Levee
Spur Excavation and Weir Widening
New Levee and Seepage Berm
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Feet
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SACRAMENTO RIVER
PRIMARY LEVEE IMPROVEMENTS
ALTERNATIVE 2
PLATE 4
The data depicted in these GIS layers are the result of digital analyses performed on a database consisting of information from a variety of governmental and other credible sources. The accuracy of the information presented is limited to the collective accuracy of the databaseon the date of the analysis. This information is believed accurate, and reasonable efforts have been made to ensure the accuracy of the data.However, the U.S. Army Corps of Engineers, Sacramento District GIS Unit expressly disclaims responsibility for damages or liability that may arise from use of this data.This product is the property of the U.S. Army Corps of Engineers, Sacramento District GIS Team, and this product's use is thereby restricted.

ATTACHMENTS

Attachment A – Hydrology Executive Report (Under Separate Cover)

Attachment B – Hydraulic Appendix Executive Report (Under Separate Cover)

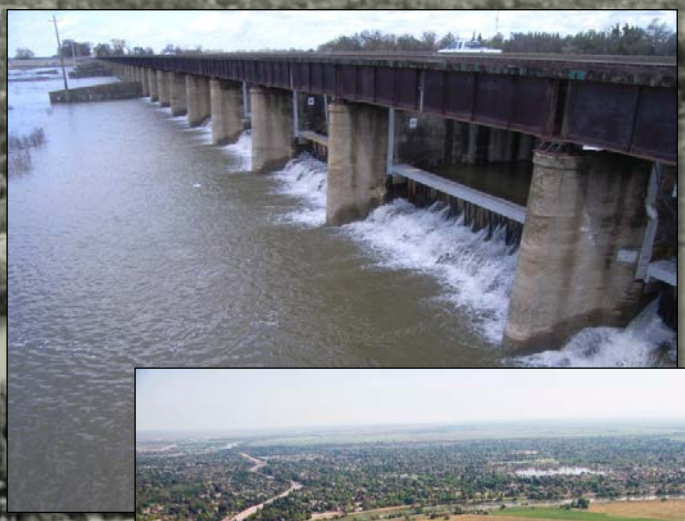
Attachment C – Geotechnical Report (Under Separate Cover)

Attachment D – Cost Engineering (Under Separate Cover)

Attachment E – Erosion Protection Report (Under Separate Cover)

American River Watershed

Common Features
General Reevaluation Report



Attachment A
Hydrology Report

December 2015

Sacramento Area Flood Control Agency

Central Valley Flood Protection Board

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:
Sacramento Weir during operation
Sacramento River facing south near the Pocket and Little Pocket neighborhoods
High flows on the American River at the Highway 160 overcrossing
Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Attachment A
Hydrology Report

U.S. Army Corps of Engineers
Sacramento District

December 2015

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AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Appendix B Hydrology Report Contents

Hydrology Executive Summary

Appendix B1 – Synthetic Hydrology Technical Documentation

Appendix B2 – American River Hydrology and Folsom Dam Reservoir Operations

Appendix B3 – Dry and Arcade Creeks Flow Frequency Curves and Synthetic 8- Flood Series Hydrographs Upstream of Steelhead Creek

Common Features General Reevaluation Report
Hydrology Technical Documentation

EXECUTIVE SUMMARY

Scope. This Attachment (hydrology documentation) describes the development of the existing conditions synthetic hydrology for the greater Sacramento area, which includes the Lower American River and the Natomas Basin. The hydrology documentation includes Common Features General Reevaluation Report (GRR), Appendix B1, Synthetic Hydrology Technical Documentation, dated September 2008, Appendix B2, American River Hydrology and Folsom Dam Reservoir Operations, dated January 2009, and Appendix B3, Dry and Arcade Creeks Flow Frequency Curves and Synthetic 8-Flood Series Hydrographs Upstream of Steelhead Creek, dated January 2010. Documentation referenced here, but not included, is the Technical Studies Documentation, Appendices B and C, for the Sacramento and San Joaquin River Basins Comprehensive Study (Comp Study), dated December 2002.

Background. The scope of this General Reevaluation Report (GRR) covers the greater Sacramento area, which includes the Lower American River and the Natomas Basin. Hydraulic and geotechnical studies of the area have been on-going and have already identified many issues (e.g. seepage, erosion, vegetation, etc) which could lead to levee failure. The latest findings indicate that the Sacramento area is still highly susceptible to flooding due to levee failure even with all the authorized repairs and improvements.

This appendix describes the development of the Folsom Dam discharge hydrographs for the floodplain delineation efforts and the hydrologic data inputs needed for the economic evaluations. The economic analysis will evaluate the extent of the damage caused by levee failures within the basin.

Comprehensive Study Methodology. The Common Features GRR is using existing conditions hydrology, which is anticipated to be adequate for determining exterior stages on all levee reaches surrounding the greater Sacramento area. The existing hydrology for the Common Features GRR is based upon the storm centering method described in the Comp Study Technical Studies Documentation, Appendices B and C: Appendix B of the Comp Study describes the development of unregulated synthetic hydrographs for specific flood frequencies at particular watershed locations; Appendix C of the Comp Study presents the transformation of the unregulated conditions synthetic hydrology to regulated conditions. The Comp Study synthetic hydrology represents the best available information for the large external sources of flooding for the greater Sacramento area and the associated hydrologic models were developed for use in regional, broad concept studies, such as the Common Features GRR.

Synthetic Flood Centerings. Three different flood centerings were investigated in the development of existing conditions hydrology for the Sacramento area: the Sacramento Mainstem at Latitude of Sacramento centering, the Shanghai Bend – Yuba River centering, and the American River centering. These centerings are described in Appendix B1, Synthetic Hydrology Technical Documentation. The American River centering hydrology is described in greater detail in Appendix B2, American River Hydrology and Folsom Dam Reservoir

Operations. This hydrology included analysis of local flooding contribution from the Natomas Cross Canal and Steelhead Creek, as discussed in Appendix B1 and B3.

Existing Conditions Hydrology for Common Features GRR. A series of hypothetical inflow hydrographs (i.e. 50%-, 10%-, 4%-, 2%-, 1%-, 0.5%-, 0.2%-annual chance flood events) were developed for the study. The Comp Study data provides the majority of the input to the hydraulic model. The one exception is the data for the American River. Both the hydrology and routing tool for American River flows differ. For consistency, the same hydrology used in other American River studies, including output from the Excel-based reservoir routing model, was utilized for the Common Features GRR. See Appendix A of the Comp Study – Synthetic Hydrology Technical Documentation, for a discussion on the differences between the Comp Study and the American River studies unregulated hydrographs for the American River. With regard to reservoir outflow hydrographs, the HEC-ResSim reservoir simulation model built for the Comp Study simulates system-wide operation for multiple reservoirs on the Sacramento River along with those on its major tributaries, however the Folsom Dam Excel-based reservoir simulation model provides the means necessary to examine Folsom Dam project features in more detail and is used in this study.

US Army Corps of Engineers
Sacramento District

American River Watershed
Common Features Project
Natomas Post-Authorization Change Report

Appendix B1
Synthetic Hydrology Technical Documentation

September 2008

AMERICAN RIVER WATERSHED COMMON FEATURES PROJECT
NATOMAS POST-AUTHORIZATION CHANGE REPORT
SYNTHETIC HYDROLOGY TECHNICAL DOCUMENTATION

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AMERICAN RIVER WATERSHED COMMON FEATURES PROJECT
NATOMAS POST-AUTHORIZATION CHANGE REPORT
SYNTHETIC HYDROLOGY TECHNICAL DOCUMENTATION

1.0 Documentation for Synthetic Flood Centerings

This chapter cites the documentation used to develop the hydrographs provided to Hydraulic Design Section as input for its calibrated HEC-RAS 4.0 model – the model used to develop water surface profiles for existing conditions (year 2007). Multiple flood centerings were tested to assure that the controlling hydrologic events were used for the hydraulic analysis. Each centering consisted of flow hydrographs developed for the specific frequency events: 50-, 10-, 4-, 2-, 1-, 0.5-, and 0.2 percent exceedence floods (8-Flood Series). The three flood centerings tested were the Sacramento Mainstem, Shanghai Bend-Yuba River, and the American River. The study area includes the Sacramento River from the Natomas Cross Canal down to Freeport and the American River from Folsom Dam down to its confluence with the Sacramento River, as well as the Natomas tributary drainage to the Natomas Cross Canal and to Steelhead Creek. **Plate 1**, the general map, shows the watersheds for the four Natomas tributaries to Steelhead Creek, the five Natomas tributaries to the Natomas Cross Canal, the American River south of the Natomas tributaries, the Feather River at its confluence with the Sacramento River, and the Sacramento River from upstream of Feather River down to its confluence with the American River. **Plate 2** shows where the hydraulic model input locations are for the five hydrographs contributing to the Natomas Cross Canal and the four hydrographs contributing to Steelhead Creek. Steelhead Creek is also known as the Natomas East Main Drainage Canal (NEMDC). The hydrographs are for an unsteady state simulation.

The three different flood centerings mentioned above are being tested in the hydraulic model to see which one produces the highest stages in which locations of the study area. Under certain conditions the American River is the controlling flood event for Steelhead Creek. The Shanghai Bend centering or the Sacramento Mainstem centering may be the controlling flood event for the Natomas Cross Canal. However, which flood centering series will produce the most critical flooding at which locations will not be known without hydraulic analysis.

1.1 Sacramento Mainstem Centering. The flood centering hydrographs were created using the methodology developed in the Comprehensive Study (the "Sacramento and San Joaquin River Basins Comprehensive Study," Technical Studies Documentation, dated December 2002, abbreviated here as Comp Study and described in **Reference 1**). The Comprehensive Study models were developed for use in regional, broad concept studies, such as the Sacramento Common Features General Reevaluation study. **Reference 1, Appendix B**: "Synthetic Hydrology Technical Documentation," describes the development of the unregulated flood hydrographs.

Unregulated flow frequency curves were developed at key mainstem and tributary locations in the Sacramento River basin. The unregulated frequency curves plot historic flood peaks and volumes with the statistical distributions of unimpaired flows (with no reservoir influence). The frequency curves display volumes, or average flow rates, for different time

durations over a range of annual exceedence probabilities. These curves are used to translate: 1) hydrographs to frequencies; and 2) frequencies to flood volumes. As part of the Comprehensive Study (Comp Study), flow frequency curves were developed for 1-, 3-, 7-, 15-, and 30-day durations. A routing model was developed to route the unregulated daily flows from the tributary locations to downstream locations for use in constructing mainstem "index" frequency curves. Mainstem locations include the Sacramento River at the Latitude of Sacramento (including flows down the Yolo Bypass) and the Feather River downstream of the Yuba River (at Shanghai Bend). The maximum flows for each winter at the mainstem locations were used to develop flow frequency curves (for 1-, 3-, 7-, 15-, and 30-day durations) for those mainstem locations. No synthetic precipitation events were needed for the hydrology. This paragraph and the paragraphs below explain the development of the synthetic flood centerings for the latitude of Sacramento; the flood centerings for Shanghai Bend were developed similarly.

Based on analysis of historic floods over the Sacramento watershed, synthetic mainstem flood centerings were developed to stress widespread valley areas. The flow frequency curves for the Latitude of Sacramento (used for the Sacramento Mainstem Centering) provide the hypothetic flood volumes that the basin will produce during simulations of each of the eight synthetic exceedence frequency flood events (50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2percent). The role of the mainstem centering is to distribute these flood volumes back into the basin, tributary by tributary, in accordance with patterns visible in historic flood events. **Reference 1, Appendix C**: "Reservoir Operations Modeling, Existing Design Operations and Reoperation Analysis," describes the development of the reservoir operations models to route the unregulated hydrographs through the headwater and major flood management reservoirs for input into the hydraulic model.

The Sacramento Mainstem flood hydrographs were developed using the flood patterns shown on **Table 1** to produce flood runoff hydrographs centered at the Latitude of Sacramento. **Table 1** shows the set of synthetic exceedence frequencies assigned to the set of tributaries listed in column 1 such that the regulated and routed hydrographs have the volumes for a flood series centered at the Latitude of Sacramento. The hydrographs have a duration of 30 days, with six 5-day waves. The pattern hydrograph used for the 5-day waves at each upstream tributary is that of the unregulated flood hydrograph for 30 December 1996 to 3 January 1997 (New Year 1997 flood) at that tributary index point. This flood pattern was used because, of the large historical floods over the Sacramento Basin, it is the flood event for which hourly hydrographs were available for the largest number of upstream tributary gages used for the Comp Study. The American River flood hydrographs are different from those used in the Comp Study. See **Section 1.3** for an explanation of the changes made for the American River centering.

Table 1
Sacramento River Mainstem Synthetic Flood Centering

Index Point	Percent Chance Exceedence						
	50%	10%	4%	2%	1%	0.50%	0.20%
Sacramento River at Shasta	84.42	17.03	8.09	4.41	2.21	1.13	0.44
Clear Cr. at Whiskeytown	80.91	17.03	10.79	6.47	3.24	1.66	0.65
Cow Cr. near Millville	80.91	16.18	9.71	5.39	2.70	1.38	0.60
Cottonwood Cr. near Cottonwood	80.91	17.03	10.79	6.47	3.24	1.66	0.65
Battle Cr. Below Coleman FH	80.91	16.18	9.71	5.39	2.70	1.38	0.60
Mill Cr. near Los Molinos	80.91	16.18	9.71	4.22	2.35	1.23	0.51
Elder Cr. near Paskenta	88.26	19.42	10.79	4.85	2.70	1.38	0.58
Thomes Cr. at Paskenta	88.26	19.42	10.79	4.85	2.70	1.38	0.58
Deer Cr. near Vina	88.26	16.18	9.71	4.22	2.35	1.23	0.51
Big Chico Cr. near Chico	88.26	16.18	9.71	4.22	2.35	1.23	0.51
Stony Cr. at Black Butte	88.26	19.42	10.79	4.85	2.70	1.38	0.58
Butte Cr. near Chico	66.70	13.63	6.08	2.75	1.38	0.71	0.30
Feather River at Oroville	53.60	11.78	4.42	2.41	1.20	0.62	0.24
Yuba R. at New Bullards Bar	55.09	12.52	4.86	2.10	1.05	0.54	0.21
Yuba R. at Englebright	55.09	12.52	4.86	2.10	1.05	0.54	0.21
Deer Cr. near Smartsville	55.12	12.52	4.86	2.10	1.05	0.54	0.21
Bear River near Wheatland	53.60	11.13	4.42	2.10	1.05	0.54	0.21
Cache Cr. at Clear Lake	52.19	12.52	6.95	4.45	2.22	1.14	0.45
N.F. Cache Cr. at Indian Vy.	52.19	12.52	6.95	4.45	2.22	1.14	0.45
American River at Folsom	55.09	12.52	4.86	2.51	1.26	0.64	0.25
Putah Cr. at Berryessa	52.19	12.52	6.95	4.45	2.22	1.14	0.45

The process of preparing flood hydrographs begins by using unregulated frequency curves to translate all of the exceedence frequencies in the synthetic patterns to average flow rates. The unregulated frequency curves were prepared using 1-, 3-, 7-, 15-, and 30-day durations. Values for the 5-, 10-, 20-, and 25-day durations were obtained through interpolation. The values from the frequency curves represent the average flow anticipated over a specific time interval. For instance, the 5-day value is the average flow expected during the highest 5-days of flooding during any of the eight synthetic exceedence events. Likewise the 10-day value is the average over the highest 10 days of flooding. Flood volumes were computed by multiplying the average flows by their respective durations. These values represented the total volumes of water anticipated during the highest 5, 10, 15, 20, 25, or 30 days of flows. Furthermore, these flood volumes were portioned into time segments by subtracting volumes of the shorter durations from the next longer duration. For example, the 5-day volume was subtracted from the 10-day volume and the remainder was equal to the amount of flood volume that is produced by the tributary between the 5-day and 10-day maximum periods. This procedure was repeated for the 10-, 15-, 20-, 25-, and 30-day durations and resulted in a set of eight synthetic exceedence frequency flood volumes produced by the tributary.

The basic pattern of all synthetic flood hydrographs was a 30-day hourly time series consisting of 6 waves, each 5 days in duration. Volumes were ranked and distributed into the basic pattern. The highest wave volume was always distributed into the fourth, or main, wave.

The second and third highest volumes preceded and followed the main wave, respectively. The fourth highest volume was distributed into the second wave and the fifth highest was distributed into the final of the six waves. The sixth and smallest wave volume was distributed into the first wave of the series. The shape of each wave is identical and the magnitude is determined by the total volume that the wave must convey. The process of converting flow frequency curves into the synthetic series of 30-day hydrographs is depicted on **Plate 3**.

There are several reasons for using a 30-day duration for the synthetic flood hydrographs. The Sacramento River watershed is so large that 5 days is not long enough for a flood wave to travel from the most distant headwater down to the mouth of the Sacramento River. The multi-wave flood hydrograph includes the smaller antecedent waves from storms that prime the watershed for the highest wave. Also, the multi-wave hydrograph is needed to (1) provide the extra flood volume needed to simulate reservoir operation during an extended period of wet weather, and (2) fill the floodplains with enough flood volume to run levee failure scenarios.

Figure 1 shows an example of the 30-day hydrograph with the 5-day waves, for unregulated and regulated conditions. The figure shows the 1 percent exceedence hydrographs, for unregulated and regulated conditions, for the Sacramento River at the confluence with the Feather River, for the Sacramento Mainstem Centering. The hydrograph for unregulated conditions is not a true representation of the hydrograph with six 5-day waves; it is the result from routed contributions of upstream tributaries. See **Figure 2** for an example of a tributary hydrograph with six 5-day waves – the Comp Study hydrograph for Folsom Lake inflow.

Figure 1

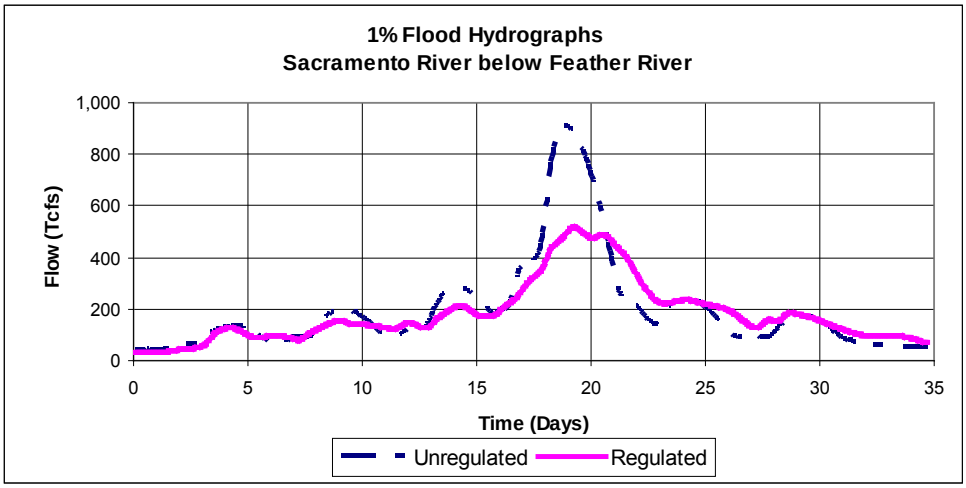
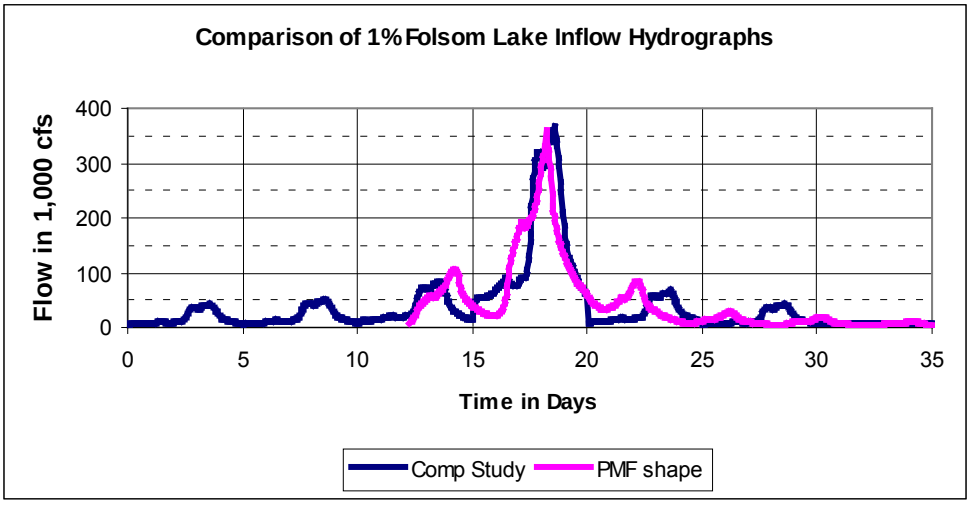


Figure 2



1.2 Shanghai Bend-Yuba River Centering. This flood centering, with a specific centering on the Yuba River and slightly more frequent concurrent event on the Feather River above Oroville, produces the maximum inundation areas along the lower reaches of the Feather and Yuba rivers. It also produces the maximum inundation area at Verona, near the confluence of the Feather River with the Sacramento River. This flood centering was not developed as part of the original Comp Study, but the Comp Study methodology described in **Reference 1** was used to develop the storm centering and flood hydrographs, which were routed through the reservoir system. **Reference 2**, the "Yuba River Basin Project General Reevaluation Report," App. A, Synthetic Hydrology and Reservoir Operations Technical Documentation, dated August 2004, corrected June 2008, documents the hydrology and modeling efforts conducted for the Feather and Yuba rivers using the Comp Study methodology. **Table 2** shows the flood patterns for the Shanghai Bend-Yuba River centering. The American River flood hydrographs are different from those used in the Comp Study. See **Section 1.3** for an explanation of the changes made.

Table 2
Feather River above Shanghai Bend Synthetic Flood Centering A
With a Specific Centering on the Yuba River

Index Point	Percent Chance Exceedence						
	50%	10%	4%	2%	1%	0.50%	0.20%
Sacramento River at Shasta	101.01	20.20	8.08	5.77	2.89	1.44	0.58
Clear Cr. at Whiskeytown	344.83	68.97	27.59	19.70	9.85	4.93	1.97
Cow Cr. near Millville	196.08	39.22	15.69	11.20	5.60	2.80	1.12
Cottonwood Cr. near Cottonwood	344.83	68.97	27.59	19.70	9.85	4.93	1.97
Battle Cr. Below Coleman FH	196.08	39.22	15.69	11.20	5.60	2.80	1.12
Mill Cr. near Los Molinos	76.34	15.27	6.11	4.36	2.18	1.09	0.44
Elder Cr. near Paskenta	140.85	28.17	11.27	8.05	4.02	2.01	0.80
Thomes Cr. at Paskenta	140.85	28.17	11.27	8.05	4.02	2.01	0.80
Deer Cr. near Vina	76.34	15.27	6.11	4.36	2.18	1.09	0.44
Big Chico Cr. near Chico	76.34	15.27	6.11	4.36	2.18	1.09	0.44
Stony Cr. at Black Butte	140.85	28.17	11.27	8.05	4.02	2.01	0.80
Butte Cr. near Chico	76.34	15.27	6.11	4.36	3.18	1.09	0.44
Feather River at Oroville	54.95	10.87	4.35	2.17	1.06	0.53	0.21
Yuba R. at New Bullards Bar	50.00	10.00	4.00	2.00	1.00	0.5	0.20
Yuba R. at Englebright	50.00	10.00	4.00	2.00	1.00	0.5	0.20
Deer Cr. near Smartsville	125.00	25.00	10.00	5.00	2.50	1.25	0.50
Bear River near Wheatland	125.00	25.00	10.00	5.00	2.50	1.25	0.50
Cache Cr. at Clear Lake	153.85	30.77	12.31	6.15	3.08	1.54	0.62
N.F. Cache Cr. at Indian Vy.	153.85	30.77	12.31	6.15	3.08	1.54	0.62
American River at Folsom	76.34	15.27	6.11	3.05	1.53	0.76	0.31
Putah Cr. at Berryessa	153.85	30.77	12.31	6.15	3.08	1.54	0.62

1.3 American River Centering. The flood patterns for the American River specific tributary centering are shown on **Table 3**. The concurrent flood hydrographs for this centering were developed using the Comp Study methodology and hydrograph shapes, based on the January 1997 New Years flood event. However, the American River specific flood hydrographs were developed using a different shape and different volumes**.** For consistency with the ongoing American River Watershed Study, the Folsom Dam inflow hydrograph shape used for the American River Common Features GRR is based upon the Probable Maximum Flood (PMF) for Folsom Dam. Use of this PMF-shape flood hydrograph predates the Comp Study. Development of the revised Folsom Dam PMF is discussed in **Reference 3**, "Folsom Dam and Lake Revised PMF Study," American River Basin, California, Hydrology Office Report, dated October 2001. The PMF was computed using the most recent Probable Maximum Precipitation criteria, presented in **Reference 4**, "Hydrometeorological Report No. 59, Probable Maximum Precipitation for California," U.S. Dept. of Commerce, NOAA, U.S. Dept of the Army Corps of Engineers, Feb 1999).

Table 3
American River Tributary Synthetic Flood Centering

Index Point	Percent Chance Exceedence						
	50%	10%	4%	2%	1%	0.50%	0.20%
Sacramento River at Shasta	250.00	50.00	20.00	10.00	5.00	2.50	1.00
Clear Cr. at Whiskeytown	555.56	111.11	44.44	22.22	11.11	5.56	2.22
Cow Cr. near Millville	178.57	35.71	14.29	7.14	3.57	1.79	0.71
Cottonwood Cr. near Cottonwood	555.56	111.11	44.44	22.22	11.11	5.56	2.22
Battle Cr. below Coleman FH	178.57	35.71	14.29	7.14	3.57	1.79	0.71
Mill Cr. near Los Molinos	121.95	24.39	9.76	4.88	2.44	1.22	0.49
Elder Cr. near Paskenta	138.89	27.78	11.11	5.56	2.78	1.39	0.56
Thomes Cr. at Paskenta	138.89	27.78	11.11	5.56	2.78	1.39	0.56
Deer Cr. near Vina	121.95	24.39	9.76	4.88	2.44	1.22	0.49
Big Chico Cr. near Chico	138.89	27.78	11.11	5.56	2.78	1.39	0.56
Stony Cr. at Black Butte	121.95	24.39	9.76	4.88	2.44	1.22	0.49
Butte Cr. near Chico	138.89	27.78	11.11	5.56	2.78	1.39	0.56
Feather River at Oroville	92.59	18.52	7.41	3.7	1.85	0.93	0.37
Yuba R. at New Bullards Bar	69.44	13.89	5.56	2.78	1.39	0.69	0.28
Yuba R. at Englebright	69.44	13.89	5.56	2.78	1.39	0.69	0.28
Deer Cr. near Smartsville	116.28	23.26	9.30	4.65	2.33	1.16	0.47
Bear River near Wheatland	116.28	23.26	9.30	4.65	2.33	1.16	0.47
Cache Cr. at Clear Lake	192.31	38.46	15.38	7.69	3.85	1.92	0.77
N.F. Cache Cr. at Indian Vy.	192.31	38.46	15.38	7.69	3.85	1.92	0.77
American River at Folsom	50.00	10.00	4.00	2.00	1.00	0.50	0.20
Putah Cr. at Berryessa	192.31	38.46	15.38	7.69	3.85	1.92	0.77

Also, the American River Watershed Study unregulated flow frequency curves for the American River were revised when the period of record was updated through 2004. See **Reference 5**, "Rain Flood Flow Frequency Analysis, American River California," Office Report, U.S. Army Corps of Engineers, Sacramento District, dated August 2004. Revision of the flood frequency curves changed the flood volumes used for the American River hydrographs for the 8-Flood Series. **Figure 2** is a graphical presentation of the flood inflow hydrographs to Folsom Lake, comparing the Comp Study 1 percent flood with the PMF-shape 1 percent flood. The graph presents the maximum 72-hour period as coincident for the two flood hydrographs for days 17 through 19.

Because the PMF-shape hydrographs for the Folsom Lake inflow are different from the Comp Study hydrographs, a volume comparison was made between the hydrographs for various exceedence events. This comparison was made to ensure that use of the PMF-shape hydrographs would not cause problems and inconsistencies. **Table 4** presents a volume comparison between the two different hydrograph shapes for the American River flood series above Folsom Dam. The table shows that the differences in volume are minor.

Table 4
Hydrograph Volume Comparison for
Inflow Hydrographs to Folsom Lake

% Event Flood	1-Day Volume (in day cfs)	3-Day Volume (in day cfs)	7-Day Volume (in day cfs)
10% (PMF Shape) 10% (Comprehensive Study) % Difference	101,000 113,000 12%	71,000 70,000 -1%	43,000 46,000 7%
4% (PMF Shape) 4% (Comprehensive Study) % Difference	156,000 174,000 10%	110,000 108,000 -2%	66,000 67,000 1%
2% (PMF Shape) 2% (Comprehensive Study) % Difference	207,000 229,000 10%	145,000 142,000 -2%	87,000 86,000 -1%
1% (PMF Shape) 1% (Comprehensive Study) % Difference	266,000 292,000 9%	187,000 181,000 -3%	112,000 107,000 -5%
0.5% (PMF Shape) 0.5% (Comprehensive Study) % Difference	334,000 363,000 8%	235,000 226,000 -4%	141,000 131,000 -8%
0.2% (PMF Shape) 0.2% (Comprehensive Study) % Difference	440,000 475,000 7%	309,000 300,000 -3%	185,000 169,000 -9%
The flow comparison is presented in Table 4 in "% Difference", which shows how much the Comprehensive Study hydrograph volume differs from the PMF shape hydrograph volume. Hydrographs are for unregulated inflow conditions.			

The PMF-shape hydrographs were routed through Folsom Dam for three without-project alternatives. In preparation for routing the PMF-shape hydrographs through Folsom Dam, the maximum 72-hour period of the PMF-shape was lined up to occur at the same time as the Comp Study American River hydrograph. See **Figure 2** above. For the PMF-shape hydrographs, the maximum 3-day flow occurs closer to the beginning of the hydrograph. As a result, outflow from Folsom Dam for the PMF-shape hydrographs does not begin until 6 p.m. of day 12 after the start of the Comp Study hydrographs for the other Sacramento River tributaries. A constant flow of 2,000 cfs was used for outflow from Folsom Dam for days 1 through 6pm of day 12 for the PMF shape flood hydrographs.

2.0 Development of Historical Flood Hydrographs for Natomas Tributaries

Historical flow hydrographs for the Natomas tributaries were developed as upstream boundary conditions on the Natomas Cross Canal and Steelhead Creek (also known as Natomas East Main Drainage Canal), for testing of the hydraulic model. The upstream boundary locations for the Natomas tributaries are shown on **Plate 2.** Six large historical flood events were chosen for which Natomas tributary flood hydrographs would be developed. The six flood events are 15 - 19 February 1986, 8 - 12 January 1995, 29 December 1996 - 3 January 1997, 22 - 26 January 1997, 2 - 6 February 1998, and 30 December 2005 - 3 January 2006. The selection of flood events was based on the amount of available precipitation data and whether any flow data, either a hydrograph or mean day flow, were available for the Dry Creek at Roseville gaging station. Hydrographs for the six floods on the Sacramento, Feather, and American rivers were available for use in the hydraulic model. The effect of any additional contribution from the Natomas tributaries could then be tested in the model. Also, from the frequency analysis presented in the Natomas General Reevaluation Report Hydrology Appendix (**Reference 6**), frequencies could be assigned to these flood events for the Natomas tributaries, which could then be compared with the magnitudes of these events on the mainstem Sacramento and American rivers for the Coincident Frequency Analysis.

This chapter discusses the computation of historical flood hydrographs first for the Steelhead Creek tributaries and then for the Natomas Cross-Canal tributaries. The historical flood hydrographs were easier to develop for Steelhead Creek because calibrated HEC-1 models had been developed in previous studies for the tributaries, an extensive network of precipitation gages covers the watershed, and hydrographs or mean day flows exist for the six flood events for the Dry Creek at Roseville gage. A mean day flow record is available for four of the six floods at the Arcade Creek near Del Paso Heights gage. **Table 5** shows what flow data are available for which storm events. Station locations are shown on **Plate 1**.

Table 5
Available Flow Data for 6 Historical Flood Events

Stream---> Gage Location--->	Dry Cr Royer Park	Dry Cr Vernon St.	Magpie Cr Del Paso Hghts	Arcade Cr Del Paso Hghts
CDEC Code or USGS Number	CDEC RYP	CDEC VRS	USGS 11447330	CDEC ACK
FLOOD EVENT	D.A. (sq.mi.) 58.63*	D.A. (sq.mi.) 77.75*	D.A. (sq.mi.) 2.30*	D.A. (sq.mi.) 31.83*
15-19 February 1986	N/A	Hydrograph	N/A	N/A
8-12 January 1995	N/A	Hydrograph	N/A	N/A
29 Dec 96 - 3 Jan 97	N/A	Mean Day	Mean Day	Mean Day
22-26 January 1997	N/A	Mean Day	Mean Day	Mean Day
2-6 February 1998	N/A	Mean Day	N/A	Mean Day
30 Dec 05 - 3 Jan 06	hydrograph	Hydrograph	N/A	Mean Day

N/A = Not Available

* = drainage area in HEC-1 model, not drainage area associated with DWR or USGS gage

Some of the precipitation gages used for the December 2005 storm isohyetal map were not available for the earlier flood events. These are mostly the stations on the Wunderground Web site and are not included in **Table 6**. **Table 6** below lists the National Climatic Data Center (NCDC) stations and California Data Exchange Center (CDEC) stations used to develop the storm isohyetal maps for one or more of the six historical flood events. **Table 6** also lists the station precipitation amounts for the 6 storms. **Plate 4** shows the locations of the precipitation gages listed in **Table 6** and the streamflow gages listed in **Table 5**.

Table 6

Precipitation Gages - Storm Totals for 6 Historical Storm Events

STATION	DATA SOURCE	CDEC STATION CODE	STORM EVENT AND PRECIPITATION (INCHES)					
			1986 15-19 FEB	1995 8-12 JAN	1996 - 97 29 DEC - 2 JAN	1997 22-26 JAN	1998 2-6 FEB	2005 - 06 30 DEC - 3 JAN
Arcade Cr-Winding Way	CDEC	AMC	N/A	N/A	** 3.93	** 6.34	** 5.79	** 4.93
Arden	CDEC	ARW	** 9.09	5.74	** 3.34	** 5.59	** 5.00	4.49
Auburn	NCDC	---	12.83	8.96	7.28	7.95	5.70	N/A
Auburn Dam Ridge	CDEC	ADR	N/A	N/A	** 6.93	** 7.84	** 5.55	4.60
CSUS	CDEC	CSU	N/A	N/A	N/A	N/A	N/A	4.80
Camp Far West	CDEC	CFW	N/A	N/A	N/A	N/A	N/A	4.63
Caperton Reservoir	CDEC	CPR	N/A	N/A	** 4.65	** 5.67	** 5.63	** 4.64
Chicago	CDEC	CHG	** 7.96	N/A	3.82	5.75	2.68	4.69
Cresta Park	CDEC	CRP	9.37	N/A	3.86	6.50	4.88	4.49
Englebright Dam	CDEC	ENG	N/A	5.48	6.20	6.56	4.83	N/A
Folsom Dam	CDEC	FLD	9.53	N/A	2.13	3.58	3.03	4.72
Folsom WTP	CDEC	FWP	N/A	N/A	N/A	N/A	5.94	N/A
Grass Valley #2	NCDC	---	** 14.9	9.51	14.73	10.77	8.69	N/A
Grass Valley	CDEC	GVY	N/A	N/A	N/A	N/A	N/A	10.72
Hurley	CDEC	HUR	N/A	N/A	2.78	3.56	3.91	4.55
Lincoln	CDEC	LCN	N/A	** 5.19	N/A	3.46	** 5.15	4.34
Loomis Observatory	CDEC	LMO	N/A	N/A	3.74	6.38	4.89	3.89
Navion	CDEC	NVN	** 9.54	N/A	N/A	6.07	5.94	N/A
Newcastle-Pineview Sch.	CDEC	NCS	N/A	N/A	** 4.96	** 6.74	** 5.94	4.93
Orangevale	CDEC	ORN	** 6.67	N/A	3.94	5.67	6.26	4.85
Rancho Cordova	CDEC	RNC	7.76	N/A	3.54	5.50	5.24	4.61
Represa	NCDC	---	7.03	5.24	3.52	4.47	4.53	3.89
Rio Linda	CDEC	RLN	** 7.28	N/A	** 2.92	** 4.77	** 5.32	** 3.90
Roseville City Hall	#	---	9.34	N/A	N/A	N/A	N/A	N/A
Roseville Fire Stn	CDEC	RSV	N/A	N/A	3.62	** 5.63	N/A	3.76
Roseville WTP	CDEC	RTP	** 8.76	N/A	** 4.30	** 6.30	** 5.95	** 5.01
Royer Park	CDEC	RYP	N/A	N/A	** 3.86	** 6.50	** 6.10	** 4.08
Sac Exec AP	NCDC	---	6.72	5.11	2.79	5.65	4.69	4.70
Sac Metro AP	CDEC	SMF	N/A	4.30	5.51	5.74	3.70	3.56
Sacramento 5 ESE	NOAA	---	7.68	5.89	2.22	4.71	4.54	5.02
Sacramento City	#	---	8.12	N/A	N/A	N/A	N/A	N/A
Sacramento Post Office	CDEC	SPO	N/A	5.89	2.46	4.75	4.60	N/A
Sierra College	#	---	9.05	N/A	N/A	N/A	N/A	N/A
Sunrise Blvd	#	---	6.82	N/A	N/A	N/A	N/A	N/A
Van Maren	CDEC	VNM	** 8.90	N/A	** 3.98	** 5.95	** 5.98	N/A
Wheatland 2NE	NCDC	---	4.90	4.40	N/A	N/A	N/A	N/A

N/A = Not Available or Missing Record

** = Recording Rain Gage pattern used to distribute this storm in HEC-1 Model

= Data from Dry Creek Basin Hydrology Report dated April 1988

2.1 Steelhead Creek Historical Flood Hydrographs.

a. December 2005 Flood. The December 2005 – January 2006 rainflood event was used to validate the HEC-1 models for Dry and Arcade creeks in **Reference 6**, the Natomas GRR Hydrology Appendix, dated October 2006. **Plate 5** shows the December 2005 – January 2006 storm isohyetal map, and **Figure 3** shows the comparison between the observed and computed hydrographs for Dry Creek at Vernon Street. The HEC-1 model was used to compute flood hydrographs at the streamgage locations, route the flows down to the downstream index locations, add the local flow above Steelhead Creek, and compute flood hydrographs for Upper NEMDC and Old Magpie Creek above and below their respective pumping stations. The computed flood hydrographs for Dry Creek at Steelhead Creek, Arcade Creek at Steelhead Creek, Upper NEMDC above and below the NEMDC Stormwater Pumping Station, and Old Magpie Creek above and below Pump 157, were provided to Hydraulic Design Section as historical flood input for this flood event. The pumping station locations are shown on **Plate 1**.

Figure 3 presents the flood hydrograph from the HEC-1 run for Dry Creek at Roseville compared with the observed hydrograph. **Table 7** presents a comparison for the peak, and 1-, 3-, and 5-day volumes between the computed hydrographs and the observed hydrographs for the Dry Creek and Arcade Creek gaging stations.

Figure 3

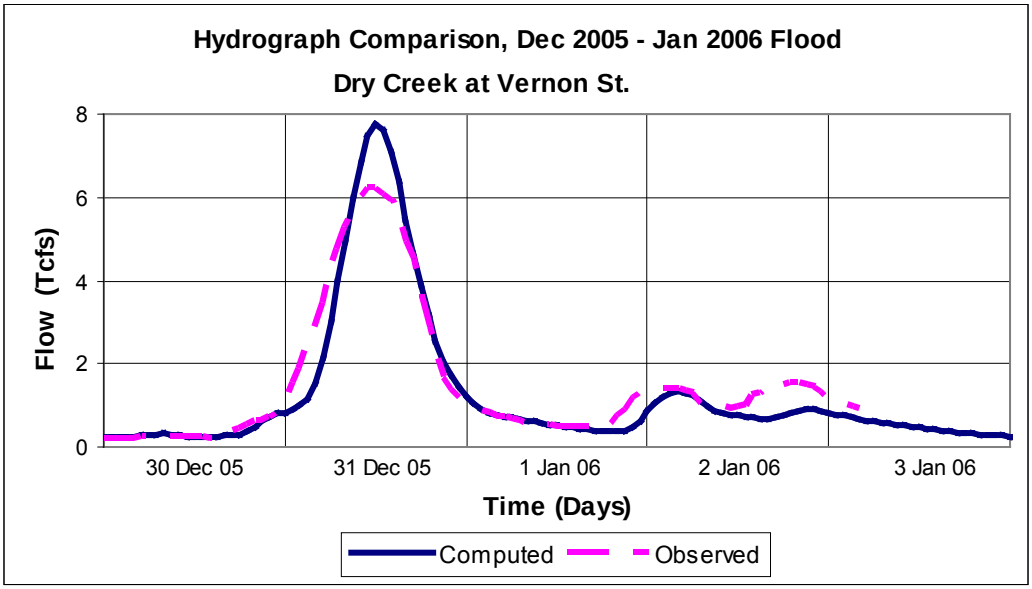


Table 7
30 December 2005 - 3 January 2006 Flood Volume Comparison
For Three Steelhead Creek Tributary Streamflow Gaging Stations

Hydrograph	Peak (cfs)	1-Day Vol. (avg cfs)	3-Day Vol. (avg cfs)	5-Day Vol. (avg cfs)
Dry Creek at Royer Park				
Observed Hydrograph	5,240	3,040	1,620	------
2006 HEC-1 Run	6,230	2,870	1,330	916
% Difference	18.9%	-5.6%	-17.9%	------
Dry Creek at Vernon St.				
Observed Hydrograph	6,250	3,820	1,930	1,424
2006 HEC-1 Run	7,760	3,920	1,810	1,252
% Difference	24.2%	2.6%	-6.2%	-12.1%
Arcade Cr. near Del Paso Heights				
Observed Hydrograph	3,460	1,900	835	536
2006 HEC-1 Run	3,240	1,870	846	561
% Difference	-6.4%	-1.6%	1.3%	4.6%

b. February 1986 Flood**.** According to **Reference 7,** Dry Creek, Placer and Sacramento Counties, California, Hydrology Office Report, revised April 1988, runoff from a large storm event like that of February 1986, can only be estimated, due to a lack of adequate streamflow data. The Dry Creek gage does not function correctly for flows above 2,000 cfs. Peak flows above that are estimated using highwater marks and slope-area measurements by the State of California. The peak flow of 13,100 cfs and associated one-day flow of 5,800 cfs listed in **Reference 7** for the February 1986 flood for Dry Creek at the Vernon Street gage are based upon a flood reconstitution, using the HEC-1 model and rainfall recording data. The flood reconstitution HEC-1 run could not be located, but available data included the reconstituted flood hydrograph for Dry Creek at Roseville, 5-day storm totals, and rainfall recording data for several stations.

Plate 6 shows the isohyetal map created for the 15 - 19 February 1986 storm, based on the station precipitation totals listed on **Table 6**. **Plate 6** may not necessarily be an accurate isohyetal map of the storm, but it shows approximate isolines of the 5-day storm amounts used in the HEC-1 model to develop the flood hydrographs for the Natomas tributaries. Eight precipitation gages used for storm distribution patterns are identified with "**" in the February 1986 rainfall column of **Table 6**. For subbasins above the Dry Creek at Roseville gage, the base flow parameters in the HEC-1 model are:

STARTQ = 9 cfs/sq.mi.
QRCSN = -0.1
RTIOR = 1.05

No base flow was used for the lower elevation subbasins in the Steelhead Creek watershed. Loss rates used were zero initial loss and 0.10 inch per hour constant loss. The watershed was wet from three days of rain prior to 15 February, the start of the maximum five-day flow.

The HEC-1 model was run to develop flood hydrographs for this storm for the four tributaries to Steelhead Creek. **Figure 4** presents the flood hydrograph from the HEC-1 run for Dry Creek at Roseville compared with the previously reconstituted flood hydrograph from **Reference 7**. **Table 8** presents a comparison for the peak, and 1-, 3-, and 5-day volumes for the two hydrographs.

Figure 4

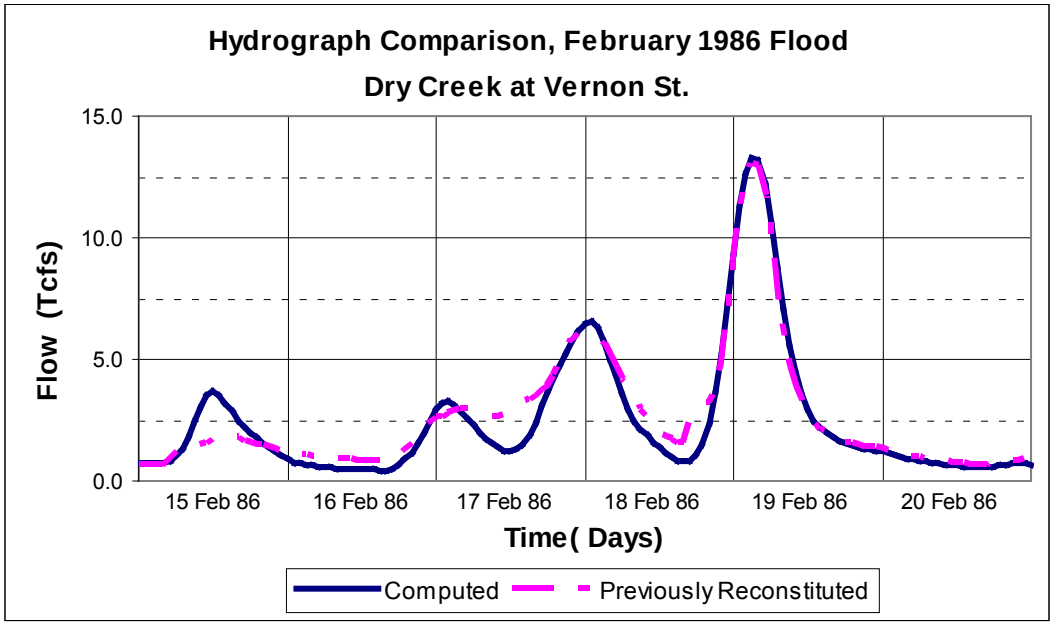


Table 8
15 – 19 February 1986 Flood Volume Comparison
Dry Creek at Roseville Gage

Hydrograph	Peak (cfs)	1-Day Vol. (avg cfs)	3-Day Vol. (avg cfs)	5-Day Vol. (avg cfs)
Ref 7 Hydrograph (1988)	13,100	5,930	4,160	2,980
2008 HEC-1 Run	13,000	5,980	3,810	2,850
% Difference	-0.8%	0.8%	-8.4%	-4.4%

c. January 1995 Flood. The 8 - 12 January 1995 storm had a very intense 6-hour period of rainfall the evening of 9 January that produced the peak flow of record on Dry Creek. **Reference 8**, "Use of Radar-Rainfall Estimates to Model the January 9 - 10, 1995 Floods in Sacramento, CA," paper presented October 1995, explains how data from a network of rain

gages were combined with radar-rainfall estimates from the National Weather Service WSR-88D radar observations to reconstitute the flood hydrograph for Dry Creek at Roseville and estimate flood hydrographs for other locations in the watershed. The HEC-1 model used a 5-minute time increment for one hundred small subbasins above the Dry Creek at Roseville gage for a 3-day hydrograph. Each subbasin or small group of subbasins had its own rainfall distribution pattern.

The Natomas GRR study is more concerned with 5-day volumes than those of shorter duration, so the rainfall period was extended back one day, to include 8 January. The Natomas GRR HEC-1 model listed in **Reference 6,** Attachment 1 was used instead of the 5-minute HEC-1 model described in **Reference 8**. The **Reference 6** model has 28 subbasins above the Dry Creek at Roseville gage instead of the 100 subbasins in the **Reference 8** model. The nearly one hundred 5-minute rainfall distribution patterns in the **Reference 8** HEC-1 model were reduced to eight patterns to distribute the January 1995 storm for the Natomas GRR HEC-1 model. The 5-minute rainfall distribution patterns were converted to hourly increments, and extended back to 8 January using the CDEC rainfall gage for Lincoln (LCN). **Plate 7** is not an accurate isohyetal map of the storm, but it shows approximate isolines of the 5-day storm amounts used in the HEC-1 model to develop the flood hydrographs for the Natomas tributaries. The isolines were based on the station precipitation totals listed on **Table 6** and subbasin storm totals in the **Reference 8** HEC-1 model. Very little rain fell on 11-12 January. The HEC-1 model for this American River GRR study was run for a 5-day time period. For subbasins above the Dry Creek at Roseville gage, the base flow parameters in the HEC-1 model are:

STARTQ = 3 cfs/sq.mi.
QRCSN = -0.1
RTIOR = 1.10

No base flow was used for the rest of the Steelhead Creek watershed. Loss rates used were zero initial loss and 0.10 inch per hour constant loss.

The HEC-1 model was run to develop flood hydrographs for this storm for the four tributaries to Steelhead Creek. **Figure 5** presents the flood hydrograph from the HEC-1 run for Dry Creek at Roseville compared with the observed flood hydrograph shown on Figure 12 of **Reference 8**, the radar-rainfall report. The rainfall distribution patterns used in the HEC-1 model produced a hydrograph with two peaks flows, not one. The higher peak is still similar in magnitude and timing to the observed peak, and the three-day volumes are nearly the same. **Table 9** presents a comparison for the peak, and 1-, and 3-day volumes for the two hydrographs. The computed Dry Creek hydrograph has only a single peak by the time it is routed down to Steelhead Creek and added to the local flow.

Figure 5

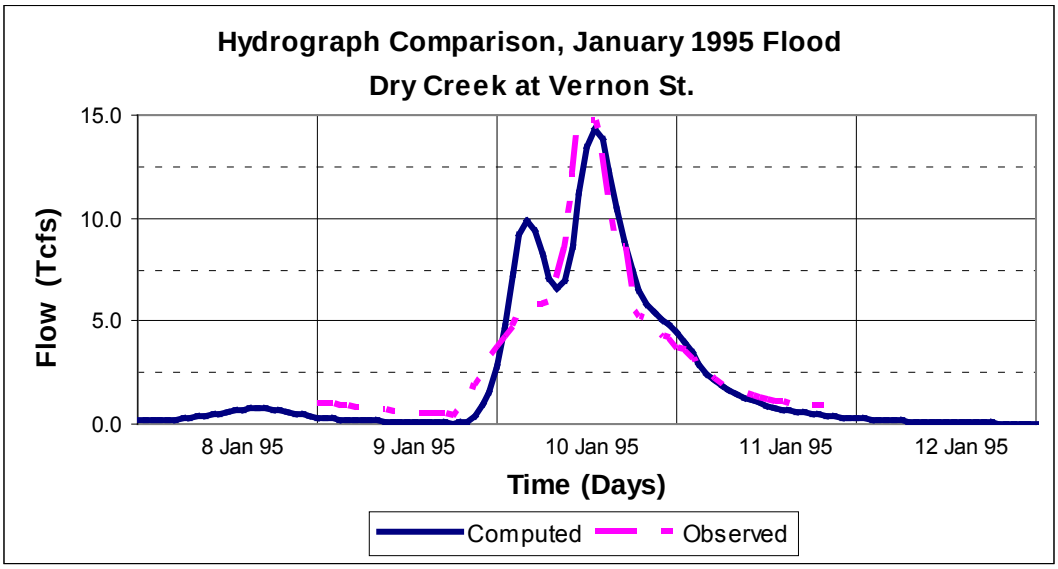


Table 9
8 – 12 January 1995 Flood Hydrograph Comparison
Dry Creek at Roseville Gage

Hydrograph	Peak (cfs)	1-Day Vol. (avg cfs)	3-Day Vol. (avg cfs)	5-Day Vol. (avg cfs)
Observed Hydrograph	14,800	7,580	3,380	------
2008 HEC-1 Run	14,400	8,390	3,360	2,120
% Difference	-2.7%	10.7%	-0.6%	------

d. 29 Dec 1996 – 3 Jan 1997 Flood. Recording rainfall data for numerous stations were available on the CDEC website for January 1997. **Table 6** lists the storm totals for these and the daily rainfall stations. The 5-day storm period for the 1997 New Years storm is from 29 December 1996 to 2 January 1997. An isohyetal map was created, based on the storm amounts for this time period, shown on **Table 6**, and subbasin storm amounts were estimated for the HEC-1 model. Nine precipitation stations, identified with "**" in the Dec '96 – Jan '97 rainfall column of **Table 6**, were used as rainfall distribution patterns in the HEC-1 model. For subbasins above the Dry Creek at Roseville gage, the base flow parameters in the HEC-1 model are:

STARTQ = 3 cfs/sq.mi.
QRCSN = -0.1
RTIOR = 1.05

No base flow was used for the rest of the Steelhead Creek watershed. Loss rates used were zero initial loss and 0.10 inch per hour constant loss.

The HEC-1 model was run to develop flood hydrographs for this storm for the four tributaries to Steelhead Creek. These hydrographs are of greater importance than merely as reconstituted hydrographs for this flood event. The shapes of these computed hydrographs for the 5-day period 30 Dec 1996 to 3 Jan 1997 are used as the 5-day pattern hydrographs in the Coincident Frequency Analysis. The 5-day flood hydrograph patterns used in the Comprehensive Study as Sacramento River tributary input hydrographs, prior to their re-distribution to the upstream reservoirs for the Comp Study reservoir operations modeling, are either the observed or computed unregulated tributary hydrographs for that 5-day period, 30 Dec 1996 to 3 Jan 1997. With all the tributary hydrographs for the same 5-day period, timing for high flows on the Natomas tributaries should historically match their actual timing with respect to timing of the other streams, including the Sacramento River at Verona flood hydrograph for the New Year 1997 flood event.

The observed flows for this flood event at the stream gages on Dry and Arcade creeks and the flood hydrographs routed to the downstream index points showed the flood to be a 30 percent chance or more frequent event for Natomas, compared with the large, low frequency flows occurring on many other Sacramento River tributaries. It would be difficult to justify basing the shapes of floods up to the 0.2 percent event upon a 30 percent chance event, so the HEC-1 model was revised. The observed storm amounts were raised by between 15 and 45 percent, to compute a somewhat rarer flood event, on which to base the synthetic flood hydrographs. With enhanced rainfall and higher runoff, the 8-Flood Series flood patterns are based on a 15 percent chance 5-day flood event. Exceedence estimates of the 5-day volumes for the six historic floods are discussed in **Section 2.1.g**. **Plate 8** shows the revised isohyetal map with the higher rainfall amounts used to develop subbasin storm totals in the HEC-1 model to develop Natomas tributary flood hydrographs

Figure 6 presents the flood hydrograph from the HEC-1 run with the increased rainfall for Dry Creek at Roseville compared with the observed mean day flow hydrograph for the Vernon Street gage. **Figure 7** presents the flood hydrograph from the HEC-1 run for Arcade Creek near Del Paso Heights USGS gage compared with the observed mean day flow hydrograph for the gage. The bars on **Figures 5 and 6** represent the observed peak flows for Dry and Arcade creeks at their respective gaging stations. **Table 10** presents a comparison for the peak, and 1-, and 3-day volumes between the computed hydrograph and the mean day flow hydrograph published for the gage. The 5-day period, 30 December 1996 to 3 January 1997, is the period for which the computed 5-day hydrographs for Dry and Arcade creeks at their confluences with Steelhead Creek and Upper NEMDC and Old Magpie Creek above their respective pumping stations are the pattern hydrographs used for the 8-Flood synthetic series.

Figure 6

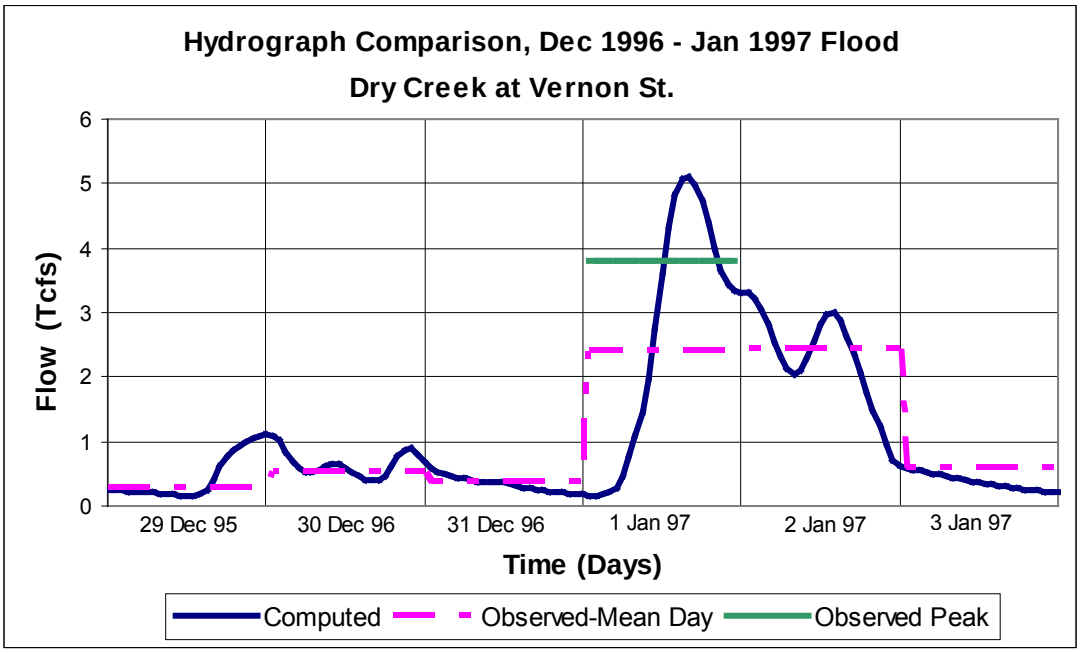


Figure 7

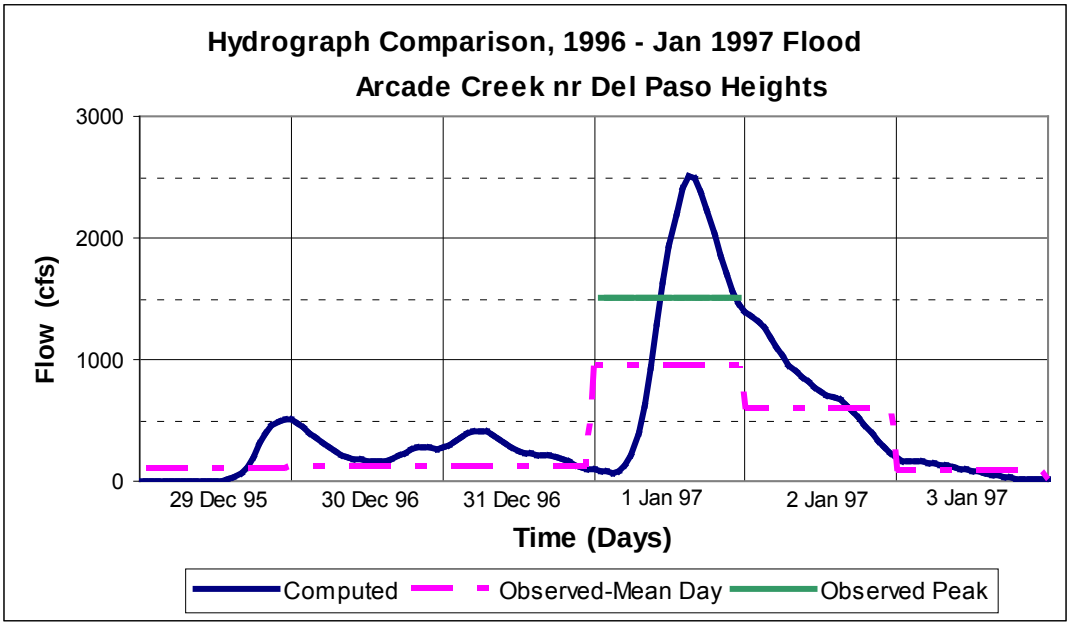


Table 10

29 December 1996 – 3 January 1997 Flood Volume Comparison

For Three Steelhead Creek Tributary Streamflow Gaging Stations

Hydrograph	Peak (cfs)	1-Day Vol. (avg cfs)	3-Day Vol. (avg cfs)	5-Day Vol. (avg cfs)
Dry Creek at Vernon St.				
Observed Hydrograph	3,800	2,440	1,810	1,262
2008 HEC-1 Run	5,120	3,470	1,770	1,303
% Difference	34.7%	42.2%	-2.2%	3.3%
Magpie Cr. near Del Paso Heights				
Observed Hydrograph	N/A	81	35	25
2008 HEC-1 Run	320	108	47	31
% Difference	------	33.3%	35.6%	22.0%
Arcade Cr. near Del Paso Heights				
Observed Hydrograph	1,510	945	551	373
2008 HEC-1 Run	2,507	1,630	778	558
% Difference	66.0%	72.5%	41.2%	49.5%

e. Mid-January 1997 Flood. The mid-January 1997 flood was not an especially rare flood event for the higher elevation tributaries to the Sacramento River. However, for the Natomas tributaries, the mid-January rainfall was greater than for the New Year 1997 storm a few weeks earlier. The greater mid-January rainfall is reflected in the higher peak flows and runoff volumes for this event on the Natomas tributaries. Compare the difference between the Dry Creek hydrographs shown on **Figure 6** and **Figure 8**. The peak flow on Arcade Creek was 150 percent of the peak flow there three weeks earlier. The rainfall from **Table 6** for the 22-26 January 1997 storm was used to develop a storm isohyetal map for the HEC-1 model. **Plate 9** may not necessarily be an accurate isohyetal map of the storm, but it shows approximate isolines of the 5-day storm amounts used in the HEC-1 model to develop the flood hydrographs for the Natomas tributaries. The observed mean day flood hydrographs for Vernon Street, Magpie Creek and Arcade Creek near Del Paso Heights were used as the observed hydrographs for the comparison between observed and computed flood hydrographs in **Table 11**. Ten precipitation stations, identified with "**" in the 22-26 January 1997 rainfall column of **Table 6**, were used as storm distribution patterns. For subbasins above the Dry Creek at Roseville gage, the base flow parameters in the HEC-1 model are:

STARTQ = 3 cfs/sq.mi.
QRCSN = -0.1
RTIOR = 1.05

No base flow was used for the rest of the Steelhead Creek watershed. Loss rates used were zero initial loss and 0.10 inch per hour constant loss.

The HEC-1 model was run to develop flood hydrographs for this storm for the four tributaries to Steelhead Creek. **Figure 8** presents the flood hydrograph from the HEC-1 run for Dry Creek at Roseville compared with the mean day hydrograph observed for the Vernon Street gage. Timing of the observed peak flows of 7,950 cfs and 7,250 cfs is based on the time that the highest stages occurred. The computed peak flows are not the same as the observed peak flows, but the observed peak flows are only one hour earlier than the computed peak flows, which is better timing than for the New Year 1997 flood hydrograph reproduction. There is not much difference between the computed and the observed 5-day flood volumes for Dry Creek. **Table 11** presents a comparison for the peak, and 1-, 3-, and 5-day volumes for the three gaging stations.

Figure 8

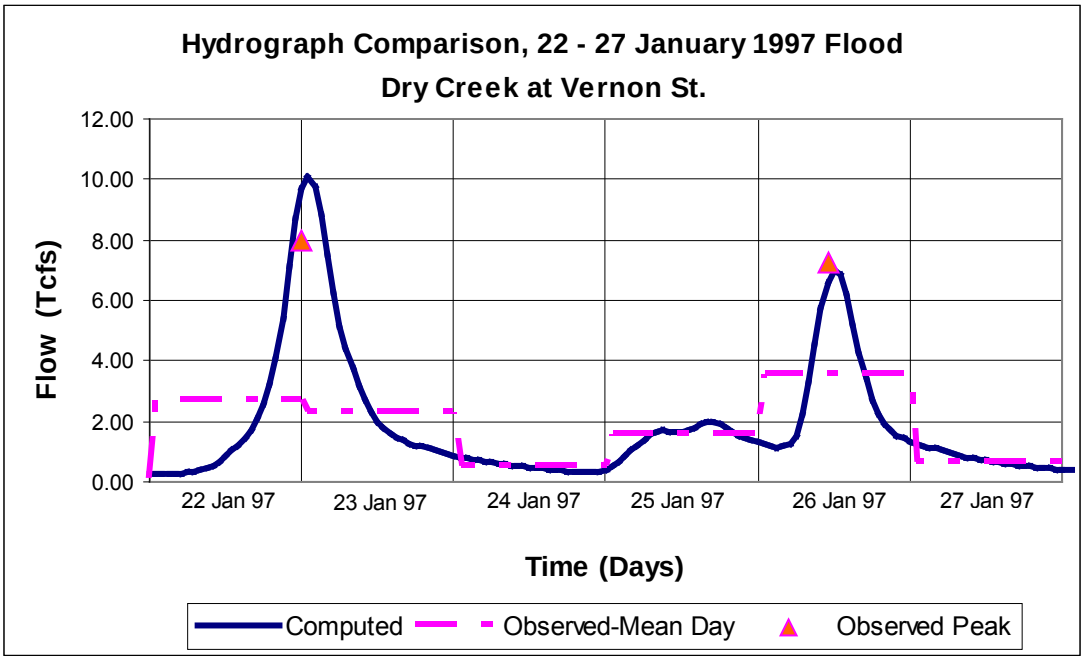


Table 11
22 - 26 January 1997 Flood Volume Comparison
For Three NEMDC Tributary Streamflow Gaging Stations

Hydrograph	Peak (cfs)	1-Day Vol. (avg cfs)	3-Day Vol. (avg cfs)	5-Day Vol. (avg cfs)
Dry Creek at Vernon St.				
Observed Hydrograph	7,950	3,550	1,886	2,142
2008 HEC-1 Run	10,060	4,810	2,200	2,204
% Difference	26.5%	35.5%	16.6%	2.9%
Magpie Cr. near Del Paso Heights				
Observed Hydrograph	560	128	47	47
2008 HEC-1 Run	570	107	45	49
% Difference	1.8%	-16.4%	-4.5%	3.2%
Arcade Cr. near Del Paso Heights				
Observed Hydrograph	2,270	1,090	591	679
2008 HEC-1 Run	3,410	1,730	714	748
% Difference	50.2%	58.7%	20.8%	10.2%

f. February 1998 Flood. Another large storm occurred over the Natomas tributaries watershed in February 1998. The storm amounts for 2 - 6 February 1998 on **Table 6** were used to create a storm isohyetal map for the event, and subbasin storm amounts were used in the HEC-1 model. **Plate 10** may not necessarily be an accurate isohyetal map of the storm, but it shows approximate isolines of the 5-day storm amounts used in the HEC-1 model to develop the flood hydrographs for the Natomas tributaries. The observed mean day flood hydrographs for the Vernon Street and Arcade Creek near Del Paso Heights gages were used for the comparison between the observed and computed flood hydrographs. Ten precipitation stations, identified with "**" in the 2-6 February 1998 rainfall column of **Table 6**, were used as storm distribution patterns. For subbasins above the Dry Creek at Roseville gage, the base flow parameters in the HEC-1 model are:

STARTQ = 3 cfs/sq.mi.
QRCSN = -0.1
RTIOR = 1.05

No base flow was used for the rest of the Steelhead Creek watershed. Loss rates used were zero initial loss and 0.10 inch per hour constant loss.

The HEC-1 model was run to develop flood hydrographs for this storm for the four tributaries to Steelhead Creek. **Figure 9** presents the flood hydrograph from the HEC-1 run for Dry Creek at Roseville compared with the mean day hydrograph observed for the Vernon Street gage. The observed peak flow at Vernon Street gage occurred two hours earlier than the computed peak flow in the HEC-1 run. There is not much difference between the computed and

the observed 5-day flood volumes for the Dry and Arcade creek gages. **Table 12** presents a comparison for the peak, and 1-, 3-, and 5-day volumes for the two gaging stations.

Figure 9

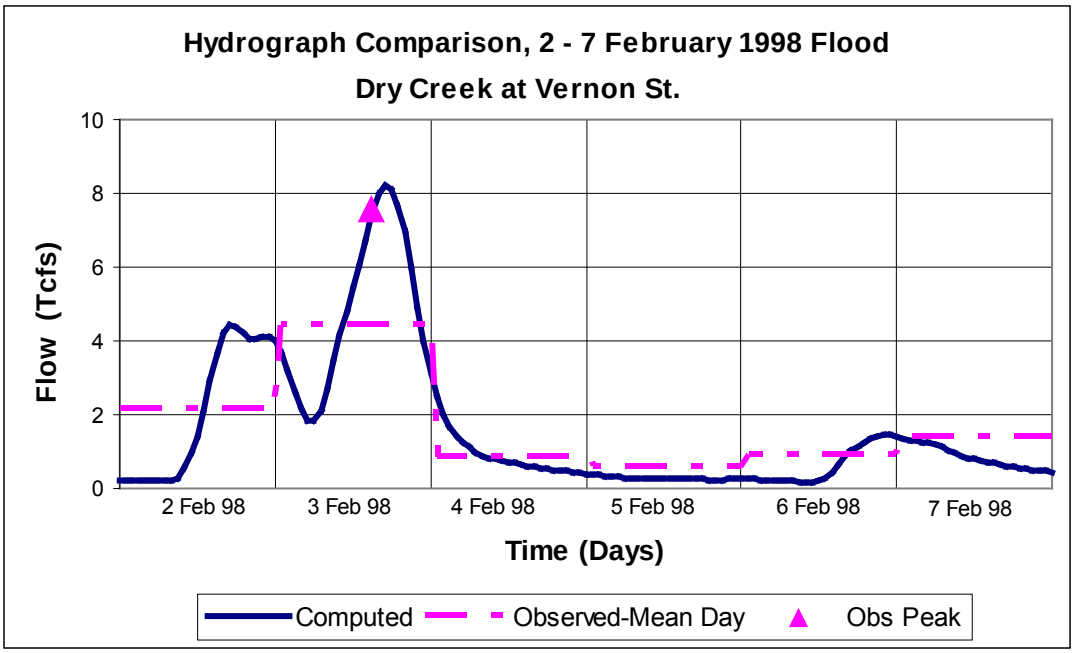


Table 12
2 - 6 February 1998 Flood Volume Comparison
For Two Steelhead Creek Tributary Streamflow Gaging Stations

Hydrograph	Peak (cfs)	1-Day Vol. (avg cfs)	3-Day Vol. (avg cfs)	5-Day Vol. (avg cfs)
Dry Creek at Vernon St.				
Observed Hydrograph	7,549	4,420	2,489	1,791
2008 HEC-1 Run	8,240	4,840	2,620	1,822
% Difference	9.2%	9.5%	5.2%	1.7%
Arcade Cr. Near Del Paso Heights				
Observed Hydrograph	3,320	1,910	1,069	715
2008 HEC-1 Run	3,190	2,100	1,120	718
% Difference	-3.9%	9.9%	4.7%	0.4%

g. 5-Day Volume Frequency Relationships. **Table 13** lists the 5-day flood volumes for the 8-Flood Series for the Steelhead Creek and Natomas Cross Canal tributaries at their downstream index points. The NEMDC Sum in **Table 13** below is the maximum 120 hours of the Steelhead Creek hydrograph developed by adding the 4 tributary hydrographs together at

their respective downstream index points. The NEMDC Sum is not necessarily the sum of the four tributary hydrograph volumes, because the maximum 120 hours for the tributary hydrographs do not have the exact same starting and ending times. The 5-day volume frequency curves for Steelhead Creek and Natomas Cross Canal are shown on **Plates 11 and 12**.

Table 13

Summary Table - 8-Flood Series - Five-Day Duration Volumes

Stream at at Mouth	D.A. (sq.mi.)	8-Flood Series Five-Day Volumes (in Acre-Feet)							
		50%	20%	10%	4%	2%	1%	0.50%	0.20%
Steelhead Cr									
Dry Cr. at NEMDC	116.48	9,250	15,450	19,800	26,600	31,000	35,600	39,800	47,200
Upper NEMDC	27.13	2,010	3,230	4,110	5,300	6,190	7,120	7,980	9,360
OldMag at NEMDC (5-DAY)	4.57	380	594	747	952	1,103	1,260	1,410	1,640
Arcade Cr. At NEMDC	40.14	3,400	5,310	6,650	8,430	9,710	11,050	12,300	14,260
NEMDC Sum	188.32	14,970	24,600	31,340	41,320	48,020	54,980	61,360	71,750
Cross Canal									
Coon Creek at WPRR	112.61	8,760	15,640	20,360	29,430	34,360	39,410	44,040	51,430
Markham Rav. at WPRR	32.36	1,840	3,310	4,370	5,660	6,700	7,760	8,810	10,480
Auburn Rav. at WPRR	79.97	6,770	11,250	14,290	19,460	22,500	25,660	28,600	33,250
Pl.Grove Cr. at WPRR	46.69	4,140	6,500	8,110	10,360	11,880	13,390	15,080	17,420
Curry Creek at WPRR	16.59	1,190	2,000	2,560	3,300	3,850	4,420	4,950	5,810
Cross Canal Sum	288.22	22,690	38,710	49,680	68,160	79,230	90,580	101,420	118,320

The 5-day volumes in **Table 13** and the volume frequency curves on **Plate 11** were used to estimate the percent exceedence of the 5-day volumes for Steelhead Creek for the six historical flood events described above. **Table 14** lists the 5-day volumes for the Steelhead Creek tributaries computed using the HEC-1 program and the storm isohyetal maps for the 6 historical floods, along with the estimated percent exceedence of the 5-day volume for Steelhead Creek hydrographs.

Table 14

5-Day Volume Frequency Relationships for Six Historical Storms

Steelhead Creek Tributaries

Steelhead Cr Index Pt	5-Day Volume (ac-ft)	5-Day Volume % Chance Event (%)	Steelhead Cr Index Pt	5-Day Volume (ac-ft)	5-Day Volume % Chance Event (%)
Feb 1986 Storm			Mid-Jan 1997 Storm		
Dry Cr. At Mouth	38,400	0.6%	Dry Cr. At Mouth	28,500	2.6%
Arcade Cr.-Del Paso Hghts	10,700	0.6%	Arcade Cr.-Del Paso Hghts	7,420	4.6%
Arcade Cr. at Mouth	12,200	0.6%	Arcade Cr. At Mouth	8,300	4.4%
Upper NEMDC abv. Pump	7,090	1.0%	Upper NEMDC abv. Pump	4,230	9.3%
Old Magpie Cr. abv. Pump	1,420	0.6%	Old Magpie Cr. Abv. Pump	810	8.0%
Steelhead Sum	58,300	0.7%	Steelhead Sum	41,600	3.6%
Jan 1995 Storm			Feb 1998 Storm		
Dry Cr. At Mouth	29,800	2.2%	Dry Cr. At Mouth	24,100	5.1%
Arcade Cr.-Del Paso Hghts	8,300	2.7%	Arcade Cr.-Del Paso Hghts	7,380	5.7%
Arcade Cr. at Mouth	9,540	2.3%	Arcade Cr. At Mouth	8,100	4.9%
Upper NEMDC abv. Pump	5,430	3.6%	Upper NEMDC abv. Pump	4,540	7.3%
Old Magpie Cr. abv. Pump	930	4.6%	Old Magpie Cr. Abv. Pump	780	9.0%
Steelhead Sum	45,700	2.4%	Steelhead Sum	37,500	5.4%
New Year 1997 Storm			New Year 2006 Storm		
Dry Cr. At Mouth	17,400	14.5%	Dry Cr. At Mouth	17,700	13.8%
Arcade Cr.-Del Paso Hghts	5,300	15.6%	Arcade Cr.-Del Paso Hghts	5,430	14.6%
Arcade Cr. at Mouth	6,100	13.5%	Arcade Cr. At Mouth	6,370	11.8%
Upper NEMDC abv. Pump	3,370	18.4%	Upper NEMDC abv. Pump	2,820	28.0%
Old Magpie Cr. abv. Pump	600	19.5%	Old Magpie Cr. Abv. Pump	700	13.0%
Steelhead Sum	27,500	14.6%	Steelhead Sum	27,600	14.4%

A sensitivity analysis of storm centerings and runoff discussed in the Natomas GRR Hydrology Appendix showed there was less than a 5 percent difference in runoff on Steelhead Creek for a 1 percent storm centering on the Steelhead drainage and a concurrent storm on Steelhead Creek with the specific centering on Cross Canal drainage. The difference in runoff was also less than 5 percent for the Natomas Cross Canal. To simplify Natomas flood centerings for the Coincident Frequency Analysis, an n-percent chance flood is assumed to be centered on the combined drainages of Steelhead Creek and Natomas Cross Canal. So, if the 5-day flood hydrograph for Steelhead Creek for the New Year 1997 flood is a 15 percent exceedence event, it is assumed to be a 15 percent exceedence event for the Natomas Cross Canal 5-day runoff volume as well. Based on the flood volumes listed in **Table 13**, the 5-day volume of the New Year 1997 flood for the Natomas Cross Canal should be about 43,300 acre-feet. Based on this combined 5-day flood volume for the Cross Canal, 5-day flood hydrographs needed to be computed for the five Cross Canal tributaries for the New Year 1997 flood, to be used in the Coincident Frequency Analysis. Computation of the Natomas Cross Canal tributary hydrographs for the New Year 1997 flood and other five historic floods is discussed in **Section 2.2**.

2.2 Natomas Cross-Canal Historical Flood Hydrographs.

a. Computing 5-Day Volumes for 6 Historical Floods on Natomas Cross Canal. There are several problems with developing historical flood hydrographs for the Natomas Cross Canal tributaries. One is the lack of precipitation stations in the Cross Canal watershed. See **Plate 2**, the watershed map showing the precipitation station locations. Also, there are no flow gages – only a few stage gages on Pleasant Grove Creek at and upstream of Fiddyment Road, and in the upper watersheds of Coon Creek and Auburn Ravine. Coon Creek and Auburn Ravine stage gage locations can be found at **Reference 9,** on the map of Sacramento County ALERT gages. The Pleasant Grove Creek stage gage locations can be found at **Reference 10**, the map of City of Roseville Flood Alert gages. The isohyetal lines on the isohyetal maps for the six historic storms (**Plates 5 through 10**) were extended from Steelhead Creek drainage north through the Cross Canal drainage.

The Civil Engineering Solutions HEC-1 models and the isohyetal maps (**Plates 5 through 10**) were used to compute preliminary runoff hydrographs for the Cross Canal tributaries for the six historical floods. The storm isohyetal maps and subbasins storm amounts for the Cross Canal tributaries were adjusted until the 5-day runoff volumes for the Cross Canal tributaries matched the percent exceedence of the 5-day Steelhead Creek tributary volumes for the same event. (See **Table 14**.) The Pleasant Grove Creek and Markham Ravine drainages are similar to Arcade Creek in east-to-west alignment, drainage area, and elevation range (below 300 feet), so that the percent exceedence event for the Arcade Creek 5-day flood volumes were used as guidance to estimate the flood volumes for those two Cross Canal tributaries. For the larger tributaries, Coon Creek and Auburn Ravine, with large contributing drainage above 300 feet (extending up to 2,000 feet for Coon Creek), the percent exceedence 5-day volumes for the six historical floods were based on the percent exceedence flood volumes for Dry Creek at Steelhead Creek. Curry Creek is adjacent to Upper NEMDC, which was used as a model in case the 5-day volumes on Curry Creek needed adjustment.

Table 15 lists the computed 5-day flood volumes from the above adjusted modeling runs for the Natomas Cross Canal tributaries, as well as the ratios of peak-to-5-day-volume for the computed hydrographs on the Steelhead Creek and Cross Canal tributaries. The HEC-1 models developed by Civil Engineering Solutions, Inc., for the Natomas Cross canal tributaries, discussed in the Natomas GRR Hydrology Appendix (**Reference 6**), assumed that future housing and urbanization projects were in place. At the present time, they have yet to be constructed. One review comment on the Hydrology Appendix was that the Cross Canal tributary peak flows computed for the Hydrology Appendix had much higher peak flows in proportion to their flood volumes and contributing drainage areas. The relationship for Cross Canal peak flows should be more in line with the ratios of peak flow to flood volume and to drainage area for the Steelhead Creek tributaries.

Table 15
Ratio of Peaks to 5-Day Volumes
for 6 Historical Floods on Natomas Tributaries

Stream at Mouth	D.A. (sq.mi.)	8-Flood Series - Peaks, Volumes and Ratios: Peak to Volume						Average Peak to Volume
		Feb-86	Jan-95	NY 1997	MidJan 97	Feb-98	NY 2006	
Steelhead Cr								
Dry Cr. At Steelhead Cr.	Peak (cfs)	10,040	12,080	5,110	7,830	7,350	6,900	
5-day Vol. (ac-ft)		38,400	29,800	17,400	28,500	24,100	17,700	
Drainage Area 116.48 sq.mi.	PK/Vol.	0.26	0.41	0.29	0.27	0.30	0.39	0.32
Upper NEMDC	Peak (cfs)	3,830	3,840	2,610	2,610	1,610	2,110	
5-day Vol. (ac-ft)		7,090	5,430	3,370	4,230	4,540	2,820	
Drainage Area 27.13 sq.mi.	PK/Vol.	0.54	0.71	0.77	0.62	0.35	0.75	0.62
Old Magpie Cr. above Pump	Peak (cfs)	831	918	603	673	389	573	
5-day Vol. (ac-ft)		1,420	930	600	810	780	700	
Drainage Area 4.57 sq.mi.	PK/Vol.	0.59	0.99	1.01	0.83	0.50	0.82	0.79
Arcade Cr. At Steelhead Cr.	Peak (cfs)	3,720	4,950	2,640	3,470	3,200	3,360	
5-day Vol. (ac-ft)		12,200	9,540	6,100	8,300	8,100	6,370	
Drainage Area 40.14 sq.mi.	PK/Vol.	0.30	0.52	0.43	0.42	0.40	0.53	0.43
Steelhead Cr. Sum	Peak (cfs)	14,060	17,840	8,470	11,300	11,050	10,860	
5-day Vol. (ac-ft)		58,300	45,700	27,500	41,600	37,500	27,600	
Drainage Area 188.32 sq.mi.	PK/Vol.	0.24	0.39	0.31	0.27	0.29	0.39	0.32
Cross Canal		Feb-86	Jan-95	NY 1997	MidJan 97	Feb-98	NY 2006	Average
Coon Creek at WPRR	Peak (cfs)	11,700	26,500	8,250	13,700	10,150	9,970	
5-day Vol. (ac-ft)		35,500	29,100	17,600	20,700	18,050	13,460	
Drainage area 112.61 sq.mi.	PK/Vol.	0.33	0.91	0.47	0.66	0.56	0.74	0.61
Markham Rav. At WPRR	Peak	6,510	4,830	2,520	4,810	2,550	4,120	
5-day Vol. (ac-ft)		8,620	4,850	3,700	5,280	5,130	3,440	
Drainage Area 32.36 sq.mi.	PK/Vol.	0.76	1.00	0.68	0.91	0.50	1.20	0.84
Auburn Rav. At WPRR	Peak (cfs)	11,700	10,200	4,290	6,840	5,490	5,700	
5-day Vol. (ac-ft)		26,450	21,000	12,500	16,360	14,100	10,200	
Drainage Area 79.97 sq.mi.	PK/Vol.	0.44	0.49	0.34	0.42	0.39	0.56	0.44
Pl.Grove Cr. At WPRR	Peak (cfs)	7,870	9,100	4,550	7,360	4,610	5,470	
5-day Vol. (ac-ft)		14,900	11,400	6,560	9,090	9,330	6,160	
Drainage Area 46.69 sq.mi.	PK/Vol.	0.53	0.80	0.69	0.81	0.49	0.89	0.70
Curry Creek at WPRR	Peak (cfs)	2,520	2,500	1,570	1,680	1,020	1,290	
5-day Vol. (ac-ft)		4,650	3,330	2,130	2,890	3,000	1,730	
Drainage Area 16.59 sq.mi.	PK/Vol.	0.54	0.75	0.74	0.58	0.34	0.75	0.62
Cross Canal Sum	Peak (cfs)	30,700	43,600	16,100	23,200	20,800	21,300	
5-day Vol. (ac-ft)		89,800	72,900	42,500	54,300	49,500	35,000	
Drainage Area 288.22 sq.mi.	PK/Vol.	0.34	0.60	0.38	0.43	0.42	0.61	0.46

Upper NEMDC (Steelhead tributary) and Curry Creek (Cross Canal tributary) are adjacent basins on the valley floor and have similar ratios of computed peak to 5-day volume for each of the six flood events. The 6-event averaged ratio of peak/5-day volume (**Table 15**, right-hand column) is the same, 0.62, for Upper NEMDC and Curry Creek.

Arcade Creek (Steelhead tributary) and Pleasant Grove Creek and Markham Ravine (Cross Canal tributaries) are similar in orientation and elevation. However, because of the highly urbanized HEC-1 models used for Pleasant Grove Creek and Markham Ravine, the 6-event averaged ratio of peak/5-day volume for Pleasant Grove Creek is 60 percent higher than for Arcade Creek and for Markham Ravine is nearly two times that of Arcade Creek.

Dry Creek (Steelhead tributary) and Coon Creek and Auburn Ravine (Cross Canal tributaries) have larger drainage areas as well as headwaters at much higher elevations than the other Natomas tributaries. Because of the highly urbanized HEC-1 models used for Auburn Ravine and Coon Creek, the 6-event averaged ratio of peak/5-day volume for Auburn Ravine is 38 percent higher than for Dry Creek and is 91 percent higher for Coon Creek than for Dry Creek.

Table 16 shows the ratios of peak-to-drainage-area for the computed hydrographs on the Steelhead Creek and Cross Canal tributaries.

Table 16
Ratio of Peaks to Drainage Areas
for 6 Historical Floods on Natomas Tributaries

Stream at Mouth	D.A. (sq.mi.)	8-Flood Series - Ratios of Peaks to Drainage Areas						Average Peak to D.A.
Steelhead Cr		Feb-86	Jan-95	NY 1997	MidJan 97	Feb-98	NY 2006	
Dry Cr. At Steelhead Cr.	Peak (cfs)	10,040	12,080	5,110	7,830	7,350	6,900	
Drainage Area (sq.mi.)								
116.48	Pk/D.A.	86.2	103.7	43.9	67.2	63.1	59.2	70.6
Upper NEMDC	Peak (cfs)	3,830	3,840	2,610	2,610	1,610	2,108	
Drainage Area (sq.mi.)								
27.13	Pk/D.A.	141.2	141.5	96.2	96.2	59.3	77.7	102.0
Old Magpie Cr. above Pump	Peak (cfs)	831	918	603	673	389	573	
Drainage Area (sq.mi.)								
4.57	Pk/D.A.	181.8	200.9	131.9	147.3	85.1	125.4	145.4
Arcade Cr. At Steelhead Cr.	Peak (cfs)	3,720	4,950	2,640	3,470	3,200	3,360	
Drainage Area (sq.mi.)								
40.14	Pk/D.A.	92.7	123.3	65.8	86.4	79.7	83.7	88.6
Steelhead Cr. Sum	Peak (cfs)	14,060	17,840	8,470	11,300	11,050	10,860	
Drainage Area (sq.mi.)								
188.32	Pk/D.A.	74.7	94.7	45.0	60.0	58.7	57.7	65.1
Cross Canal		Feb-86	Jan-95	NY 1997	MidJan 97	Feb-98	NY 2006	Average
Coon Creek at WPRR	Peak (cfs)	11,700	26,500	8,250	13,700	10,150	9,970	
Drainage Area (sq.mi.)								
112.61	Pk/D.A.	103.9	235.3	73.3	121.7	90.1	88.5	118.8
Markham Rav. At WPRR	Peak (cfs)	6,510	4,830	2,520	4,810	2,550	4,120	
Drainage Area (sq.mi.)								
32.36	Pk/D.A.	201.2	149.3	77.9	148.6	78.8	127.3	130.5
Auburn Rav. At WPRR	Peak (cfs)	11,700	10,200	4,290	6,840	5,490	5,700	
Drainage Area (sq.mi.)								
79.97	Pk/D.A.	146.3	127.5	53.6	85.5	68.7	71.3	92.2
Pl.Grove Cr. At WPRR	Peak (cfs)	7,870	9,100	4,550	7,360	4,610	5,470	
Drainage Area (sq.mi.)		14,900	11,400	6,560	9,090	9,330	6,160	
46.69	Pk/D.A.	168.6	194.9	97.5	157.6	98.7	117.2	139.1
Curry Creek at WPRR	Peak (cfs)	2,520	2,500	1,570	1,680	1,020	1,290	
Drainage Area (sq.mi.)								
16.59	Pk/D.A.	151.9	150.7	94.6	101.3	61.5	77.8	106.3
Cross Canal Sum	Peak (cfs)	30,700	43,600	16,100	23,200	20,800	21,300	
Drainage Area (sq.mi.)								
288.22	Pk/D.A.	106.5	151.3	55.9	80.5	72.2	73.9	90.0

The 6-event averaged ratio of peak/drainage area (**Table 16**, right-hand column) is nearly the same for the adjacent stream drainages, Upper NEMDC and Curry Creek, with ratios of 102 and 106.3, respectively. These basins are in close agreement for ratios of both peak to 5-day

volume and peak to drainage area. The computed historical reproduction hydrographs for Curry Creek do not appear to need adjustment.

The 6-event averaged ratio of peak/drainage area for Arcade Creek is 88.6. While Markham Ravine and Pleasant Grove Creek are the tributaries to the Natomas Cross Canal most similar to Arcade Creek, the 6-event averaged ratio of peak/drainage area for Markham Ravine is 47 percent higher than for Arcade Creek and for Pleasant Grove Creek is 57 percent higher than for Arcade Creek. These higher ratios for the Cross Canal tributaries can be explained by the HEC-1 models that included future urbanization on those watersheds. The peak flows for present conditions on Markham Ravine and Pleasant Grove Creek should be lower.

The 6-event averaged ratio of peak/drainage area for Dry Creek is 70.6. The Cross Canal tributaries most similar to Dry Creek are Auburn Ravine and Coon Creek. The 6-event averaged ratio of peak/drainage area for Auburn Ravine is 31 percent higher than that for Dry Creek while the averaged ratio for Coon Creek is 68 percent higher than for Dry Creek. The peak flows for present conditions on Auburn Ravine and Coon Creek should be lower.

Based on the differences in the ratios presented in **Tables 15 and 16**, the hydrographs for Auburn Ravine, Coon Creek, Markham Ravine, and Pleasant Grove Creek were reshaped with lower peak flows. This process is explained in **Section 2.2.b**.

b. Re-shaping the Natomas Cross Canal Historical Hydrographs. Once the 5-day runoff volumes for the six historic floods on the Natomas Cross Canal tributaries were determined, the flood hydrographs were re-shaped (except for Curry Creek), with lower peak flows, more in line with the peak to volume and to drainage area ratios for the Steelhead Creek tributaries (**Tables 15 and 16** above). The same Steelhead Creek tributaries were used for the hydrograph patterns: Arcade Creek at Steelhead Creek as a pattern for Pleasant Grove Creek and Markham Ravine at their downstream WPRR index points, and Dry Creek at Steelhead Creek as a pattern for Auburn Ravine and Coon Creek at their downstream WPRR index points. The computed flood volumes for the Cross Canal tributaries remained the same, but volume lost by re-shaping for lower peak flows was offset by the addition of recession flow. The timing of the peak flows on the Cross Canal tributaries was not changed. Examples of re-shaping of the Cross Canal tributary hydrographs for the New Year 1997 flood are shown on **Figure 10**, Pleasant Grove Creek at WPRR, based on Arcade Creek, and **Figure 11**, Coon Creek at WPRR, based on Dry Creek at Steelhead Creek.

The figures show how the high peak flows on the Cross Canal tributaries were reduced by hydrograph re-shaping. Rapid hydrograph fluctuations were filled in. Recession base flow was added to the hydrographs for the Cross Canal tributaries with major contributing drainage above 300 feet (Coon Creek and Auburn Ravine). Minor waves in the flood hydrographs were not adjusted. While the Arcade Creek hydrograph appears to have base flow, the higher flow trailing after the main wave is due to water being pumped from interior drainage areas upstream of the mouth of Arcade Creek.

Figure 10

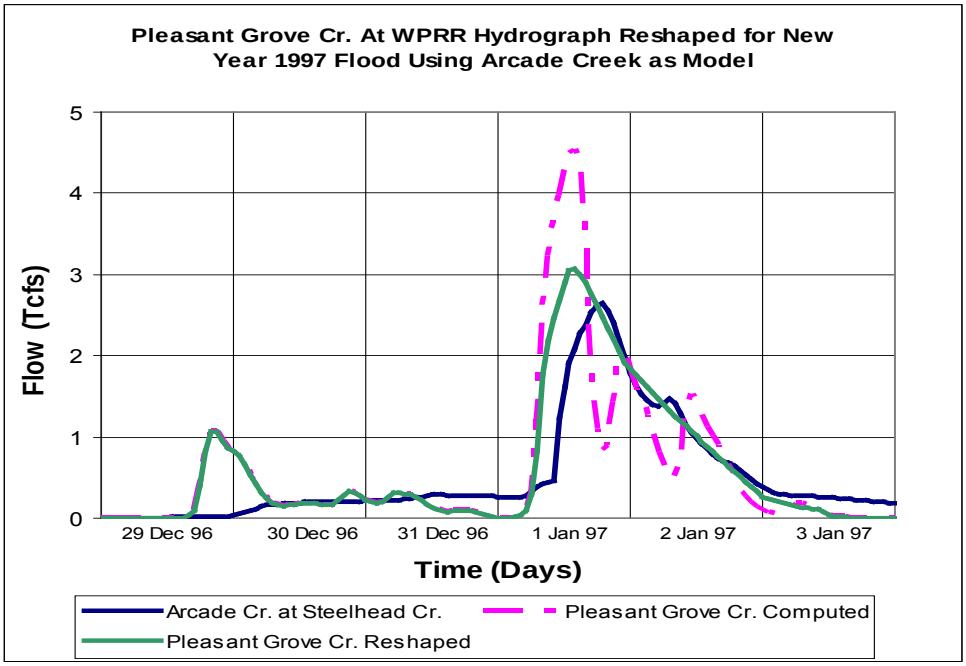
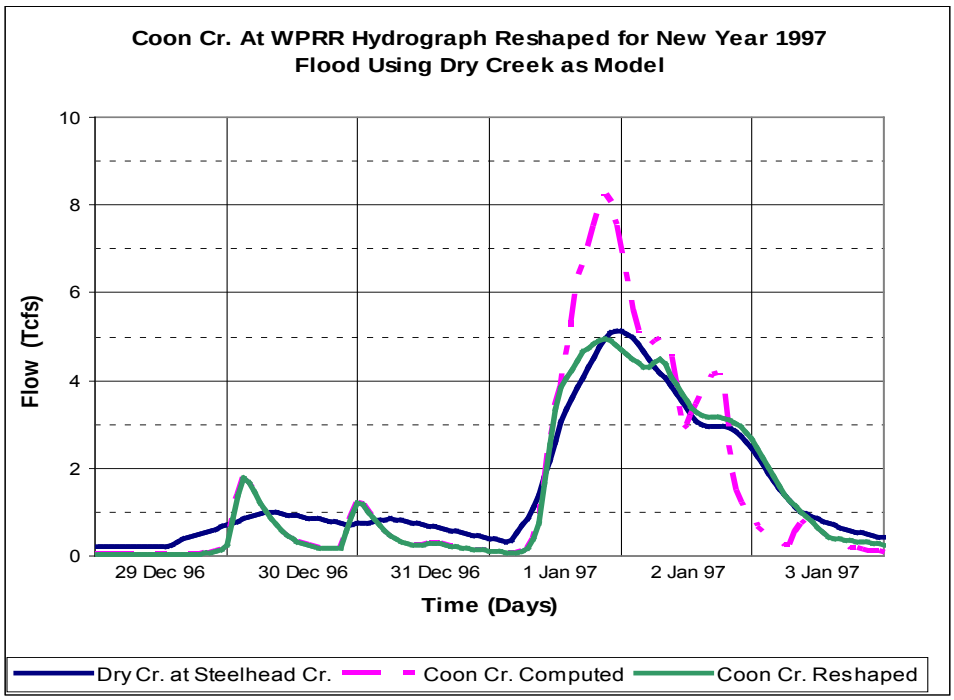
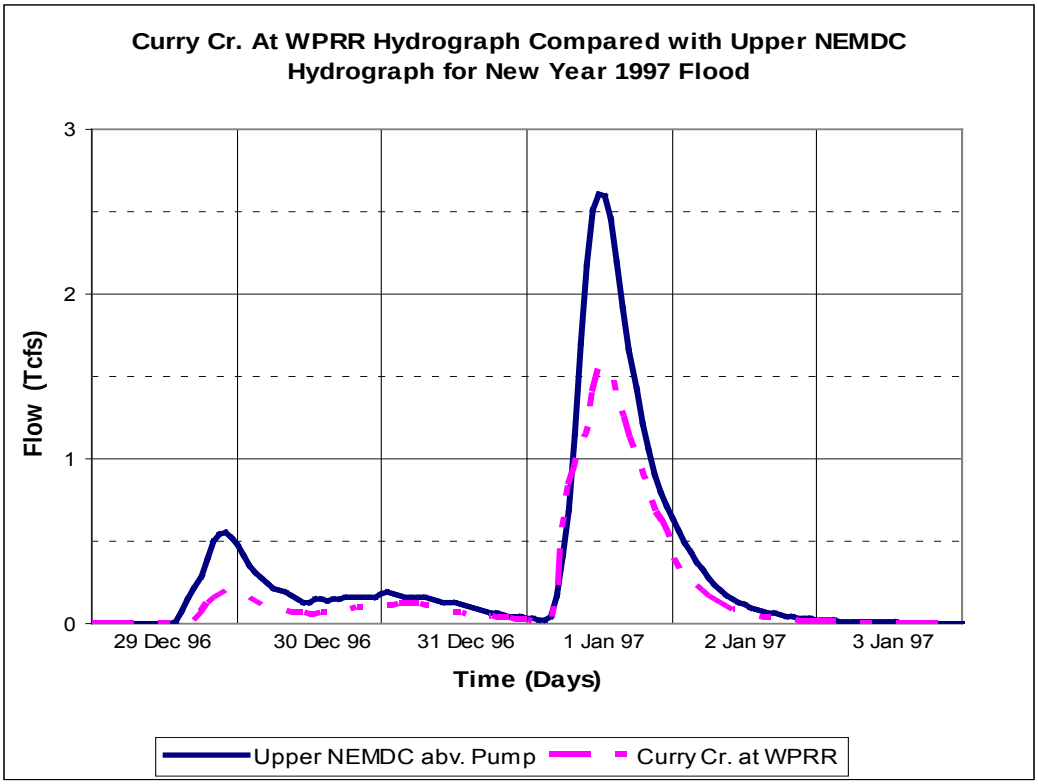


Figure 11



The smaller valley tributaries, Upper NEMDC and Old Magpie Creek, have higher peak flows in proportion to their flood volumes and drainage areas, but those peak flows would not have as much effect on the downstream Steelhead Creek hydrograph, even if they contributed directly to Steelhead Creek instead of being pumped in; their drainage areas and flood volumes are small compared with the larger tributaries, Dry and Arcade creeks. The contribution from Curry Creek to flows at the Natomas Cross Canal does not have a large effect either. The Rio Linda rainfall gage was used to distribute the precipitation over these two drainages for the six historical storms. The ratios of peak to flood volume and to drainage area for Curry Creek are very similar to the ratios for Upper NEMDC. The historical flood hydrograph for Curry Creek was not re-shaped. **Figure 12** presents the flood hydrographs for Curry Creek and Upper NEMDC for the New Year 1997 flood.

Figure 12



2.3 Use of Historical Flood Hydrographs on Natomas Tributaries. The Natomas tributary hydrographs for the six historic floods were provided to Hydraulic Design Section to be used for upstream boundary conditions in the hydraulic modeling. The historic flood hydrographs were at the following locations: Coon Creek at WPRR, Markham Ravine at WPRR, Auburn Ravine at WPRR, Pleasant Grove Creek at WPRR, Curry Creek at WPRR, Upper NEMDC above and below the NEMDC Stormwater Pumping Station, Dry Creek above Steelhead Creek confluence, Old Magpie Creek above and below Pump Station 157, and Arcade Creek above Steelhead Creek confluence. **Plate 13** shows the New Year 1997 computed flood hydrographs for Curry

Creek and the Steelhead Creek tributaries and the reshaped flood hydrographs for Pleasant Grove Creek, Auburn Ravine, Markham Ravine, and Coon Creek.

3.0 Development of 8-Flood Series Hydrographs for Natomas Tributaries

Development of the 8-Flood Series hydrographs for the Natomas tributaries follows Comprehensive Study methodology. The Comprehensive Study used 30-day hydrographs consisting of six 5-day waves, with the 4th wave being the highest. The process includes: 1) obtaining the average flood flow rates from the unregulated frequency curves, 2) separating these average flows into wave volumes, and 3) distributing volumes into the 6-wave series.

All of the Natomas tributaries at their respective downstream index points are unregulated. The index points for Upper NEMDC and Old Magpie Creek are upstream of their respective pumping stations. The 5-day volume frequency curves for the Natomas tributaries are shown on **Plates 11 and 12. Plates 14 and 15** present the 10-day volume frequency curves. The 5-day volumes for the 8-Flood Series for the Natomas tributaries are listed on **Table 13** in **2.1.g. Table 17** below lists the 10-day volumes for the 8-Flood Series.

Table 17

Summary Table - 8-Flood Series - Ten-Day Duration Volumes

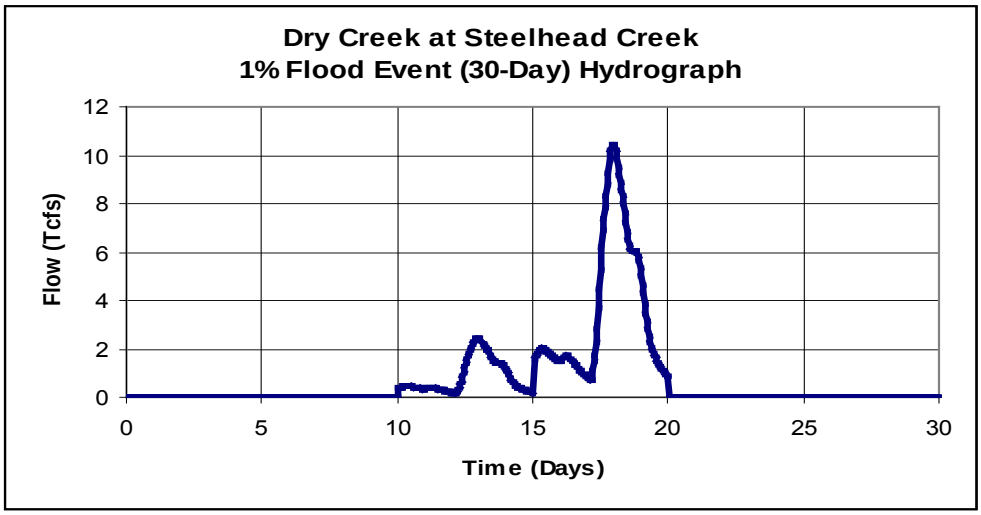
Stream at	D.A.	8-Flood Series Five-Day Volumes (in Acre-Feet)							
at Mouth	(sq.mi.)	50%	20%	10%	4%	2%	1%	0.50%	0.20%
Steelhead Cr									
Dry Cr. at NEMDC	116.48	11,000	18,300	23,600	32,700	38,200	43,900	49,100	58,700
Upper NEMDC	27.13	2,400	3,840	4,920	6,400	7,510	8,700	9,760	11,500
OldMag at NEMDC (5-DAY)	4.57	470	724	891	1,200	1,390	1,590	1,770	2,070
Arcade Cr. at NEMDC	40.14	4,220	6,570	8,190	10,300	11,900	13,600	15,100	17,600
NEMDC Sum	188.32	18,090	29,434	37,601	50,600	59,000	67,790	75,730	89,870
Cross Canal									
Coon Creek at WPRR	112.61	10,900	19,500	25,400	38,300	44,700	51,400	57,600	67,300
Markham Rav. at WPRR	32.36	2,380	4,170	5,450	7,320	8,610	9,920	11,200	13,300
Auburn Rav. at WPRR	79.97	8,600	14,200	18,100	25,300	29,300	33,400	37,300	43,400
Pl.Grove Cr. at WPRR	46.69	5,160	8,060	10,200	13,100	15,000	17,000	19,200	22,100
Curry Creek at WPRR	16.59	1,490	2,490	3,180	4,120	4,820	5,540	6,230	7,330
Cross Canal Sum	288.22	28,530	48,420	62,330	88,140	102,430	117,260	131,530	153,430

For consistency with the Comprehensive Study, the computed New Year 1997 flood hydrographs for the Natomas tributaries at their respective downstream index points, or upstream of their respective pumping stations for Old Magpie Creek and Upper NEMDC, were used as the pattern hydrographs for the synthetic 8-Flood Series. For the Comprehensive Study, the basic pattern of all synthetic flood hydrographs was a 30-day hourly time series consisting of six

waves, each 5 days in duration. Flood volumes were ranked and distributed into the basic pattern. The highest wave volume was distributed into the fourth, or main, wave. The second highest volume preceded the main wave. So, the two highest waves are in the middle ten days of the 30-day hydrograph. The upstream tributary index points used for the Comprehensive Study are listed on **Table 1**. They flow out of the mountains to the east, west, and north of the Sacramento Valley and have high flows during the rainy season. The Natomas tributaries flow out of the foothills or originate on the valley floor. Flows on these tributaries can be high during and immediately after a rainstorm. Without additional rainfall, the flows drop to base flow or to urban runoff levels. The average flows are a lot lower than for the Comp Study tributaries on **Table 1**. The Natomas tributary flows for the four smaller waves would be so minor, that zero runoff was assumed for the 30-day hydrographs except for the middle 10 days (Waves 3 and 4).

The 1 percent flood hydrograph for Dry Creek at Steelhead Creek was developed in the following way. The 5-day flood pattern hydrograph for 30 Dec 1996 to 3 Jan 1997 for Dry Creek at its downstream index point is shown on **Figure 11** and **Plate 13**. The 5-day flood volume for this pattern hydrograph is 17,400 acre-feet. The 5-day flood volume for the 1 percent flood for Dry Creek is 35,600 acre-feet. The ratio of the 1 percent event 5-day volume to the New Year 1997 5-day volume is 35,600 / 17,400 or 2.046. This ratio was applied to the hourly ordinates of the computed 5-day New Year 1997 hydrograph for Dry Creek at Steelhead Creek, to define the 1 percent flood hydrograph for Wave 4 at the Dry Creek index point. The difference between the 1 percent 5-day volume (35,600 ac-ft) for Dry Creek at Steelhead Creek index point and the 1 percent 10-day volume (43,900 ac-ft) for the Dry Creek index point is 8,300 acre-feet. The ratio of 8,300 ac-ft to the New Year 1997 5-day volume for Dry Creek at Steelhead Creek is 8,300 / 17,400, or 0.477. This ratio was applied to the New Year 1997 flood hydrograph at the Dry Creek index point, to define the hydrograph for Wave 3 of the 30-day 1 percent event flood hydrograph at the Dry Creek index point. **Figure 13** below shows the shape of the 30-day 1 percent event hydrograph for Dry Creek at Steelhead Creek, with zero flow for waves 1 – 2 and 5 – 6. Wave 4 is higher than Wave 3.

Figure 13



The rest of the floods in the 8-Flood Series for Dry Creek, as well as the hydrographs for the other eight Natomas tributaries, were developed using the same method. These hydrographs are consistent in shape and timing with the synthetic flood hydrographs for the Sacramento River tributary index points listed on **Table 1**.

The 30-day hydrographs for Upper NEMDC above the NEMDC Stormwater Pumping station and Old Magpie Creek above Pump 157 were routed through their respective pumping stations for each of the 8-Flood Series.

The Natomas tributary 30-day hydrographs for the 8-Flood Series were provided to Hydraulic Design Section for use as upstream boundary conditions for the hydraulic model. For Upper NEMDC and Old Magpie Creek, hydrographs for above and below their respective pumping stations were provided to Hydraulic Design Section.

4.0 Natomas Cross Canal (NCC) and Steelhead Creek (SHC) Coincident Frequency Study

The Comprehensive Study hydrology included coincident flood centerings for the Sacramento River tributaries large enough to have an influence on the flows downstream of their confluences with the mainstem. Flood hydrograph contributions from the tributary Natomas Cross Canal (NCC) and Steelhead Creek (SHC) are negligible in comparison with the mainstem flood flows, such that the tributary flow or stage hydrographs do not need to be considered when developing stage-frequency functions for the mainstem channels. However, the mainstem channel stages still need to be considered when developing stage-frequency functions on the tributaries. For this phase of the analysis, the Sacramento Mainstem flood series is used as the mainstem for the Natomas Cross Canal, and either the American River or the Sacramento Mainstem is used as the mainstem for the Steelhead Creek tributary, depending upon percent exceedence. For low mainstem stage conditions, Steelhead Creek flows directly to the Sacramento River rather than mingling flows with the American River.

4.1 Total Probability Theorem. Instead of the Comprehensive Study concurrent flood centering methodology, a total probability approach was used to evaluate coincident flood stages on the Natomas Cross Canal and Steelhead Creek. The procedure used was an extension of the Total Probability method documented in **Reference 11**, Procedures for Developing Stage-Probability Functions for Tributary Streams, prepared by David Ford Consulting Engineers (Ford) in February 2007.

Tangible benefit of a flood management project is computed, in part, as the expected value of inundation damage reduced. This computation requires a stage-frequency function at the location of interest. If that location is on a tributary stream, development of the function must account properly for the influence of the mainstem stream into which the tributary flows. A systematic, uniform approach is required for development of the stage-frequency functions for the locations of interest. The procedure begins with an assessment of the degree to which the tributary is dependent on the mainstem. An overview flowchart for the tributary analysis procedure is shown on **Plate 16**.

If the tributary is not dependent on mainstem conditions (Case 1), then the necessary information can be developed using typical riverine analyses: estimate the discharge for a specified probability, use that as the upstream boundary condition, and use a rating curve or similar control as the downstream boundary condition for the hydraulics model.

If tributary conditions are hydraulically dependent on mainstem conditions, can the frequency of the stage at the tributary location be predicted, given the mainstem conditions? If so (Case 3), then the Comprehensive Study methodology is used to develop the tributary flow-frequency function and the mainstem stage-frequency function. A channel model is developed for the reach of interest, and a resulting stage-frequency function is derived for the tributary index location.

If tributary conditions cannot be predicted reliably from mainstem conditions (Case 2), then combinations of boundary conditions are applied to the standard watershed and channel models. Using the results from analysis of tributary stages computed with varying downstream

boundary conditions, the total probability equation is used to compute the desired stage-frequency function at the tributary location. The equation is:

$$F(stage_{tributary}) = \sum_{\substack{mainstem \\ conditions}} (F(stage_{tributary} \mid stage_{mainstem}) \times F(stage_{mainstem}))$$

If a correlation exists between the tributary and mainstem, but is not definitive (Case 4), then a conditional probability analysis needs to be done. Practical methods to accomplish this have yet to be developed and field-tested.

4.2 Application to Natomas Tributaries. The coincident-frequency procedures that Ford used to develop stage-frequency curves for the Natomas Cross Canal and Steelhead Creek channels are described in the memorandum, "NCC/SHC Coincident Frequency Study: Exposition of Analytical Procedures," dated September 10, 2008, prepared by David Ford Consulting Engineers (**Reference 12**). Primary technical tasks include assessing hydrologic dependence between tributary and mainstem channels and identifying flow regimes where hydrologic independence may be presumed. A secondary task is identifying timing differences between tributary and mainstem peak stages. Total probability methodology relies on historical rainfall and streamflow data. Stage records from the California Data Exchange Center (CDEC, **Reference 13**) were used for the analysis. Due to the lack of stage data on the Natomas Cross Canal, CDEC stage records for the Dry Creek gage at Vernon Street (VRS) were substituted to develop a cross-correlation with the Sacramento River at Verona (VON) records. Records for the Sacramento River at I Street (IST) and at Ord Ferry (ORD) gages were used to supplement/correct the VON stage records. Similarly, due to the unavailability of long-term records for Steelhead Creek, Arcade Creek (AMC) records were cross-correlated with American River at H-Street gage (HST) records. American River at Fair Oaks (AFO) records were used to fill in missing values in the HST record. **Table 18** summarizes the primary stream gages used for this study. Gaging station locations (except for ORD) are shown on **Plate 1**.

Table 18
CDEC Gage Records Used for Hydrologic Dependence Analysis

Gage Name	CDEC gage ID	Period of Record
Sacramento River at Verona	VON	01Jan1984 – Present
Sacramento River at I Street	IST	01Jan1984 – Present
Sacramento River at Ord Ferry	ORD	01Jan1984 – Present
American River at H Street	HST	01Jan1984 – Present
American River at Fair Oaks	AFO	02Nov1998 – Present
Dry Creek at Vernon Street	VRS	19Oct1996 – Present
Arcade Creek at Winding Way	AMC	29Oct1996 – Present

The memorandum, "Cross-Correlation Analysis Results for NCC/SHC Coincident-Frequency Study," dated April 17, 2008, prepared by David Ford Consulting Engineers (**Reference 14**), describes the methods Ford used to assess conditions of hydrologic dependence between (1) Steelhead Creek and the American River, (2) Natomas Cross Canal and the

Sacramento River, and (3) the American River and the Sacramento River. It also identifies peak-stage timing differences between each tributary and the downstream mainstem channel.

Table 19 shows the tributary/mainstem confluence water surface elevations used as input in the Hydraulic Design Section's hydraulic models for the Natomas Cross Canal (NCC) and Steelhead Creek (SHC) tributaries as a function of mainstem annual exceedence probability (AEP) stages. Water surface elevation (WSEL) values are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29). Water surface elevations on SHC and NCC in **Table 19** correspond to stages on the American River and on the Sacramento River, respectively. For the more frequent mainsteam AEP between 0.50 and 0.04, Steelhead Creek stages are affected more by stages on the Sacramento River than by flows down the American River.

An analytical approach based on historical storm event data was used to characterize tributary/mainstem dependencies. Local event Annual Exceedence Probabilities (AEPs) were assigned to individual storm events, based on precipitation records from rainfall gages close to the SHC and NCC drainages. Rainfall frequency data was provided by Rainfall Depth-Duration Frequency Analysis for California Rain Gages (**Reference 15**), assembled by retired California State Climatologist Jim Goodridge. Historical mainstem peak flows were matched to concurrent local rainfall events on an event-by-event basis. Based on local storm magnitudes, the set of historic events was partitioned into return-frequency classes. Distributions for rarer AEP events were based on projected regional meteorologic patterns. Only rainfall and flow/stage records collected after 1980 were used for the analysis. It was assumed that n-year local flow event corresponded to the n-year local rainfall event, and that mainstem/tributary conditional distribution patterns can be extrapolated for rarer events using general knowledge of regional storm patterns and local channel hydraulics.

Table 19
Applied Stage-Frequency Functions for Mainstem AEP Events

Mainstem-event AEP	Steelhead Creek (SHC) Downstream WSEL (ft. NGVD29)	Natomas Cross Canal (NCC) Downstream WSEL (ft. NGVD29)
0.500	24.09	33.08
0.200	24.80	35.10
0.010	25.70	36.34
0.040	30.71	39.34
0.020	32.65*	40.10
0.010	35.43*	41.62
0.005	37.18*	43.00
0.002	42.62*	44.35

Notes:
AEP = Annual Exceedence Probability
WSEL = Water Surface Elevation
* WSEL is stage for American River conditions. All other WSELs are stages on the Sacramento River Mainstem.

The Hydraulic Design models were used to generate peak water surface elevations for the SHC and NCC index points for various combinations of tributary discharge and fixed mainstem stage (per **Table 19**). The tributary discharge rates were characterized by local-event AEP; similarly, the downstream confluence stages were characterized by mainstem AEP. The computed NCC and SHC index point stage values corresponded to regulated mainstem conditions.

4.3 Computational Results. Ford developed stage-frequency functions for the Natomas Cross Canal and Steelhead Creek index points. **Table 20** presents the stage-frequency functions for the NCC and SHC index points based on Ford's coincident-frequency evaluation. The stage values were computed under regulated mainstem conditions. Water surface elevation (WSEL) values are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

Table 20

Computed Stage-Frequency Functions for Local AEP Events

Local-event AEP	Steelhead Creek (SHC) Index Point WSEL (ft. NGVD29)	Natomas Cross Canal (NCC) Index Point WSEL (ft. NGVD29)
0.500	26.3	33.9
0.200	28.6	34.5
0.010	29.9	34.8
0.040	31.4	36.6
0.020	33.4	37.8
0.010	35.5	38.6
0.005	37.4	40.1
0.002	40.1	42.4

Notes:
AEP = Annual Exceedence Probability
WSEL = Water Surface Elevation
SHC index point is located at RM 3.713
NCC index point is located at RM 4.323

Stages listed in **Table 20** are based on UNET modeling, not on the latest HEC-RAS model. The above stages may change when the HEC-RAS model is used for the analyses. The memorandum, "NCC/SHC Coincident Frequency Study: Computational Results," dated September 10, 2008 prepared by Ford (**Reference 16**), provides additional details regarding the results in **Table 20** from the analyses - the special factors considered, the hydraulic profiles and probabilistic relations used in the computations, and the coincident stage-frequency functions.

Table 21 shows the combination of which mainstem flood hydrographs are being used in combination with which Natomas tributary flood hydrographs in the HEC- RAS hydraulic model. These flood hydrograph combinations are being used in preparation for the F3 Conference Milestone. Different combinations of floods may be tested for later analysis.

Preliminary analysis determined that, for the mouth of the Natomas Cross Canal, the flood stages for the Sacramento Mainstem and Shanghai-Yuba centerings were similar. So the Shanghai-Yuba flood series hydrographs are not being used in the current phase (pre-F3 Milestone) of the analysis, but will be tested later.

Table 21
Flood Hydrograph Combinations used in HEC-RAS Hydraulic Model
for Current Phase of Analysis

Sacramento Mainstem Flood-event AEP	Steelhead Creek Flood-event AEP	Natomas Cross Canal Flood-event AEP
0.500	0.500	0.500
0.200	0.500	0.500
0.010	0.200	0.200
0.040	0.010	0.010
0.020	0.040	0.040
0.010	0.020	0.020
0.005	0.010	0.010
0.002	0.005	0.005
American River Flood-event AEP	Steelhead Creek Flood-event AEP	Natomas Cross Canal Flood-event AEP
0.500	0.500	0.500
0.200	0.500	0.500
0.010	0.200	0.200
0.040	0.010	0.010
0.020	0.040	0.040
0.010	0.020	0.020
0.005	0.010	0.010
0.002	0.005	0.005

Notes: AEP = Annual Exceedence Probability

5.0 List of References

1. Sacramento and San Joaquin River Basins Comprehensive Study, Technical Studies Documentation. Appendix B: Synthetic Hydrology Technical Documentation. Appendix C: Reservoir Operations Modeling, Existing Design Operations and Reoperation Analyses. State of California Reclamation Board. U.S. Army Corps of Engineers, Sacramento District. December 2002**.**

2. Yuba River Basin Project General Reevaluation Report, Appendix A, Synthetic Hydrology & Reservoir Operations Technical Documentation. U.S. Army Corps of Engineers, Sacramento District. Aug 2004, corrected June 2008.

3. Folsom Dam and Lake Revised PMF Study, American River Basin, California, Hydrology Office Report. U.S. Army Corps of Engineers, Sacramento District. October 2001.

4. Hydrometeorological Report No. 59, Probable Maximum Precipitation for California. U.S. Department of Commerce, National Oceanic and Stmospheric administration. U.S. Army Corps of Engineers. February 1999.

5. Rain Flood Flow Frequency Analysis, American River, California, Office Report. U.S. Army Corps of Engineers, Sacramento District. August 2004.

6. Natomas General Reevaluation Report, Natomas Cross Canal and Steelhead Creek Watersheds, Placer, Sacramento, and Sutter Counties, California, Hydrology Appendix. U.S. Army Corps of Engineers, Sacramento District. October 2006.

7. Dry Creek, Placer and Sacramento Counties, California, Hydrology Office Report. U.S. Army Corps of Engineers, Sacramento District. July 1984, revised April 1988

8. "Use of Radar-Rainfall Estimates to Model the January 9-10, 1995 Floods in Sacramento, CA," by David C. Curtis, Ph.D., NEXRAIN Corporation, and John H. Humphrey, Ph.D., P.E., C.C.M., HYDMET, Inc. Paper presented October 1995

9. Sacramento County ALERT System gage map: <http://www.sacflood.org/alrtloc1.htm>.

10. City of Roseville Public Works Web page with access to maps with local gaging station locations: <http://www.roseville.ca.us/pw/engineering/floodplain_management/roseville_current_stream_levels/default.asp>.

11. Procedures for Developing Stage-Probability Functions for Tributary Streams. Prepared by David Ford Consulting Engineers, Inc. February 26, 2007.

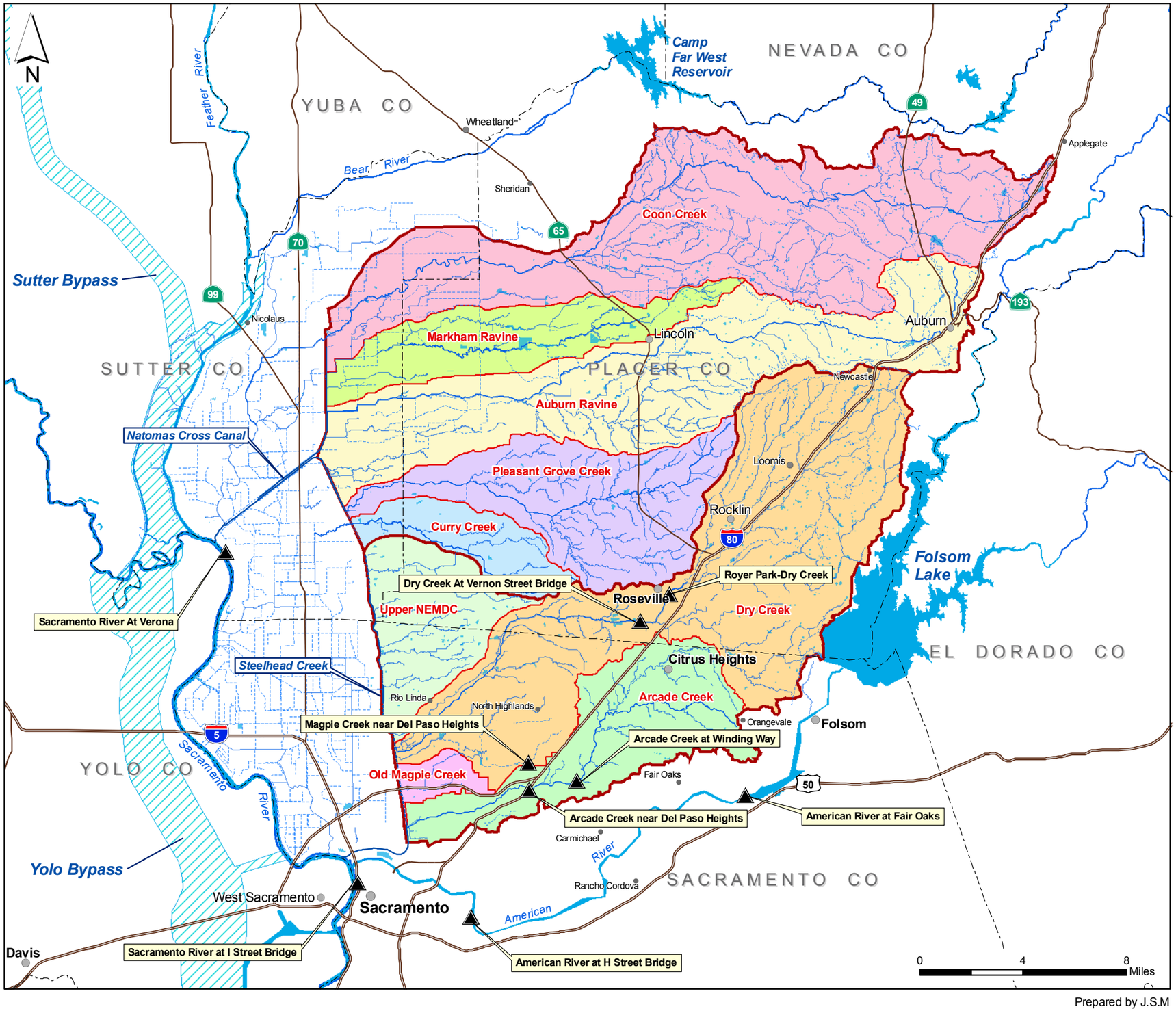
12. Memorandum: NCC/SHC Coincident-Frequency Study: Exposition of Analytical Procedures. Prepared by David Ford Consulting Engineers, Inc. September 10, 2008.

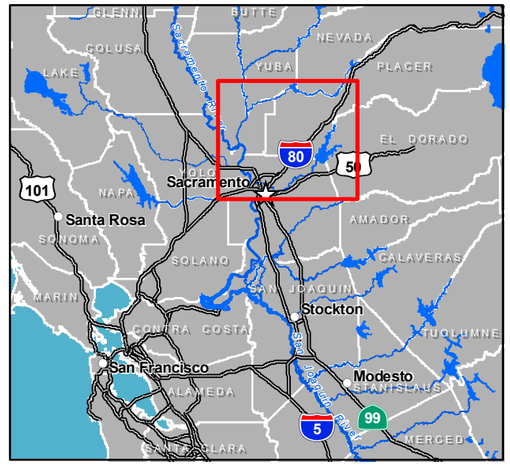
13. California Data Exchange Center (CDEC), the access point to the California Department of Water Resources' operation hydrologic data at: <http://cdec.water.ca.gov>.

14. Memorandum: Cross-Correlation Analysis Results for NCC/SHC Coincident-Frequency Study. Prepared by David Ford Consulting Engineers, Inc. April 17, 2008.

15. Rainfall Depth-Duration Frequency Analysis for California Rain Gages. Mr. James Goodridge, retired State of California climatologist. Revised 2005.

16. Memorandum: NCC/SCH Coincident Frequency Study: Computational Results. Prepared by David Ford Consulting Engineers, Inc. September 10, 2008.





Legend

- Stream Gage
- Watershed
- Sub-Watershed
- Lake or Major River
- River or Stream
- Canal or Ditch
- Freeway
- Highway
- County Boundary
- City or Town

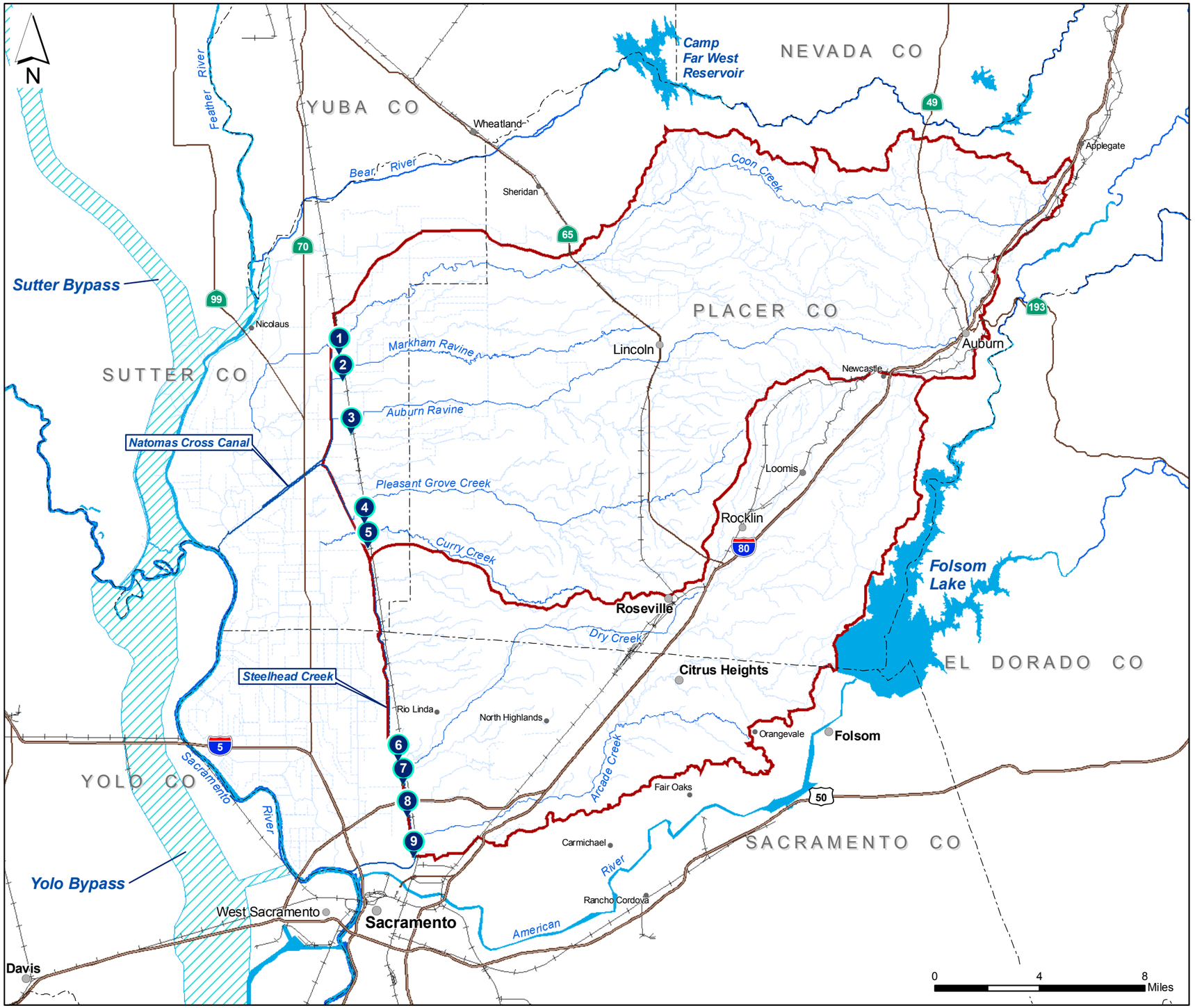
American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

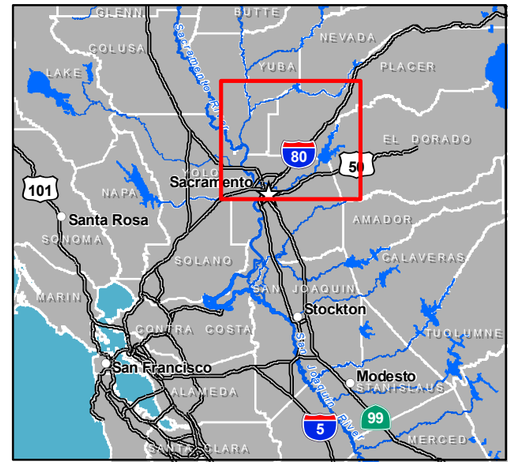
GENERAL MAP

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 1





Legend

- Watershed
- Lake or Major River
- River or Stream
- Canal or Ditch
- City or Town
- Freeway
- Highway
- Railroad
- County Boundary

Input Sites

1. Coon Creek
2. Markham Ravine
3. Auburn Ravine
4. Pleasant Grove Creek
5. Curry Creek
6. Upper NEMDC Tribs
7. Dry Creek
8. Old Magpie Creek
9. Arcade Creek

American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

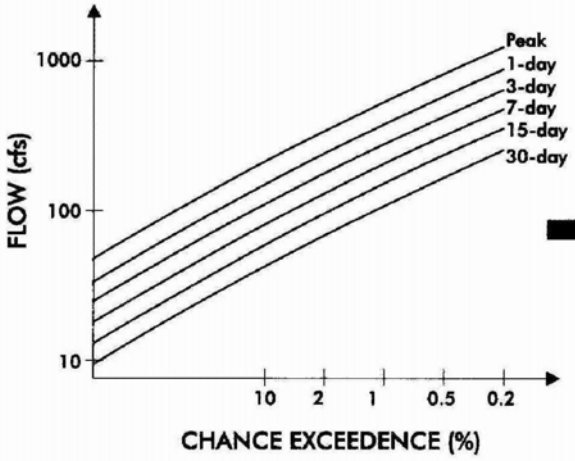
NATOMAS TRIBUTARY INPUT LOCATIONS FOR HYDRAULIC MODEL

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

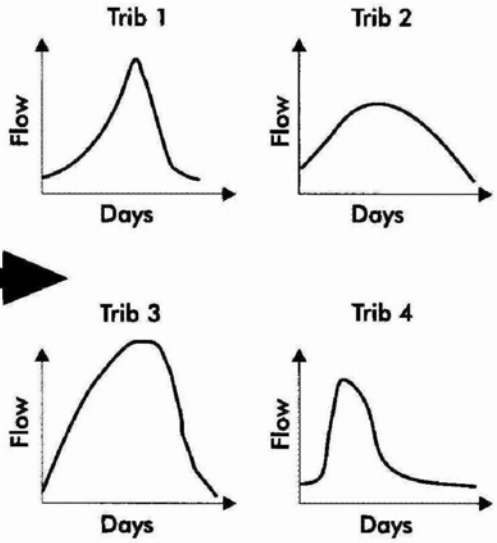
PLATE 2

Full Natural Flow



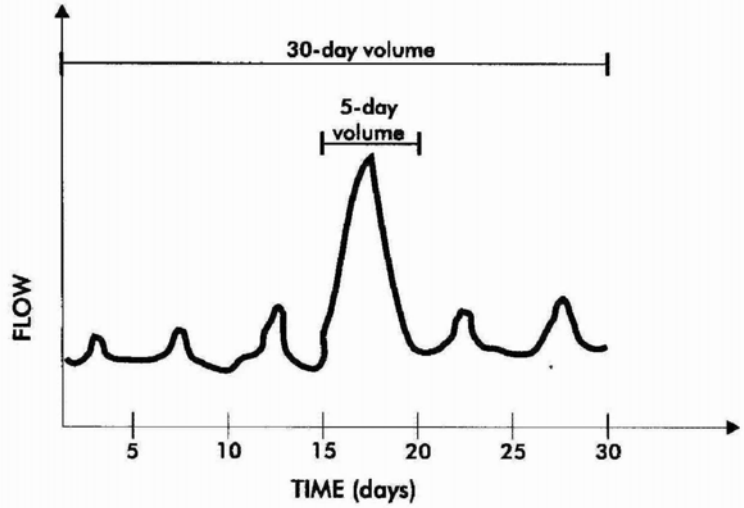
Full natural flow volumes were developed for each of 7 synthetic exceedence events on each tributary

Tributary-Specific Patterns



Tributary-specific hydrograph patterns were used to translate 5-day incremental volumes to flow patterns

Flow Patterns were combined to develop a 30-day period



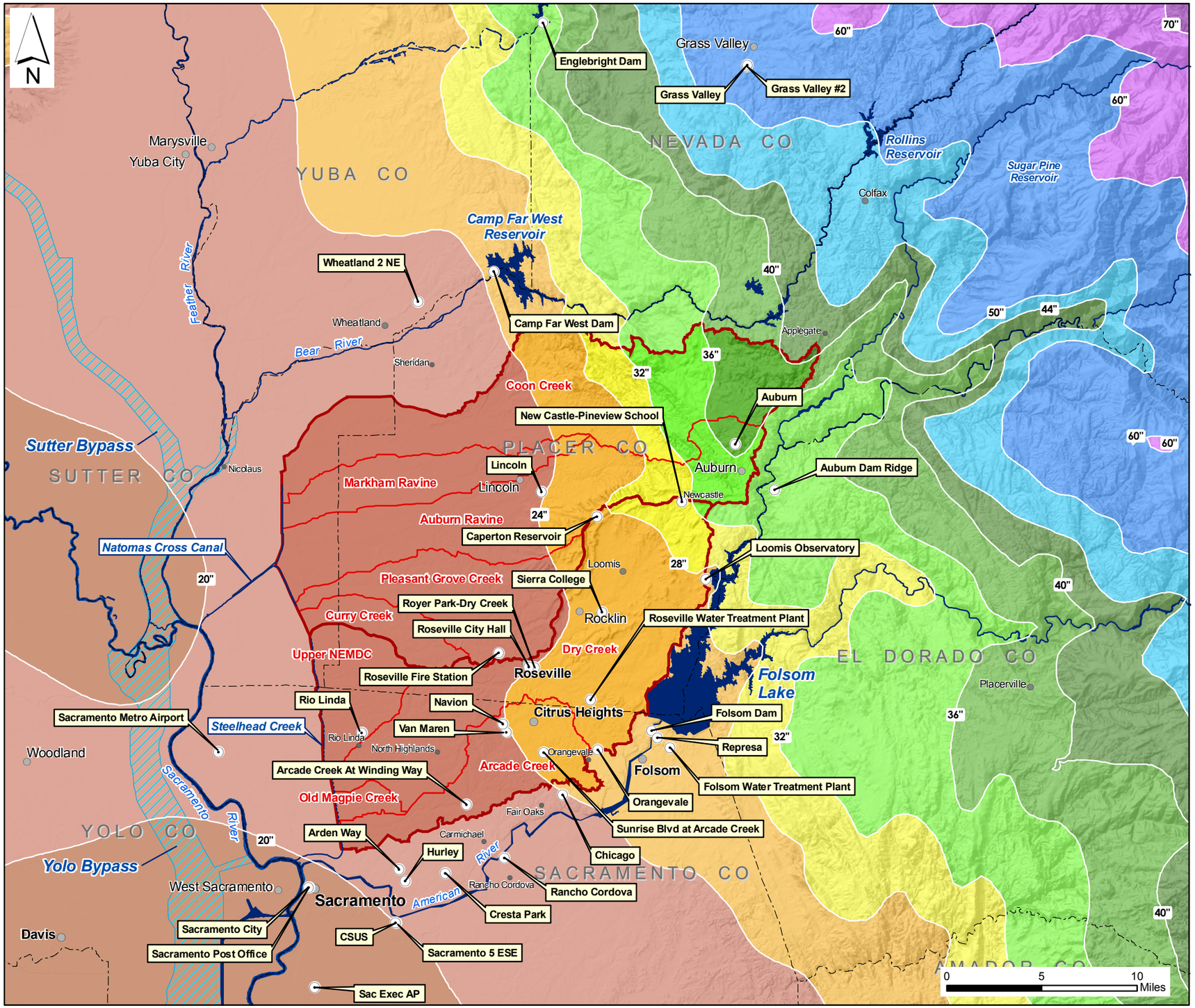
Resulting 30-day hydrographs for each of the 7 exceedence events on each tributary

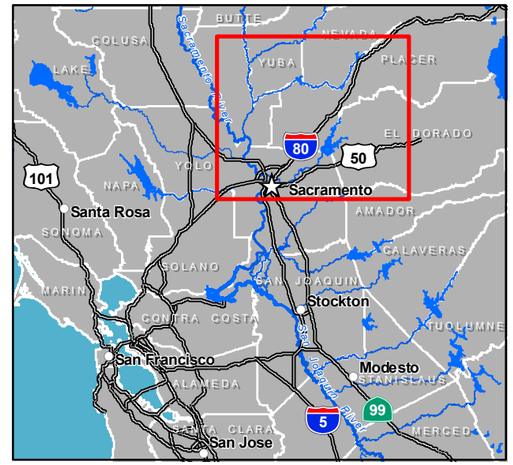
Sacramento & San Joaquin River Basins Comprehensive Study

HYDROGRAPH CONSTRUCTION

U.S. Army Corps of Engineers
Reclamation Board, State of California

July 2002





Legend

- Precipitation Gage
- Watershed
- Sub-Watershed
- Lake or Major River
- River or Stream
- Canal or Ditch
- County Boundary
- City or Town

Average Annual Precipitation (Inches):

18 - 20	32 - 36	50 - 60
20 - 24	36 - 40	60 - 70
24 - 28	40 - 44	70 - 80
28 - 32	44 - 50	

Precipitation data from the PRISM Group at Oregon State University - ***UNITED STATES AVERAGE ANNUAL PRECIPITATION, 1971 - 2000***

American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

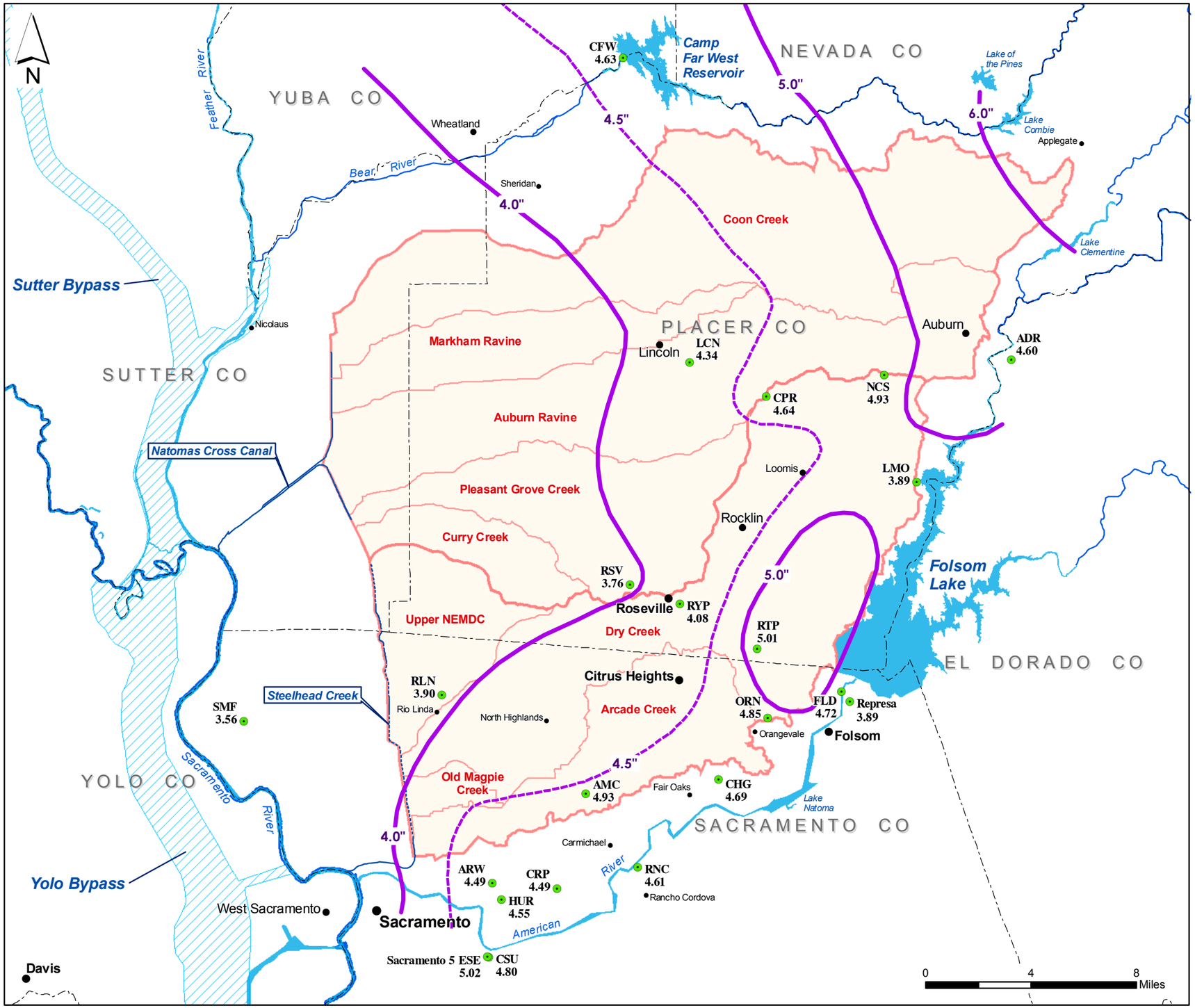
AVERAGE ANNUAL PRECIPITATION

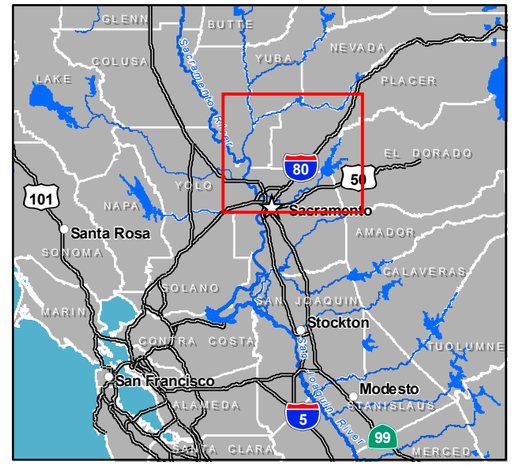
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by J.S.M

SEP 2008

PLATE 4





Legend

- Precip Gage (Event Total in inches)
- Isohyet
- Watershed
- Sub-Watershed
- Lake or Major River
- River or Stream
- County Boundary
- City or Town

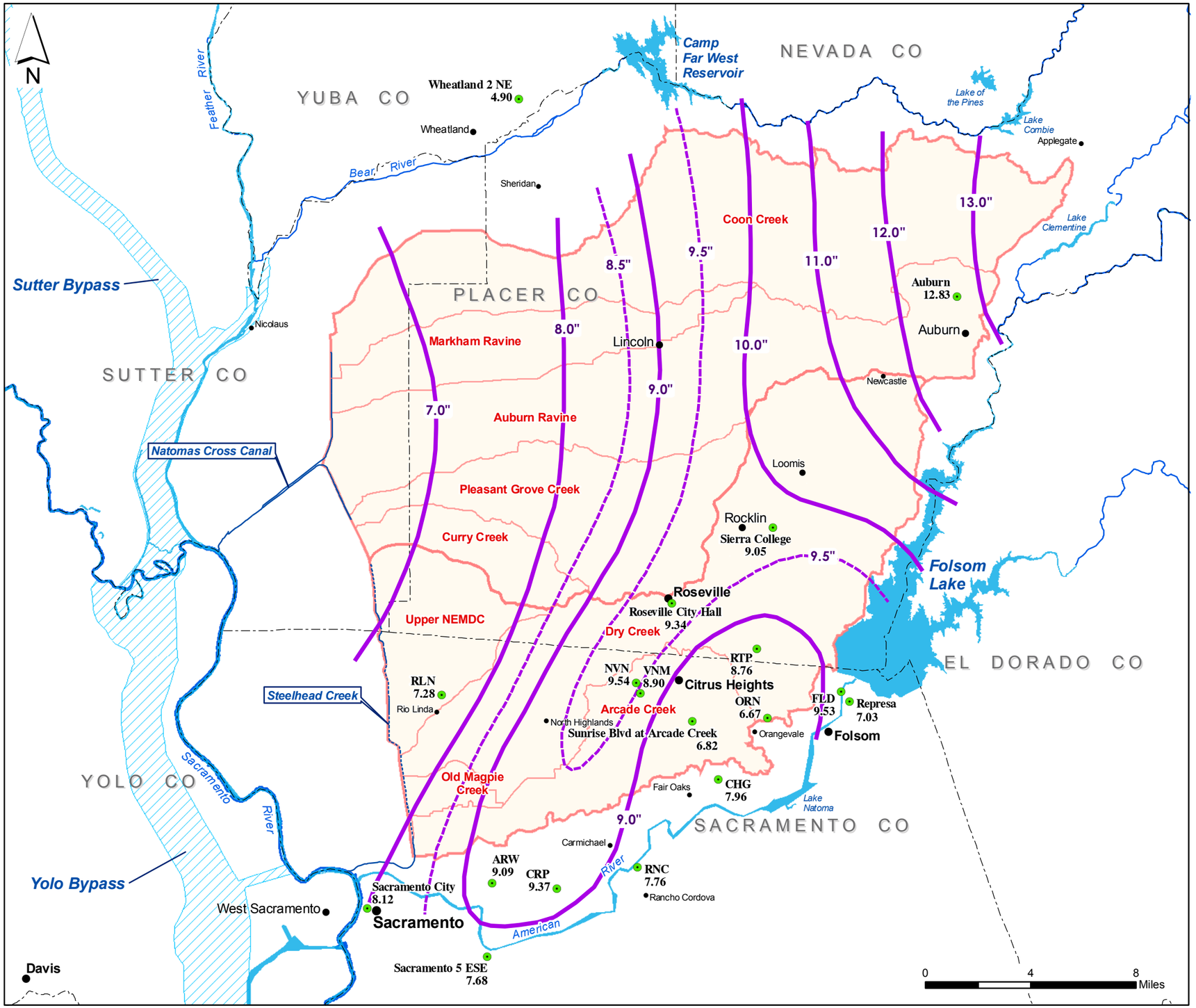
American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

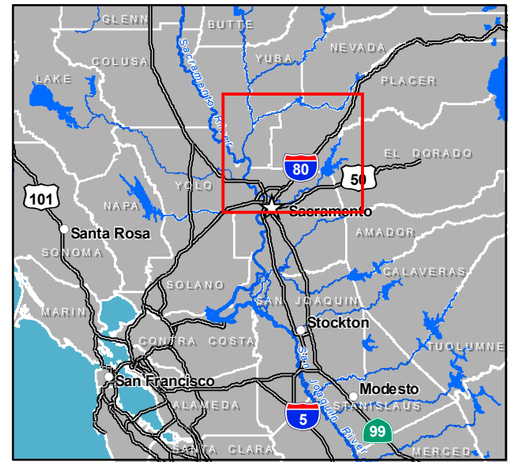
ISOHYETAL MAP FOR EVENT STORM 30 DEC 2005 - 2 JAN 2006

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 5





Legend

- Precip Gage (Event Total in inches)
- Isohyet
- Watershed
- Sub-Watershed
- Lake or Major River
- River or Stream
- County Boundary
- City or Town

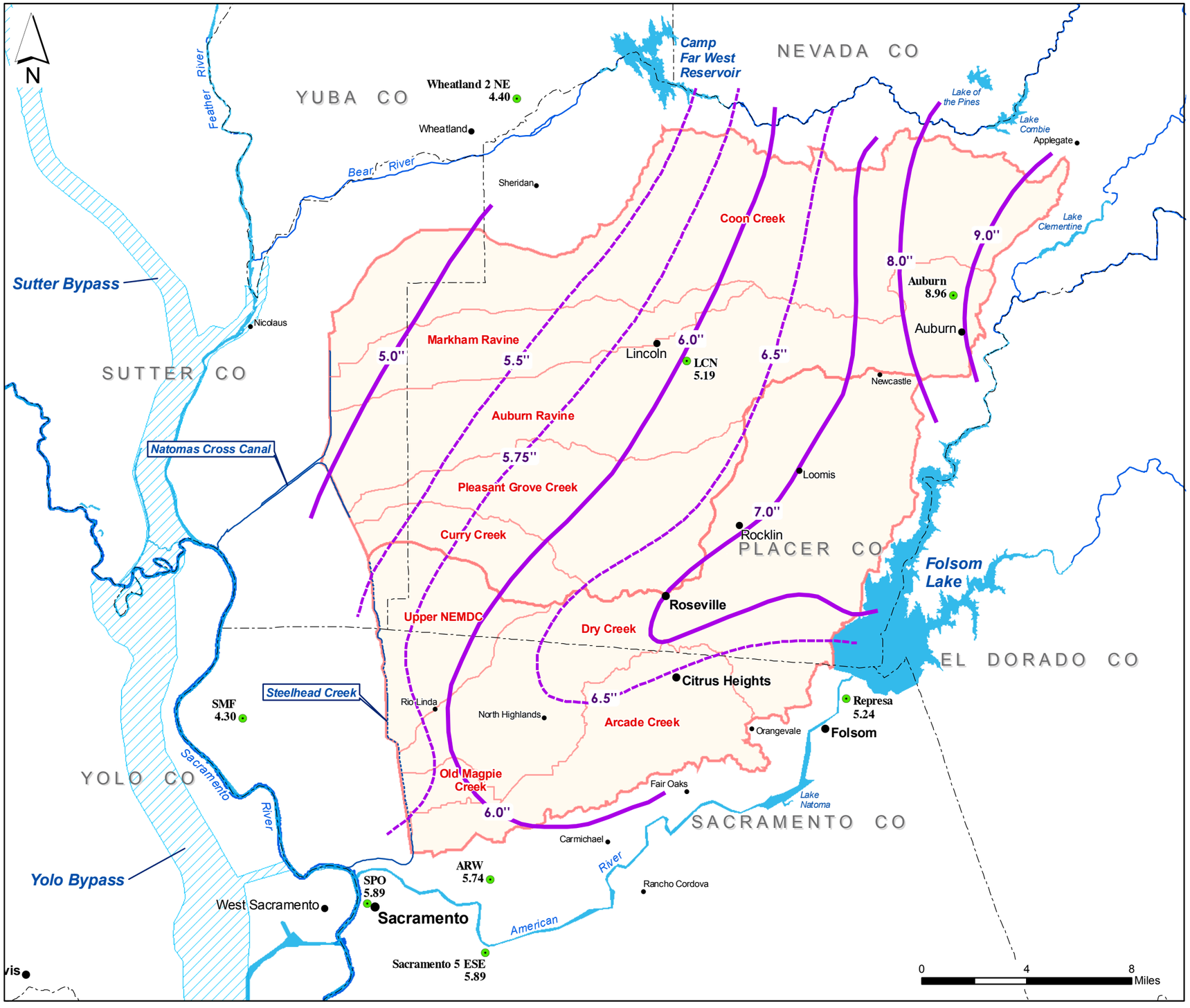
American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

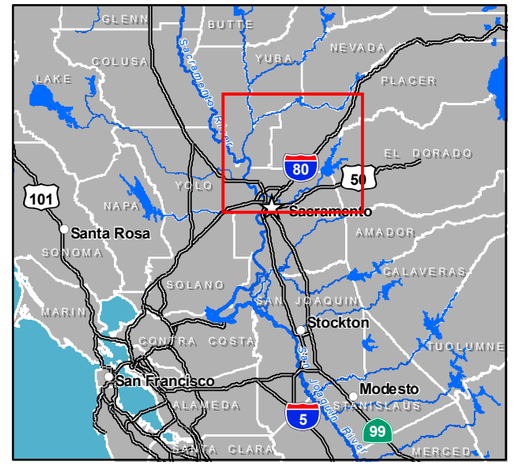
ISOHYETAL MAP FOR EVENT STORM
15 FEB - 19 FEB 1986

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 6





Legend

- Precip Gage (Event Total in inches)
- Isohyet
- Watershed
- Sub-Watershed
- Lake or Major River
- River or Stream
- County Boundary
- City or Town

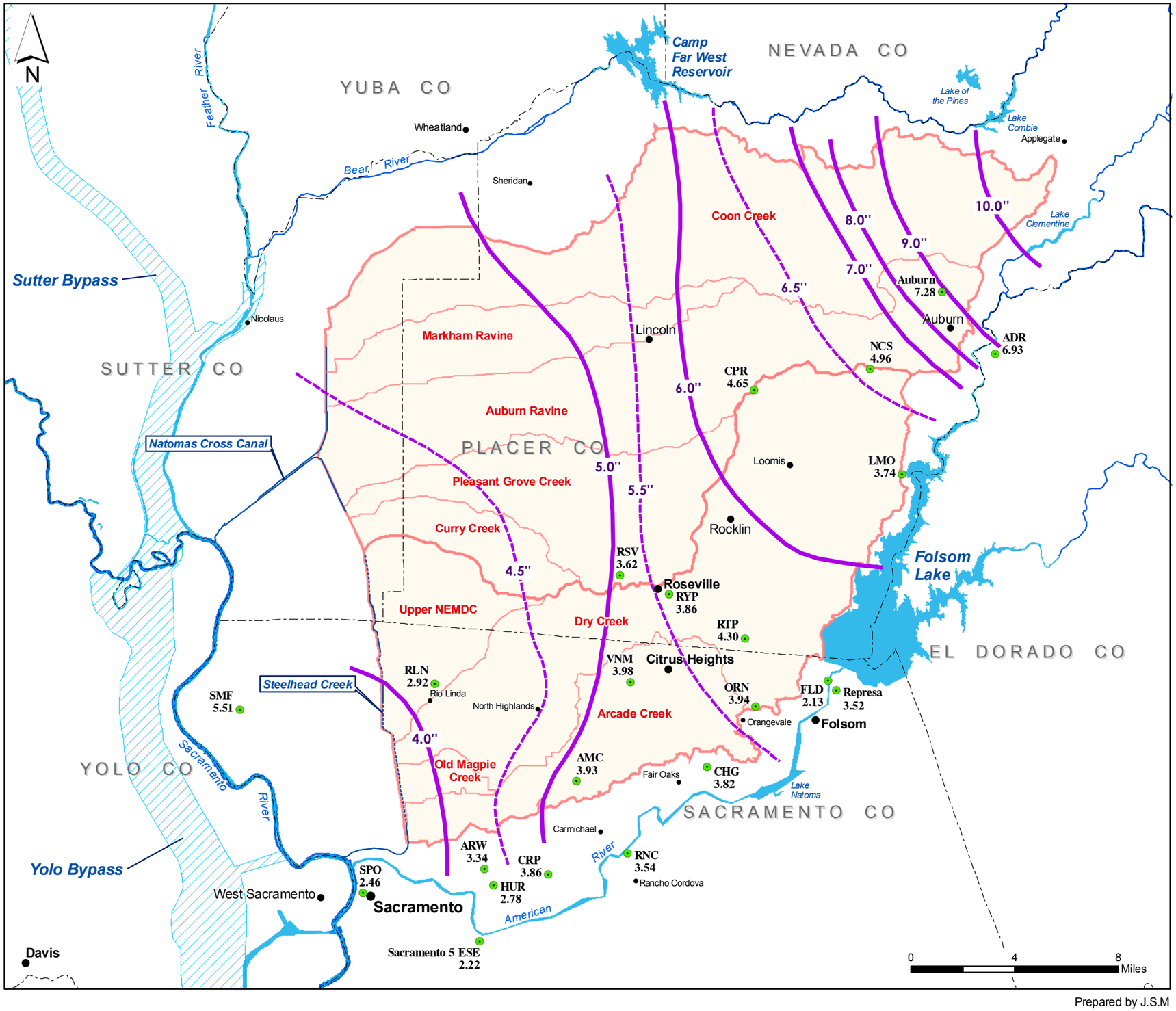
American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

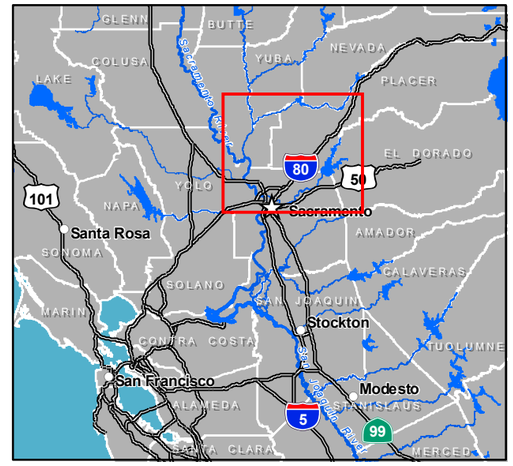
ISOHYETAL MAP FOR EVENT STORM 8 JAN - 12 JAN 1995

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 7





Legend

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- Isohyet
- Watershed
- Sub-Watershed
- Lake or Major River
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- City or Town

American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

ISOHYETAL MAP FOR EVENT STORM
29 DEC 1996 - 2 JAN 1997

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

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PLATE 8

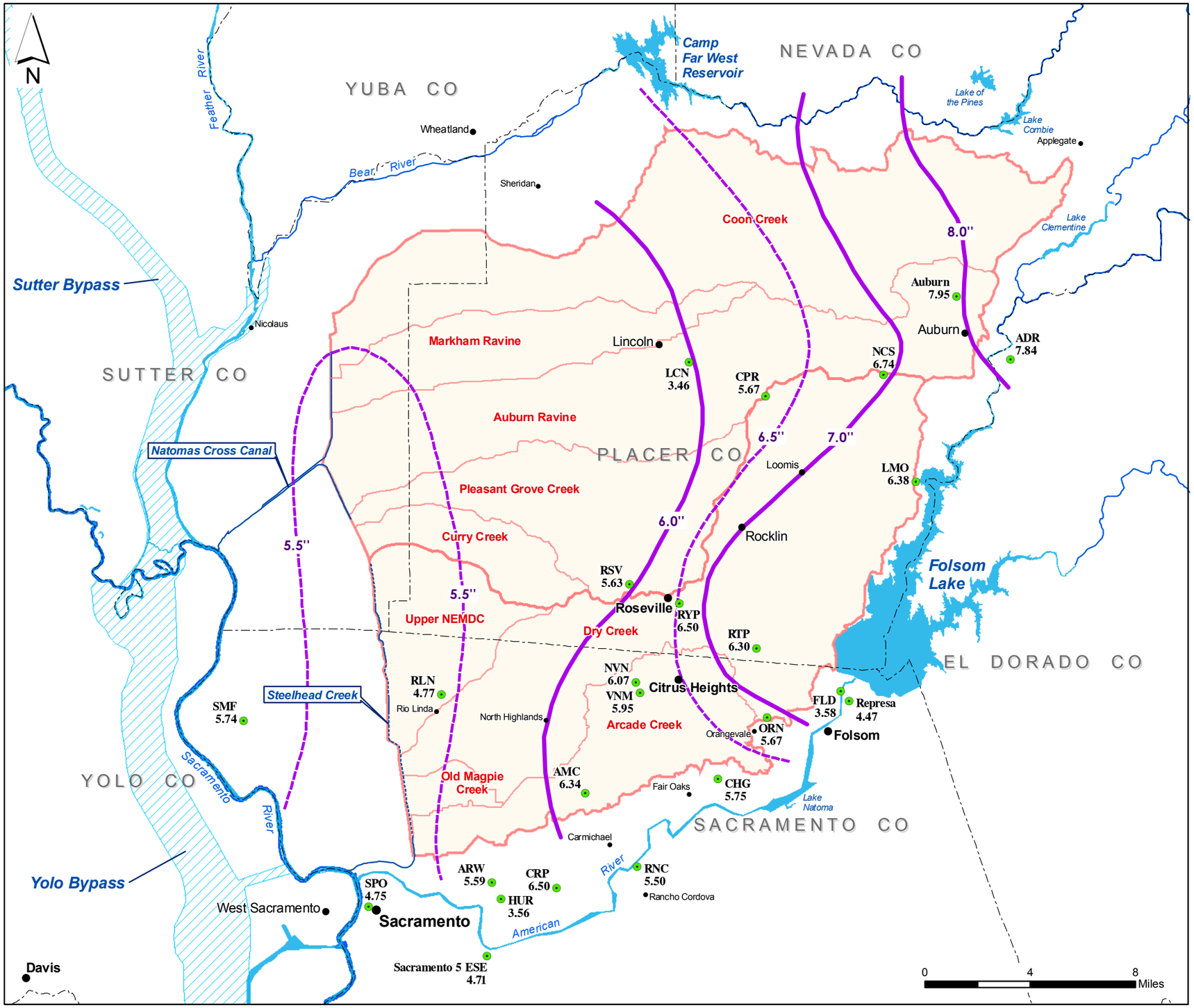

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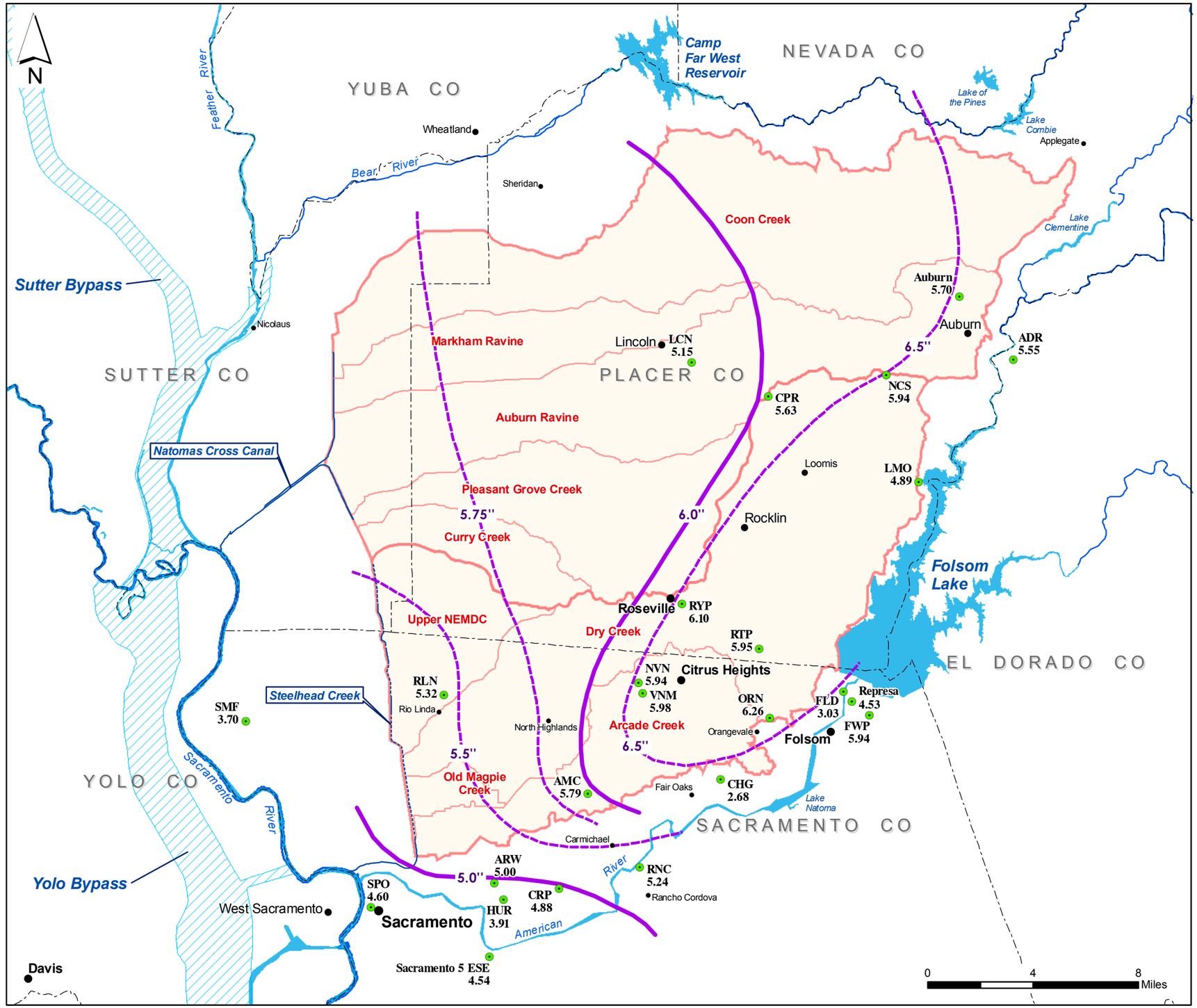
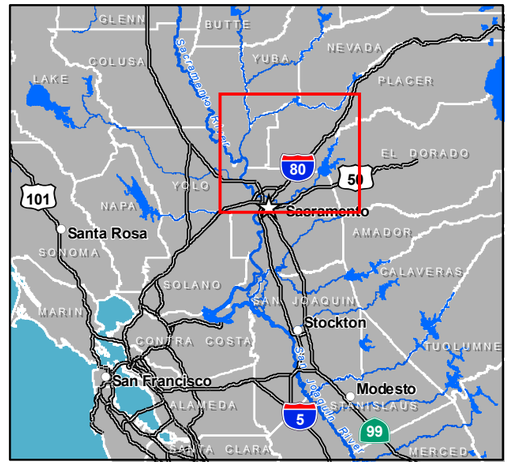
PLATE 9





Legend

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- Isohyet
- Watershed
- Sub-Watershed
- Lake or Major River
- River or Stream
- County Boundary
- City or Town

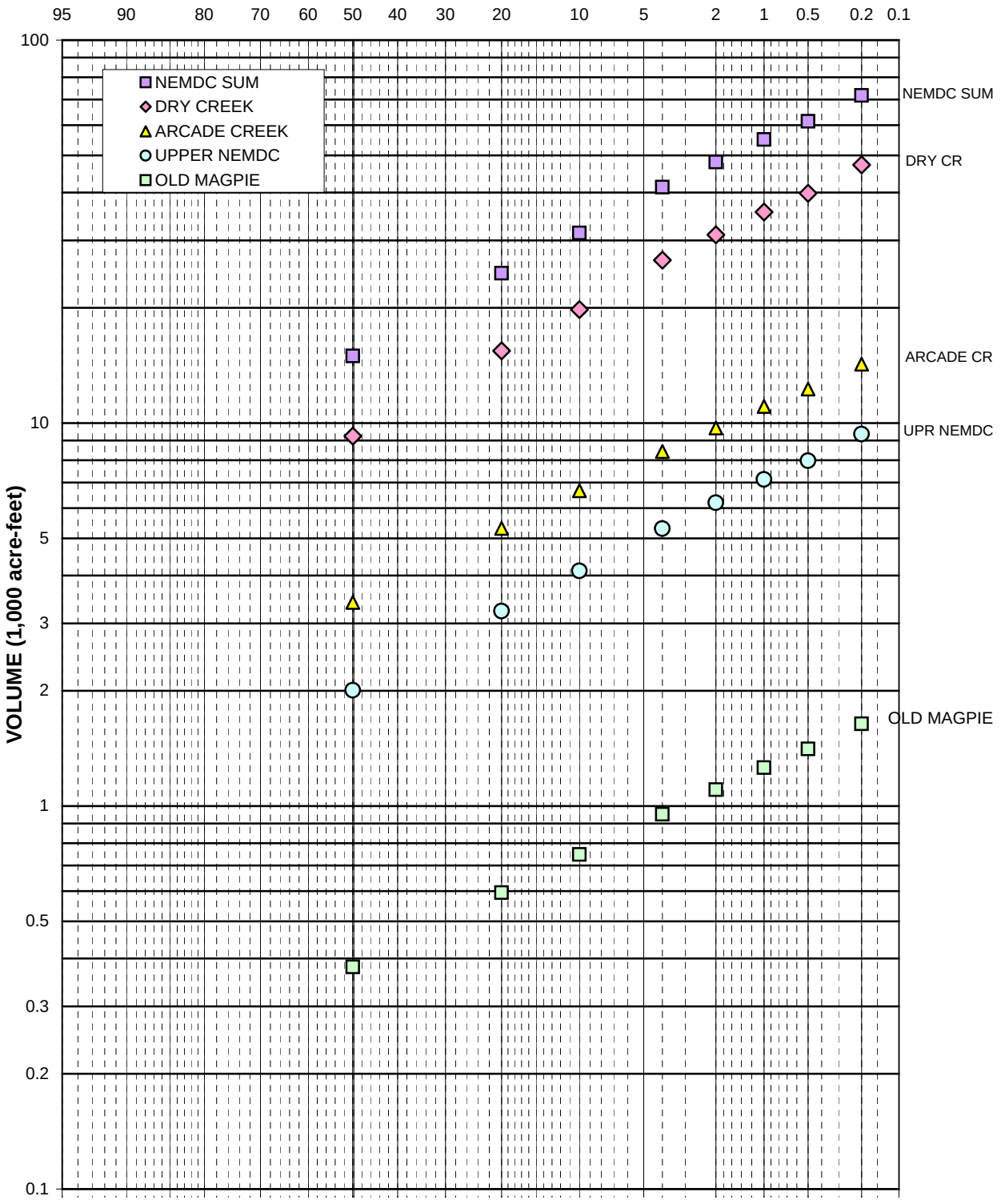
American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

ISOHYETAL MAP FOR EVENT STORM
2 FEB - 6 FEB 1998

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 10



NOTES:

Dry Creek 116.48 sq. mi.

Arcade Creek 40.14 sq. mi.

Upper NEMDC 27.13 sq. mi.

Old Magpie Sum 4.57 sq. mi.

NEMDC Sum 188.32 sq. mi.

AMERICAN RIVER COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CALIFORNIA

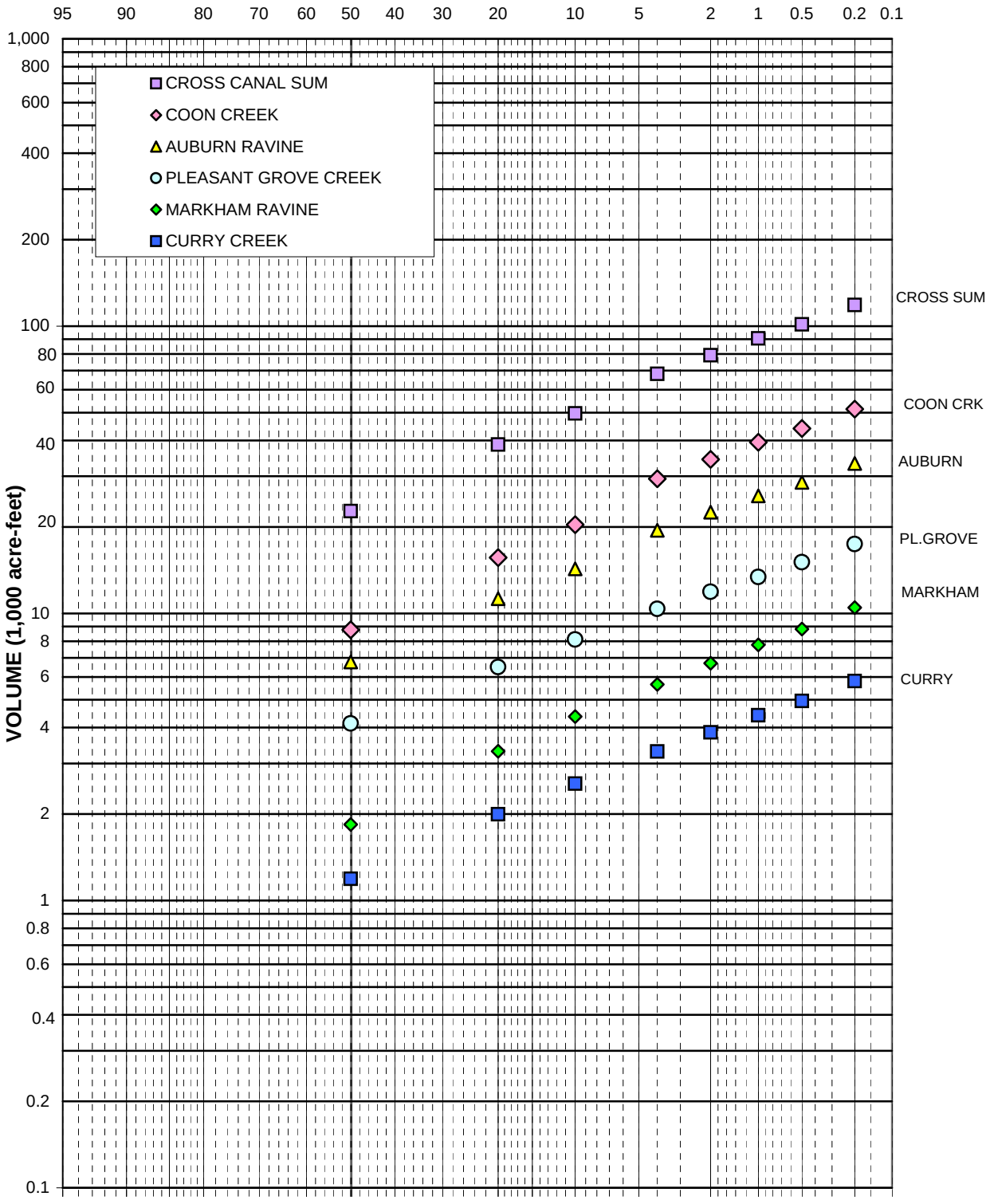
5-DAY VOLUME FREQUENCY CURVES STEELHEAD CREEK DRAINAGE

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Developed by LLW and prepared by JLB

SEP 2008

PLATE 11



NOTES:

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Pleasant Grove Creek 46.69 sq. mi.

Markham Ravine 32.36 sq. mi.

Curry Creek 16.59 sq. mi.

Cross Canal Sum 288.22 sq. mi.

Developed by LLW and prepared by JLB

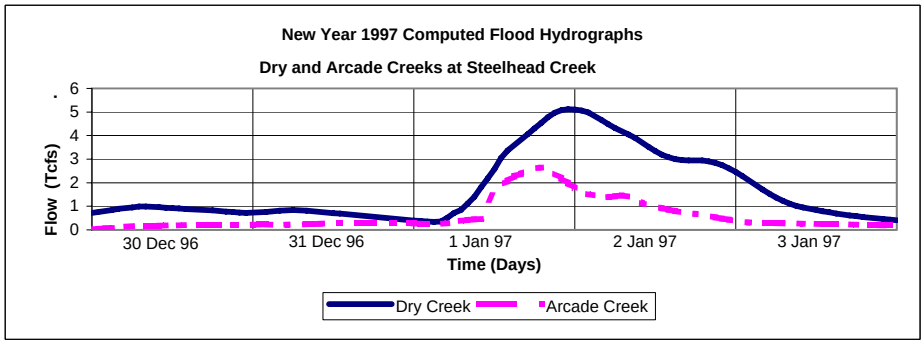
AMERICAN RIVER COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CALIFORNIA

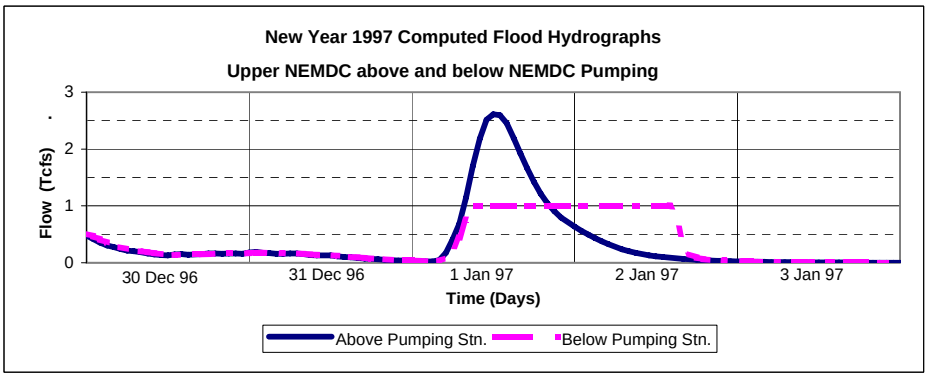
5-DAY VOLUME FREQUENCY CURVES CROSS CANAL TRIBUTARIES

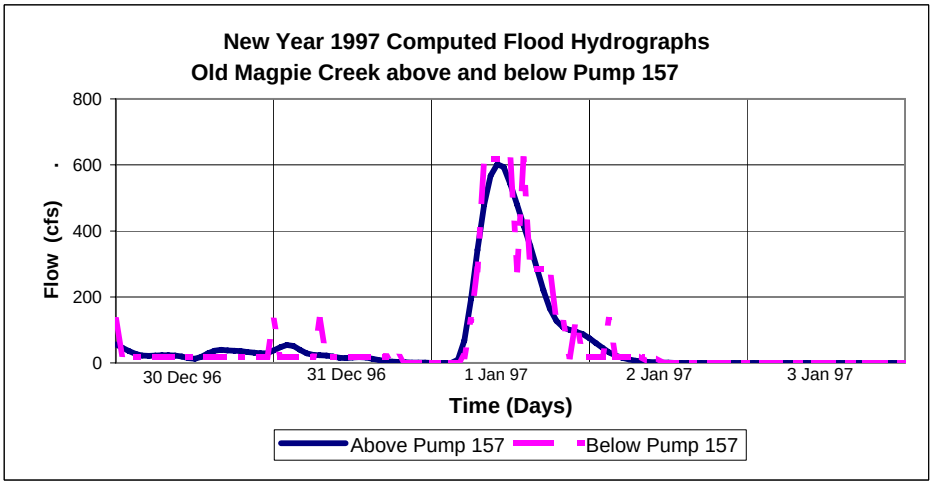
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 12







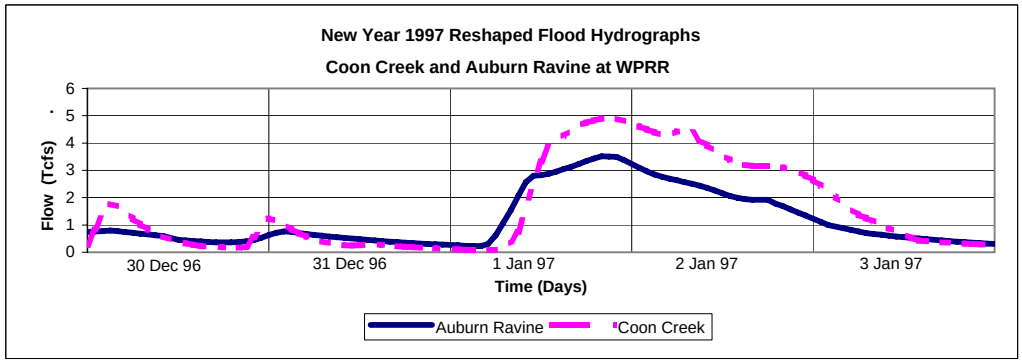
AMERICAN RIVER COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CALIFORNIA

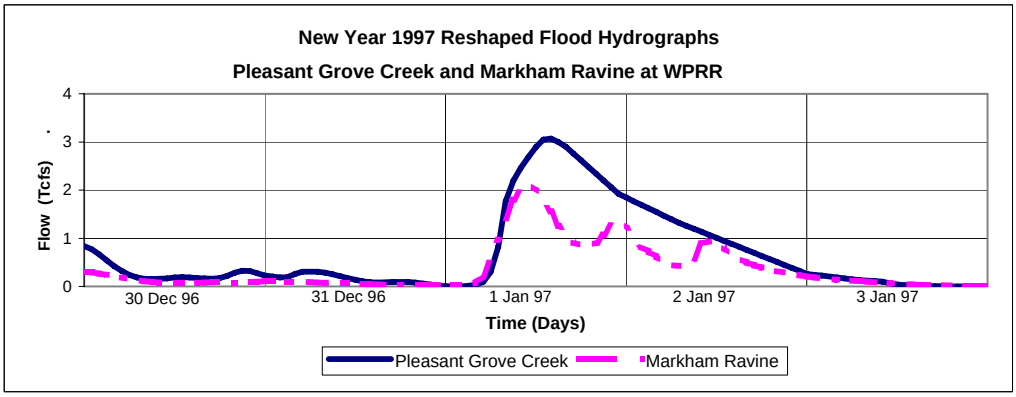
COMPUTED AND RESHAPED HYDROGRAPHS FOR FOR NEW YEAR 1997 FLOOD EVENT STEELHEAD CREEK TRIBUTARIES

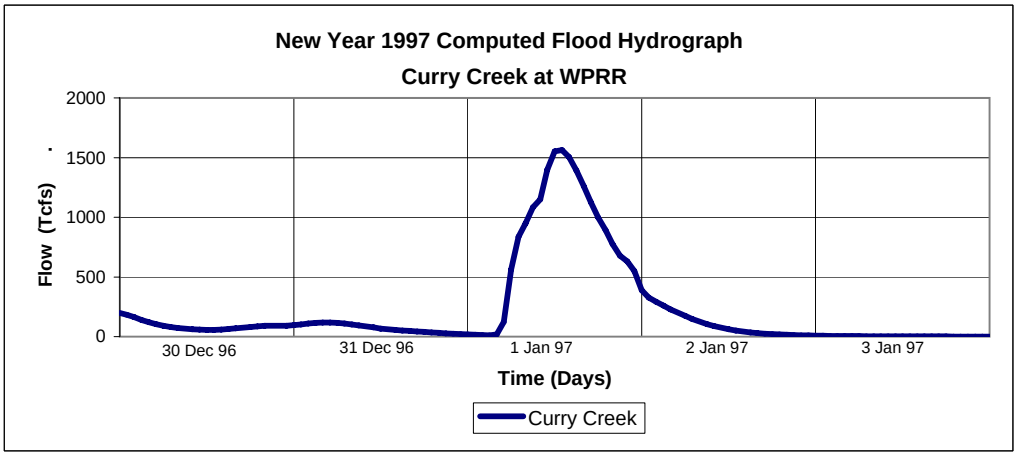
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 13-A







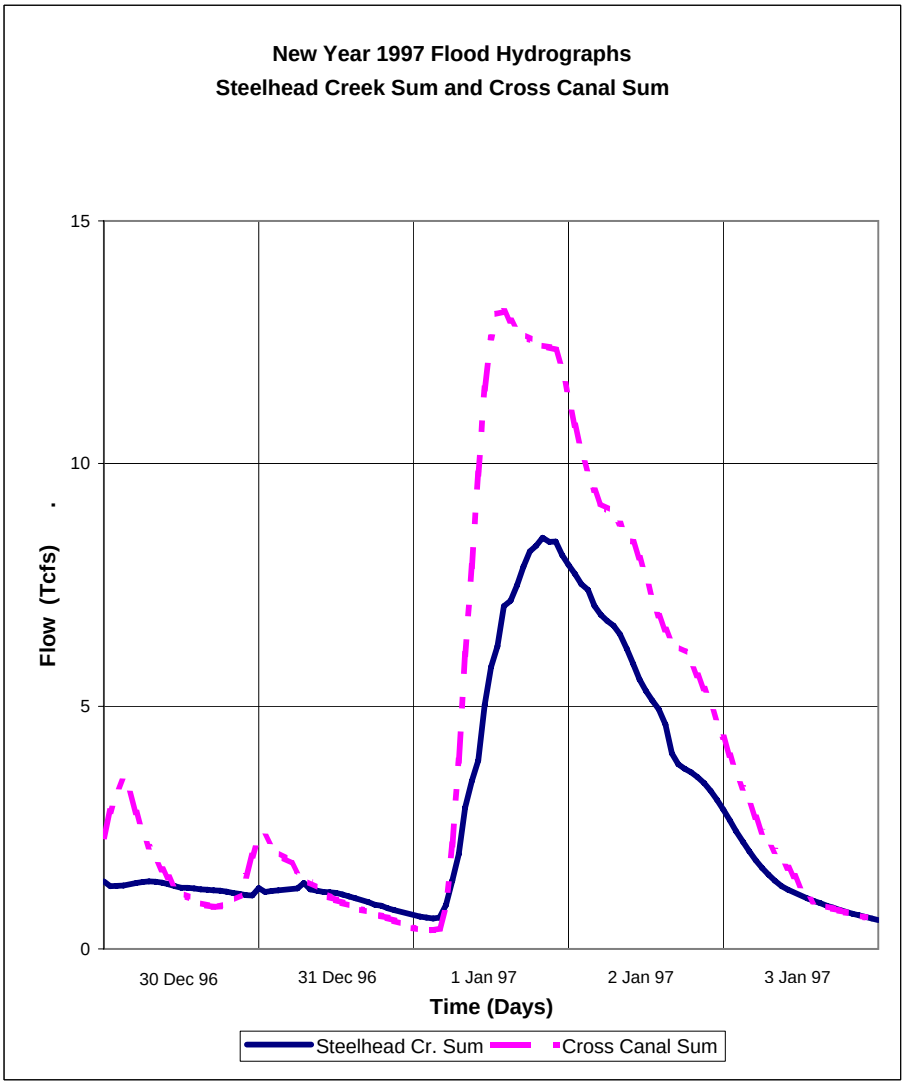
AMERICAN RIVER COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CALIFORNIA

COMPUTED AND RESHAPED HYDROGRAPHS FOR FOR NEW YEAR 1997 FLOOD EVENT NATOMAS CROSS CANAL TRIBUTARIES

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 13-B



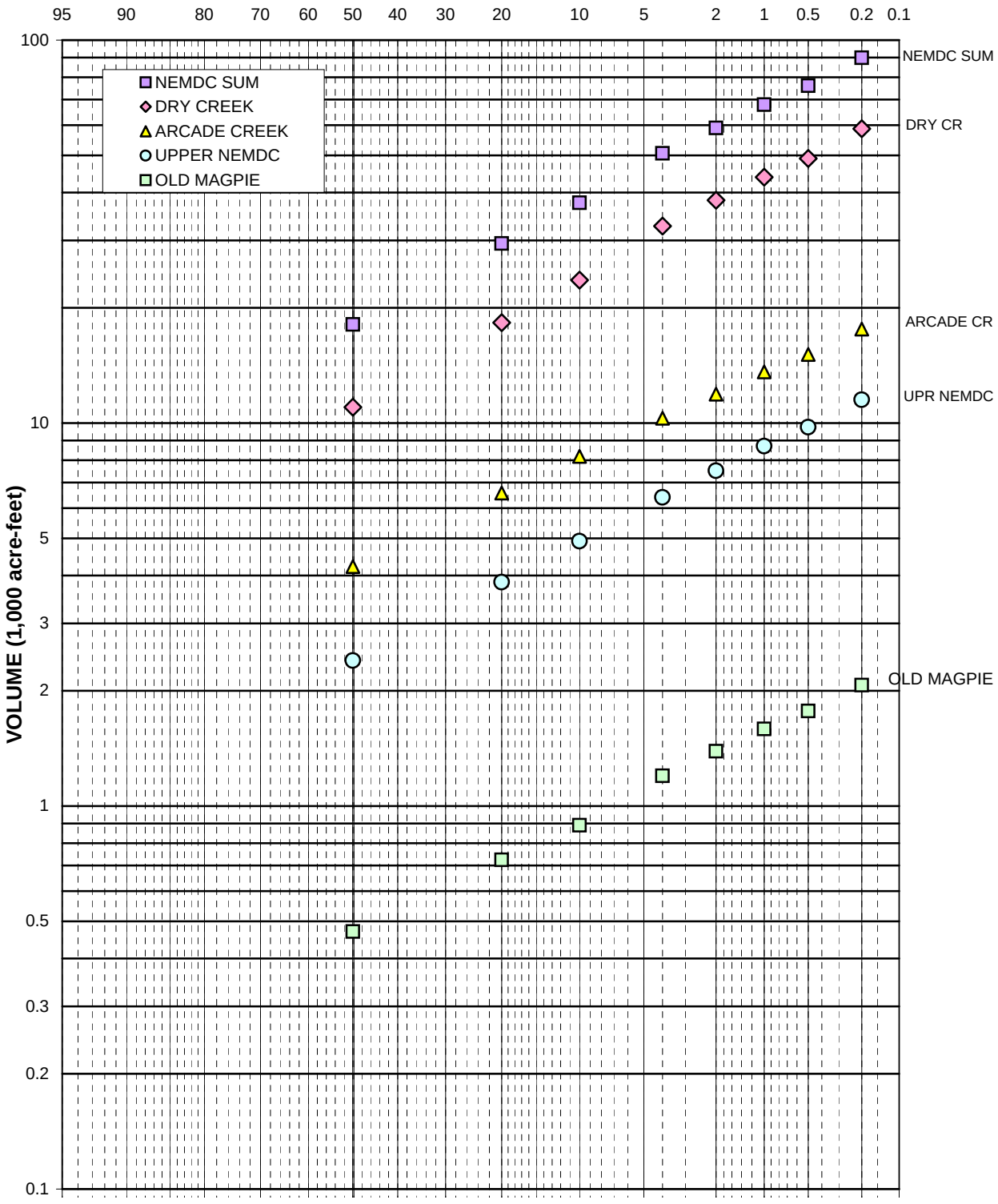
AMERICAN RIVER COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CALIFORNIA

COMPUTED AND RESHAPED HYDROGRAPHS FOR FOR NEW YEAR 1997 FLOOD EVENT
STEELHEAD CREEK SUM
NATOMAS CROSS CANAL SUM

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 13-C



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AMERICAN RIVER COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CALIFORNIA

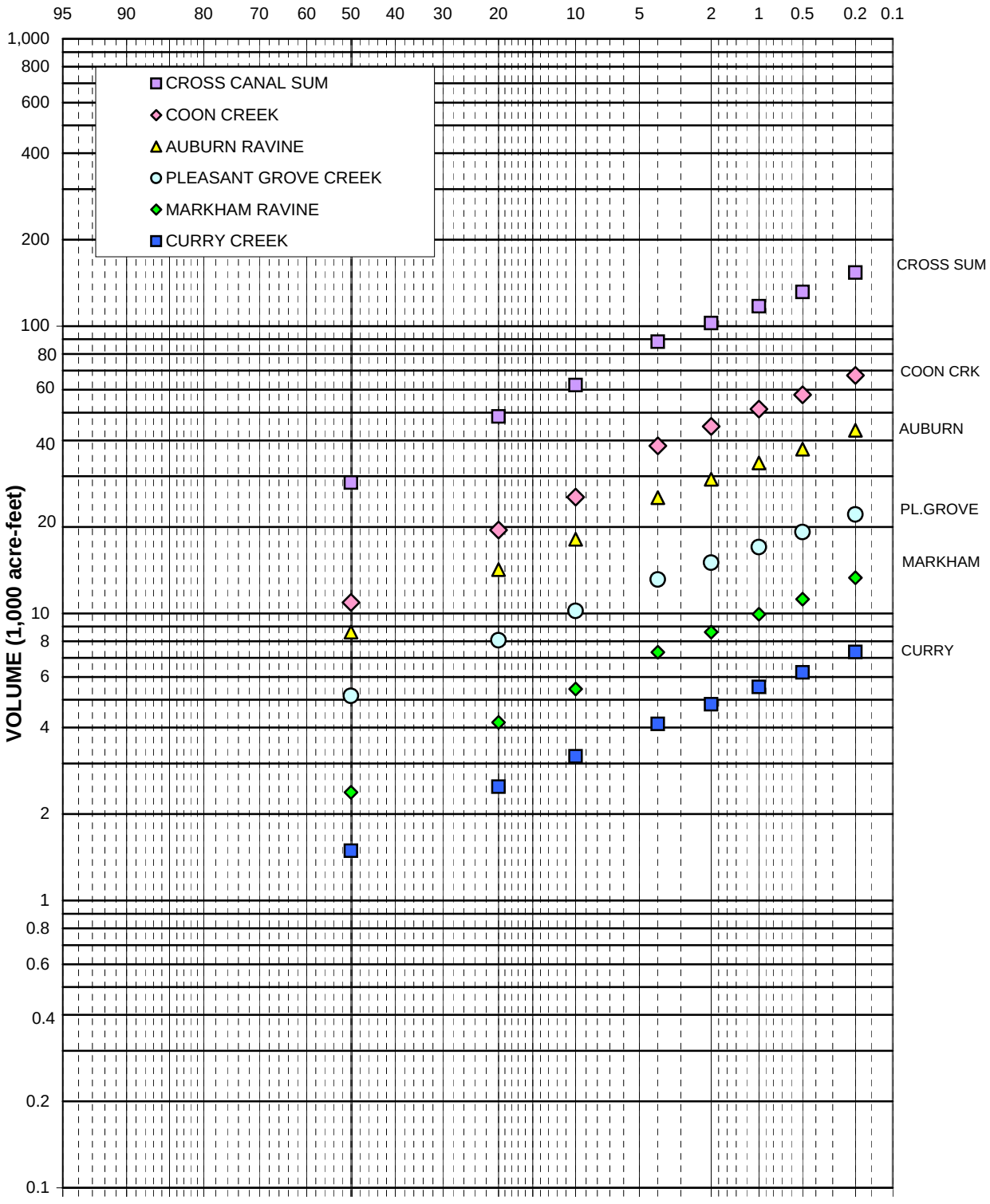
10-DAY VOLUME FREQUENCY CURVES STEELHEAD CREEK DRAINAGE

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Developed by LLW and prepared by JLB

SEP 2008

PLATE 14



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Curry Creek 16.59 sq. mi.

Cross Canal Sum 288.22 sq. mi.

Developed by LLW and prepared by JLB

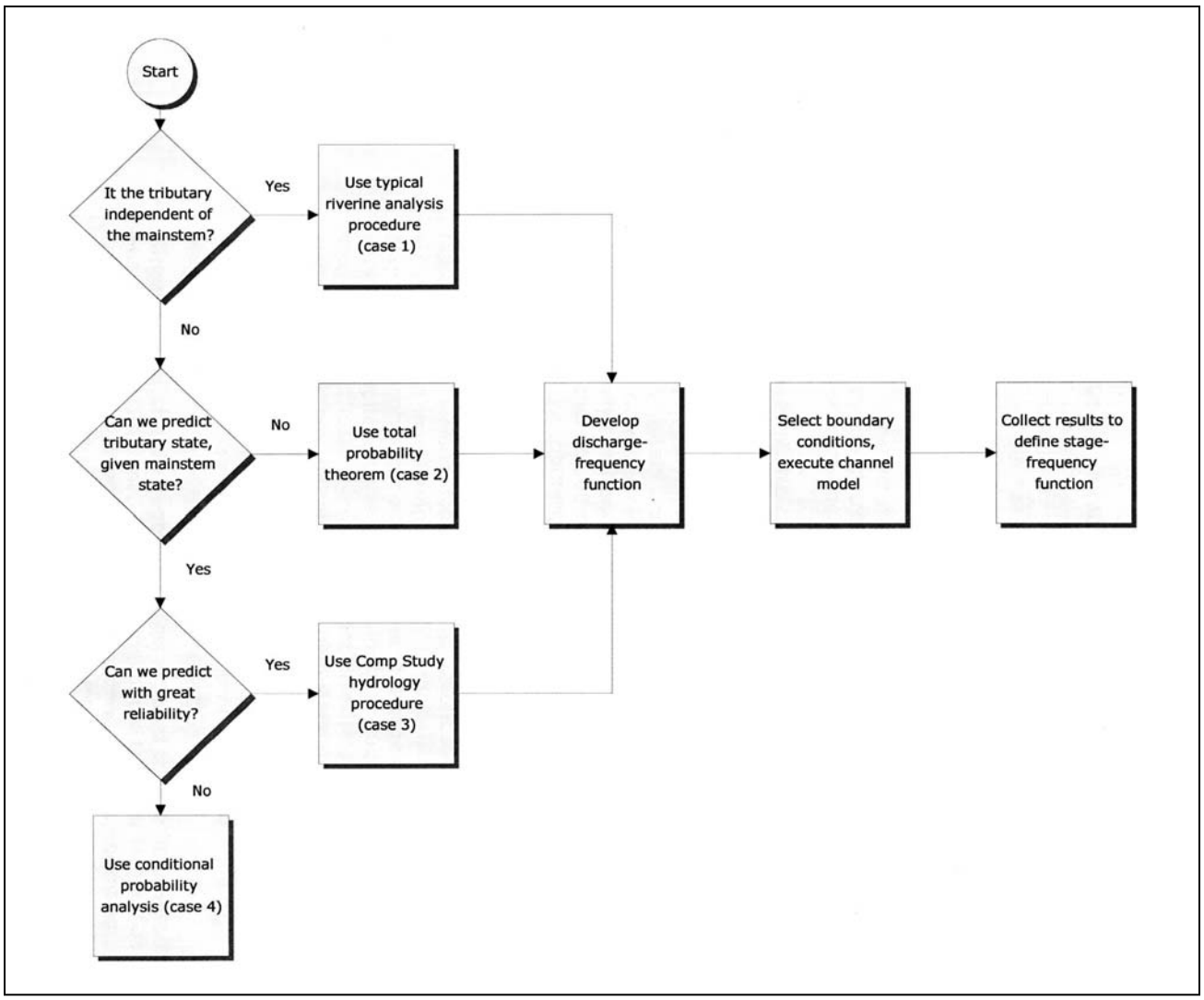
AMERICAN RIVER COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CALIFORNIA

10-DAY VOLUME FREQUENCY CURVES CROSS CANAL TRIBUTARIES

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SEP 2008

PLATE 15



Overview Flowchart for Tributary Analysis Procedure

American River Watershed
Common Features Project
Natomas Post-Authorization Change Report

American River Hydrology
&
Folsom Dam Reservoir Operations

APPENDIX B2

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AMERICAN RIVER HYDROLOGY & FOLSOM DAM RESERVOIR OPERATIONS

A-1 Purpose

The scope of this General Reevaluation Report (GRR) covers the greater Sacramento area, which includes the Lower American River and the Natomas Basin. Hydraulic and geotechnical studies of the area have been on-going and have already identified many issues (e.g. seepage, erosion, vegetation, etc) which could lead to levee failure. The latest findings indicate that the Sacramento area is still highly susceptible to flooding due to levee failure even with all the authorized repairs and improvements. The economic analyses will evaluate the flood risk and cost benefit of fixing the identified problems. This write-up covers the development of the Folsom Dam discharge hydrographs provided to Hydraulic Design for the floodplain delineation efforts and the development of the hydrologic data inputs provided to Economics for the HEC-FDA model. The economic analysis will evaluate the extent of the damage caused by levee failures within the basin. Two scenarios were evaluated for the existing condition: the without-project (WO) condition and the future without-project condition, which is labeled as the no-action (NA) condition. These scenarios provide the information needed to perform an incremental analysis of the state of the levees at various levels of improvement (objective release 115,000 cfs, 145,000 cfs, or 160,000 cfs) and of the affect of the levee state when combined with the other authorized project components. Generally, these scenarios are hypothetical and would not be built or implemented as stand-alone projects. The reservoir routings covered herein were developed for planning purposes, only. All reservoir elevations provided herein use the NGVD29 vertical datum.

A-2 Background

As an interim means of reducing flood risk, Congress authorized the American River Common Features Project under Section 101(a) (1) of the Water Resources Development Act (WRDA) 1996. The features that were common to three candidate plans identified by the Corps, SAFCA, and the State of California Reclamation Board (State Reclamation Board) in the 1996 Supplemental Information Report (SIR) were covered in the authorization. The levee repairs and improvements included:

- 24 miles of slurry wall in the levees along the lower American River
- 12 miles of levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal
- Installation of three telemeter streamflow gages upstream from the Folsom Reservoir
- Modification to the flood warning system along the lower American River
- Raising the left bank of the non-Federal levee upstream of Mayhew Drain for a distance of 4,500 feet by an average of 2.5 feet
- Raising the right bank of the American River levee from 1,500 feet upstream to 4,000 feet downstream of the Howe Avenue Bridge by an average of 1 foot
- Modifying the south levee of the Natomas Cross Canal for a distance of 5 miles to ensure that the south levee is consistent in level with the level of protection provided by the authorized levee along the east bank of the Sacramento River
- Modifying the north levee of the Natomas Cross Canal for a distance of 5 miles to ensure the height of the levee is equivalent to the height of the south levee as authorized (above)
- Installing gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates
- Installing a slurry wall in the north levee of the American River from the east levee of the Natomas east Main Drain upstream for a distance of approximately 1.2 miles
- Installing a slurry wall in the north levee of the American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to the end of the existing levee

Section 366 of WRDA 1999 authorized more improvements which included the raising and strengthening of the levees along the American River and additional work in Natomas.

The Common Features GRR was initiated because the economic basis for the original authorization has changed. The Common Features Project has been subject to significant cost increases due to major design modifications and to additional work proposals. Further investigations into additional modes of levee failure (i.e. slope stability, seepage, underground utilities and vegetative growth and long term degradation effects that include erosion) have revealed that in order to ensure the integrity of the levee system, while sustaining 160,000 cfs, much more work is required than was originally identified under WRDA 96 and WRDA 99. According to *Appendix D – Hydraulic Technical Documentation of the F3 Document*, the hydraulic modeling and geotechnical studies have identified potential seepage issues on both the Sacramento and American Rivers and erosion issues on the American River. In order to better describe the potential impact of flooding within the entire Sacramento area, the scope of the Common Features project must be expanded to consider the risk of levee failure along the Sacramento River, American River and the Natomas Basin. This system-wide approach provides a more comprehensive view of the flood risk to the Sacramento metropolitan area.

Congress also authorized the "Folsom Modifications Project" under Section 101 of WRDA 1999 and the "Folsom Dam Raise Project" in 2003. Although these projects were authorized independently, the project performances are intertwined based on when the projects are assumed completed. Due to constructability issues with the "Folsom Modifications Project", both the "Folsom Modifications Project" and the "Folsom Dam Raise Project" required reexamination. The Corps sought to combine the objectives of these two authorized projects with Reclamation's dam safety project. This resulted in the Joint Federal Project (JFP), which met the flood damage reduction and dam safety objectives of the USACE, Reclamation, and the local sponsor. The ability of the downstream levees to handle 160,000 cfs is a key factor in achieving the following goals: 1) control the 1-in-200 year event by holding the release at 160,000 cfs (or less) and 2) control the PMF event while maintaining at least 3 ft of freeboard.

A-3 American River Hydrology

The Comprehensive Study data provides the majority of the input to the Hydraulic Design HEC-RAS model. The one exception is the data for the American River. Both the hydrology and routing tool for American River flows differ. Although the HEC-ResSim model built for the Comprehensive Study simulates system-wide operation for multiple reservoirs on the Sacramento River along with those on its major tributaries, the Folsom Dam Excel-based reservoir routing model provides the means necessary to examine Folsom Dam project features in more detail. For consistency, the same hydrology used in other American River studies was utilized for the Common Features GRR. See *Appendix A – Synthetic Hydrology Technical Documentation* for a discussion on the differences between the Comprehensive Study and the American River studies unregulated hydrographs for the American River.

A series of hypothetical inflow hydrographs (i.e. 50%-, 10%-, 4%-, 2%-, 1%-, 0.5%-, 0.2%-annual chance flood events) were developed for the flood risk management analyses. See **Figure A-1**. Design flood hydrographs can be patterned after historical or hypothetical events. In this instance, the flood hydrographs are patterned after the synthetic 2001 PMF event. Each hydrograph consists of multiple waves -- as would occur if a series of storms moved through the region. The sequencing of waves is an important aspect to consider when developing synthetic flood hydrographs. Antecedent waves could induce encroachment into the flood pool prior to the arrival of the main wave. This situation is most likely to occur when a project has limited release capability as under the existing project condition.

The selected hydrograph pattern is proportioned to match the annual maximum 3-day volume and peak for designated exceedance probabilities. The 3-day duration is considered the most critical within the American River basin. Past analyses has shown that the 3-day duration has the greatest impact on operation of the existing flood control system (Folsom Dam and the downstream levees), as well as plan formulation for the American River Basin and most other Sacramento Basin tributaries.

Longer duration hydrographs (more than 3-days) are utilized in the modeling because:

a) Atmospheric rivers tend to produce 3 - 5 day precipitation waves in this region
b) After a levee break, the large, flat floodplain areas in the Sacramento area may take more than 3 days to fill
c) More than 3 days must be simulated to account for timing between the larger Sacramento River and smaller American River.

Critical duration is the most challenging volume to the safe operation of the project to protect downstream. The maximum storage (filling of the reservoir) and maximum downstream discharge occurs during the maximum 3-day unregulated inflow, rather than after that period. While critical duration is described as the 3-day, the Folsom Dam inflow hydrographs are actually balanced to multiple durations (including the critical 3-day volume). The hydrograph is balanced to all durations shown in Table A-1 (page B2-4) which includes the peak, 1-, 3-, 7-, 15-, and 30-day durations.

The flood volumes are obtained from a family of unregulated inflow frequency curves. The statistics used to generate these curves were last updated in 2004 using the statistical procedures and methodologies outlined in *Bulletin 17B, Guidelines for Determining Flood Flow Frequency* (United States Geologic Survey [USGS], 1982). *Rain Flood Flow Frequency Analysis, American River, California* (Corps, 2004) documents this process from start to finish beginning with preparation of the data and ending with development of the Log Pearson III statistics presented in **Table A-1.** The mean daily flow at the Fair Oaks gage downstream was used to develop the unregulated inflow for Folsom Dam. The drainage area between Fair Oaks and Folsom Dam does not generate a significant amount of local flow.

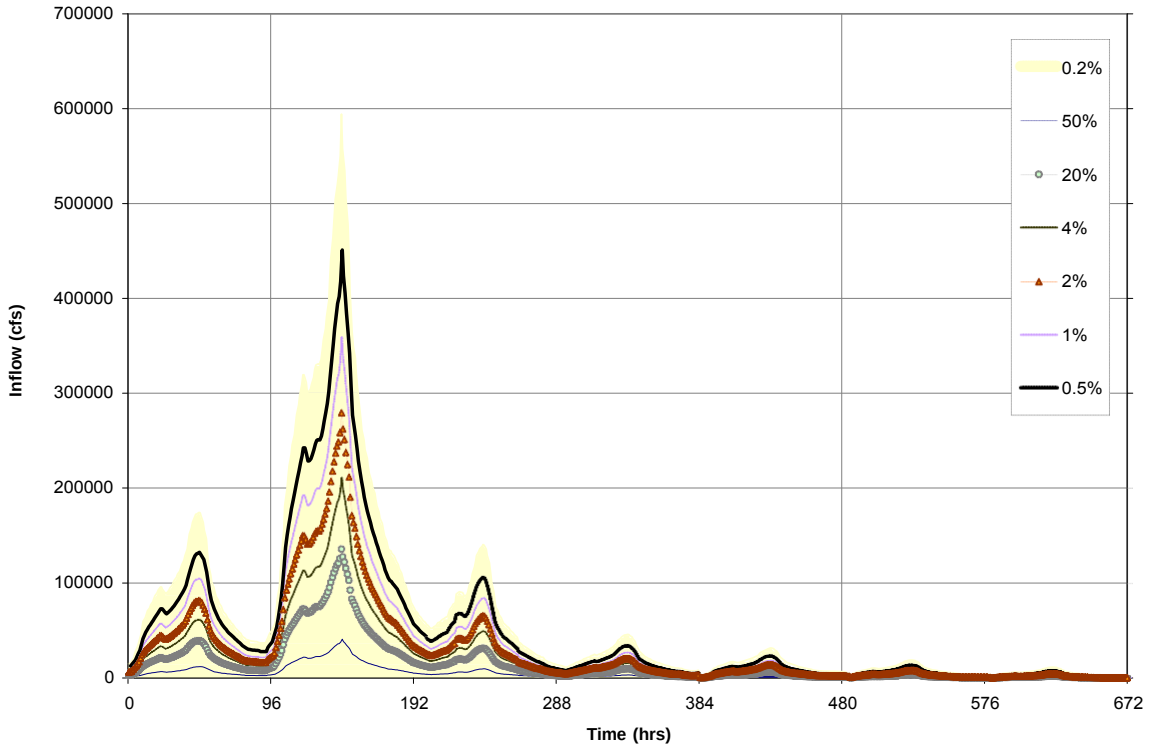

FIGURE A-1
FLOOD HYDROGRAPHS

The flood hydrographs above are based on a storm centered over the American River basin. Other storm centerings (i.e. Shanghai Bend, the mainstem of the Sacramento River) were considered to identify the conditions that would put the most stress on levee locations susceptible to failure. *Appendix A – Synthetic Hydrology Technical Documentation* contains a discussion regarding the development of the Comprehensive Study hydrographs based on the different storm centerings. The Comprehensive Study results were used to identify the coincident frequencies on the American River given a 50%-, 10%-, 4%-, 2%-, 1%-, 0.5%-, or 0.2%-annual chance flood event occurring elsewhere outside the American River basin. These coincident frequencies were used to develop two additional sets of flood hydrographs, one for the Shanghai Bend centering and another for the Sacramento River mainstem centering.

TABLE A-1: American River at Fair Oaks (1905-2004) – Unregulated Inflow Statistics

Duration	Log Mean (cfs)	Log Standard Deviation (cfs)	Skew
Peak	4.581	0.430	-0.08
1 Day	4.453	0.425	-0.05
3 Day	4.326	0.414	-0.05
7 Day	4.162	0.398	-0.13
15 Day	4.015	0.373	-0.26
30 Day	3.897	0.360	-0.42

The family of unregulated rain flood frequency curves generated from these statistics is presented in **Figure A-2**. Exceedance frequencies can be read off of the mean 3-day rain flood frequency curve (**Figure A-3**). For the 0.01 probability event, the mean 3-day volume is 188,400 cfs.

A-4 Reservoir Model and Operating Assumptions

The Folsom Dam Operations and Planning Model was updated to include the latest storage capacity table developed in 2005, the auxiliary spillway rating curves derived from the Folsom Dam Auxiliary Spillway physical model study results from Nov 2007, and the dam safety assumptions coordinated with Reclamation.

a. Water Control Plan

The Water Control Diagram (WCD) provides the guidelines and limitations defining the release and storage of water within the flood control space. Around 1995, an interim WCD was implemented for Folsom Dam. This interim WCD is the product of an operational agreement between Reclamation and the Sacramento Area Flood Control Agency (SAFCA). The Folsom Dam WCD maintains a minimum allowable flood control reservation of 400,000 acre-feet. With an additional 270,000 acre-feet of variable flood space based on creditable storage available in upstream reservoirs, a maximum flood control reservation of 670,000 acre-feet is possible. This WCD will be referred to as the 400/670 WCD **(Figure A-4)**. The 400/670 diagram is more conservative than the WCD contained in the 1986 Folsom Dam Water Control Manual so there is no conflict in operation.

Under WRDA 1999, Congress directed the reduction of the variable flood control space from the current operating range of 400,000-670,000 acre-feet to 400,000-600,000 acre-feet upon the completion of improvements to Folsom Dam. The modifications to the project will include the construction of an auxiliary spillway under the JFP project, which will be followed by a 3.5 ft dam raise. The hypothetical future WCD for Folsom Dam is herein referred to as the 400/600 WCD **(Figure A-5)**.

completion of improvements to Folsom Dam. The modifications to the project will include the construction of an auxiliary spillway under the JFP project, which will be followed by a 3.5 ft dam raise. The hypothetical future WCD for Folsom Dam is herein referred to as the 400/600 WCD **(Figure A-5)**.

Operation within the surcharge pool is prescribed by the applicable Emergency Spillway Release Diagram (ESRD). The diagram is constructed following procedures in EM 1110-2-3600, "Engineering and Design – Management of Water Control Systems". The ESRD smoothes the transition from releases made under normal flood operation releases to those required for dam safety. The diagram indicates the minimum permissible release that can be made without endangering the structure and without releasing quantities in excess of natural runoff. The ESRD attenuates Folsom Dam flood outflows to a level less than the inflow to the dam. The release specified is made immediately in order to reduce the magnitude of later releases. The objective of the ESRD is to avoid creating a worse situation than already exists and to provide a set of rules to increase flows above the downstream channel capacity in order to protect the dam from overtopping. The ESRD instructs the operators on how and when to make this key operating decisions when the only information known is reservoir elevation and the current release.

b. Operational Limitations

1) Surcharge Storage (Flood Pool) Limitation

Per Code of Federal Regulations (CFR) 33.208.11, the project owner (Reclamation) has full responsibility for the safety of the dam/appurtenant facilities and for regulation of the project during surcharge utilization. In 2007, the Corps and Reclamation reached an agreement that Reclamation practices and standards should take precedence in defining dam safety operation and criteria. The maximum surcharge space requirement is greatly affected by the inflow design flood volume, the total discharge capacity of the project, and the plan of operation. Folsom Dam spillway was originally sized to handle a much smaller inflow design event (the probable maximum flood – aka PMF). The maximum surcharge pool level of 475.5 ft and the accompanying 5 feet of freeboard are no longer sufficient under current conditions. According to the report *American River Basin, California, Folsom Dam and Lake Revised PMF Study* (Corps, 2001), Folsom Dam can only pass 70 percent of the PMF -- assuming full operation of the outlets and spillway gates and no dam failure; The amount of overtopping is estimated to be 3.5 feet above all earthen structures.

Under the Joint Federal Project, the maximum surcharge storage space requirement would increase from elevation 475.5 to elevation 477.5. This increase is accompanied by a decrease in the freeboard requirement per Reclamation's freeboard analyses. Freeboard space above the maximum allowable surcharge storage is needed to prevent overtopping mainly by wind or wave action. The authorized storage space would remain constant and independent of any modifications to the project. The dam safety operation for the Folsom Dam project is constrained by downstream safety considerations which limit or delay increases above what the levees can handle until the reservoir water surface exceeds the designated Flood Pool. The release is held to the emergency objective release while the pool is less than or equal to the designated Flood Pool. Under the existing operation, the Flood Pool is set at elevation 470.0 ft. The 1986 ESRD allows usage of about 45,000 acre-feet of surcharge storage between elevation 466 ft (normal full pool) and elevation 470.0 ft. Once the Flood Pool is exceeded, any delays in meeting the dam safety release requirement may put the dam and downstream inhabitants at greater risk.

2) Discharge Rate of Increase Limitation

Corps guidance EM 1110-2-1420, "Engineering and Design - Hydrologic Engineering Requirements for Reservoirs" states that project operation plans should ensure that release rates-of-change be gradual and not exceed the historical maximum rates of increase. The current Folsom Dam rate-of-increase is 15,000 cfs per 2-hour period. This requirement was applied to all the Scenarios while the discharge remained at or below the emergency objective release. Thereafter, the rate of increase is unlimited for the WO conditions -- similar to the existing operation. For the NA conditions, the rate-of-increase changes to 100,000 cfs/hr while the discharge remains at or below 360,000 cfs. This criterion was coordinated with Reclamation as a requirement for their dam safety operation under the JFP project

and the recommended plan (JFP project plus 3.5 ft Dam Raise) as described in the 2007 PAC document.

3) Downstream Channel Limitations

The objective release for normal flood control operation is specified by the WCD. Prior to the authorized Common Features levee improvements, the normal objective release was thought to be 115,000 cfs. Given the information available today, the actual "safe" target for an indefinitely sustained release is 90,000 cfs. The 90,000 cfs offers a zero percent chance of levee failure for the WO condition. The authorized levee improvements enable the levee system to handle 115,000 cfs under normal flood operations. The 115,000 cfs offers a zero percent chance of levee failure for the NA condition. The objective release changes once the emergency flood control operation begins. For the WO condition, the emergency objective release increases to 115,000 cfs. For the NA-145 Scenario, the emergency objective release is increased to 145,000 cfs. For the W-160 Scenario, the emergency objective release is increased to 160,000 cfs. The ability of the downstream channel to sustain 160,000 cfs is a critical assumption for the Joint Federal Project.

A-5 Scenario Description

The Common Features GRR study covers two different Folsom Dam flood routing scenarios for the existing condition: the without-project condition and the no-action future without-project) condition. The without-project (WO) represents the period prior to any work on the levees. The objective release is limited to 115,000 cfs. The no-action condition represents the current state of the levee system after all the authorized repairs and improvements are complete. Under the NA condition, the downstream levees can sustain 145,000 cfs. All together, there are six routings under the existing condition: WO1, WO2, WO3, NA1-145, NA2-145, and NA3-145. There are three routings under the "with-project" condition: W1-160, W2-160, and W3-160. Refer to **Table A-2** for key information associated with the various scenarios. The following describes the assumptions for each alternative. Given study time constraints, a standard ESRD was assembled for each alternative. No effort was made to "optimize" or tailor the ESRDs beyond establishing the total spillway capacity available, the "Flood Pool" elevation, the emergency objective release limit, and placement of the minimum induced surcharge curve.

a. WO Scenarios

This represents the levee condition existing prior to WRDA 1996 & 1999. The emergency objective release is 115,000 cfs. Prior to the authorized repairs/improvements, the American River levees were thought capable of handling 115,000 cfs under normal flood operations and 160,000 cfs for a short duration to facilitate downstream evacuation. Current studies estimate that the capacity of the levee system under the "without-project condition" was actually closer to 90,000 cfs as a "safe" release for normal flood control operation and no more than 115,000 cfs for emergency releases.

1) WO1 – This represents the levee condition existing prior to WRDA 1996 & 1999. The emergency objective release is 115,000 cfs. The dam safety release is restricted to 115,000 cfs until the water surface reaches 470.0 ft to facilitate evacuation of the downstream. The water control plan consists of the 400/670 water control diagram used in conjunction with a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam cannot pass the PMF without maintaining adequate freeboard. For dam safety purposes, outflow is made to match inflow once the water surface reaches pool elevation 475.5 feet.

2) WO2 – This represents the levee condition existing prior to WRDA 1996 & 1999. The emergency objective release is 115,000 cfs. The dam safety release is restricted to 115,000 cfs until the water surface reaches 470.0 ft to facilitate evacuation of the downstream. This scenario reflects improvements to Folsom Dam -- the construction of the Joint Federal Project (auxiliary spillway). The water control plan consists of the 400/600 water control diagram along with a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam cannot pass the PMF without overtopping the dam. For dam safety purposes, outflow is made to match inflow once the water surface reaches pool elevation 475.5 feet.

3) WO3 – This reflects additional improvements to Folsom Dam, the construction of the Joint Federal Project (auxiliary spillway) followed by a 3.5 ft dam raise. The emergency objective downstream release is 115,000 cfs. The dam safety release is not allowed to exceed 115,000 cfs until the water surface reaches 470.0 ft in order to facilitate evacuation of the downstream. The water control plan consists of both a 400/600 water control diagram and a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam cannot pass the PMF without overtopping the dam. For dam safety purposes, outflow is made to match inflow once the water surface reaches pool elevation 475.5 feet.

b. NA Scenarios

The NA scenarios represent the levee condition following the completion of WRDA 1996 & 1999. The downstream levees are capable of sustaining 145,000 cfs. Only, NA2 and NA3 operations are designed to pass the PMF -- meaning these scenarios can contain the resultant maximum surcharge volume within the maximum surcharge pool as specified in **Table A-2**. The resultant freeboard meets the freeboard requirement set by Reclamation for dam safety purposes. This also satisfies the Corps minimum freeboard requirement per regulation *ER 1110-8-2 (FR), "Engineering and Design - Inflow Design Floods for Dams and Reservoirs"*. No other goals or performance criteria were targeted in the NA2-145 and NA3-145 routings. The operation for the NA scenarios is intended to show increased performance as modifications are made to the project. NA3-145 outperforms NA2-145 which in turn must be better than NA1. Except for the downstream emergency objective release constraint of 145,000 cfs, NA2-145 and NA3-145 have operational criteria similar to the future with-project described in the next section.

1) NA1 – This scenario reflects no improvements to Folsom Dam. The emergency objective release is 145,000 cfs. The dam safety release is restricted to 145,000 cfs until the water surface exceeds 470.0 ft to facilitate evacuation of the downstream. The water control plan is comprised of the 400/670 water control diagram and a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam cannot pass the PMF without maintaining adequate freeboard. For dam safety purposes, outflow is made to match inflow once the water surface reaches pool elevation 475.5 feet.

2) NA2 – This scenario reflects an improvement made to Folsom Dam -- the construction of the Joint Federal Project (auxiliary spillway). The dam safety release is restricted to 145,000 cfs until the water surface reaches 466.0 ft to facilitate evacuation of the downstream. Downstream considerations no longer trump the dam safety operation within the surcharge space above pool elevation 466.0 ft. The water control plan consists of the 400/600 water control diagram along with a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam can pass the PMF without overtopping the dam.

3) NA3 -- This reflects additional improvements to Folsom Dam, the construction of the Joint Federal Project (auxiliary spillway) followed by the 3.5 ft dam raise. The height of the emergency gates will be increased to enable the three emergency spillway gates to remain in the closed position for a longer period, if necessary. The emergency objective downstream release is 145,000 cfs. The dam safety release is not allowed to exceed 145,000 cfs until the water surface exceeds 471.5 ft. The water control plan consists of both a 400/600 water control diagram and a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam can pass the PMF without overtopping the dam.

c. W Scenarios

The W scenarios are the future with-project condition. The W2 and W3 scenarios can pass the PMF while still satisfying the minimum 3 ft freeboard requirement for the top of dam. These scenarios are intended to show the increased performance gained by fixing the problems identified post WRDA 1996/1999 authorization. W2-160 and W3-160 have strong similarities to the 2007 PAC Report alternatives. W2-160 and W3-160 have the goal of passing the single 1-in-200 yr design event while maintaining a release of 160,000 cfs. Per coordination with Reclamation on the JFP, their preference is that this design event be maintained within the authorized normal full pool (elevation 466 feet). For the

raise project, Reclamation prefers that the maximum water surface for the design event be confined at or below Flood Pool .5 feet.

1) W1 – This scenario reflects no improvements to Folsom Dam. The emergency objective release is 160,000 cfs. The dam safety release is restricted to 160,000 cfs until the water surface exceeds 466.0 ft. The water control plan is comprised of the 400/670 water control diagram and a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam cannot pass the PMF without maintaining adequate freeboard. For dam safety purposes, outflow is made to match inflow once the water surface reaches pool elevation 475.5 feet.

3) W2 – This scenario reflects an improvement made to Folsom Dam -- the construction of the Joint Federal Project (auxiliary spillway). The dam safety release is restricted to 160,000 cfs until the water surface exceeds 466.0 ft. Downstream considerations no longer trump the dam safety operation within the surcharge space above pool elevation 466.0 ft. The water control plan consists of the 400/600 water control diagram along with a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam can pass the PMF without overtopping the dam.

3) W3 -- This reflects additional improvements to Folsom Dam, the construction of the Joint Federal Project (auxiliary spillway) followed by the 3.5 ft dam raise. The height of the emergency gates will be increased to enable the three emergency spillway gates to remain in the closed position for a longer period, if necessary. The emergency objective downstream release is 160,000 cfs. The dam safety release is not allowed to exceed 160,000 cfs until the water surface reaches 471.5 ft. The water control plan consists of both a 400/600 water control diagram and a hypothetical emergency spillway release diagram. Under this scenario, Folsom Dam can pass the PMF without overtopping the dam.

TABLE A-2: DESCRIPTION OF SCENARIOS

Alternative	Top of Dam	Maximum Surcharge Flood Pool[1]	Freeboard [3]	Flood Pool [4]	Emergency Objective Release	Normal Flood Control Reservation Range [5]
	El, ft	El, ft	El, ft	El, ft	Cfs	El, ft (acre-feet)
WO1 Pre-Common Features	480.5	475.5[2]	5	470.0	90,000 (< 35% encroachment) 115,000 (> 35% encroachment)	425.8 to 388.3 (400,000 – 670,000)
WO2 Pre-Common Features Auxiliary Spillway	480.5	475.5[2]	5	470.0	90,000 (< 35% encroachment) 115,000 (> 35% encroachment)	425.8 to 399.7 (400,000 – 600,000)
WO3 Pre-Common Features Auxiliary Spillway Folsom Dam Raise 3.5 ft	484.0	479.0	5	470.0	90,000 (< 35% encroachment) 115,000 (> 35% encroachment)	425.8 to 399.7 (400,000 – 600,000)
NA1-145 Common Features	480.5	475.5	5	470.0	145,000	(425.8 to 388.3 400,000 – 670,000)
NA2-145 Common Features Auxiliary Spillway	480.5	477.5	3	466.0	145,000	425.8 to 399.7 (400,000 – 600,000)
NA3-145 Common Features Auxiliary Spillway Folsom Dam Raise 3.5 ft	484.0	481.0	3	471.5	145,000	425.8 to 399.7 (400,000 – 600,000)
W1-160 Common Features	480.5	475.5	5	470.0	160,000	(425.8 to 388.3 400,000 – 670,000)
W2-160 Common Features Auxiliary Spillway	480.5	477.5	3	466.0	160,000	425.8 to 399.7 (400,000 – 600,000)
W3-160 Common Features Auxiliary Spillway Folsom Dam Raise 3.5 ft	484.0	481.0	3	471.5	160,000	425.8 to 399.7 (400,000 – 600,000)

KEY
El, ft – Elevation in feet

Notes:

1. *These values reflect the highest allowable pool elevation given both freeboard and top of dam height requirements. The maximum surcharge flood pool is established by routing a PMF through the reservoir. The PMF has been updated or revised periodically (e.g. 1946, 1980, 1991, and 2001).*
2. *The existing project requires more surcharge storage than is available under the original project design. Under existing conditions with no modifications to Folsom Dam, the 2001 PMF event would overtop Folsom Dam.*
3. *Reclamation has determined that 3 feet provides sufficient freeboard for the with-project scenarios (no action).*
4. *The FDR flood pool elevations are associated with the JFP and 3.5 Ft Dam Raise projects described in the PAC document. The release from Folsom Dam will not exceed 160,000 cfs as long as the water surface remains at or below the FDR flood pool.*
5. *The authorized storage space allocation for flood control differs with the scenarios. The flood space requirement itself varies seasonally. The maximum space would be needed only during the most critical flood period (December through February)*

A-6 Summary of Routing Output Analyses

a. WO Scenarios (pre-dates improvements authorized under WRDA 1996 & 1999)

With the addition of an auxiliary spillway in WO2, the main benefit gained is the ability to accelerate evacuation of the flood space. Although the downstream channel was originally designed to sustain an objective release of 115,000 cfs under normal flood operations, the current findings is that the potential for levee failure was greater than thought possible at that time. Under today's standards, the downstream channel was never maintained well enough to sustain safe releases of 115,000 cfs. To ensure zero percent chance of failing the downstream levees, the normal objective release requirement should have been reduced to 90,000 cfs. According to the attached **Figure A-8**, WO1 is able to limit the release to 90,000 cfs up to a 1-in-25 yr chance event. WO2 and WO3 must not utilize the extra capacity made available by the addition of the auxiliary spillway beyond this "safe" level except for events larger than a 1-in-25 yr chance event. Reservoir encroachment is the unit of measurement selected to identify event size. The encroachment volume for a 1-in-25 yr chance event never exceeded 35% in the WO1 routing. Therefore, larger events would be characterized by their larger encroachment percentages. Thus, the model was adjusted to limit the release to 90,000 cfs as long as the encroachment level remained at or below 35%. Thereafter, the release restriction would be lifted and the discharge would be allowed to ramp up to 115,000 cfs.

The operation for the WO scenarios is intended to show increased performance as modifications are made to the Common Features project and improvements are made to Folsom Dam. WO3 outperforms WO2 which in turn is better than WO1. The WO scenarios were not intended to pass the PMF. Operation for the WO scenarios was not constrained by any measurable criteria (i.e. passing a certain percentage of the PMF or limiting the magnitude of any dam overtopping to a certain amount). These scenarios cannot contain the resultant maximum surcharge volume within the confines of the maximum surcharge pool specified in **Table A-2**. The resultant freeboard is also less than the required freeboard amount. For these scenarios, the operation postpones making releases greater than 115,000 cfs due to downstream considerations by using up to 4 ft of surcharge storage space. The dam safety release is restricted to 115,000 cfs until the water surface reaches 470.0 ft to facilitate evacuation of the downstream.

b. NA Scenarios

The ESRDs created for the various scenarios may be considered much too efficient. The NA3-145 alternative is an example of this. According to the attached **Figure A-9**, the routing results indicate that Folsom Dam operations can hold the release at 145,000 cfs for a 1-in-200 yr event. Note, however, significant use of the surcharge space is required to achieve this result. The "Flood Pool" is being greatly exceeded. The release is appropriate given the circumstances in the routing with rapidly falling inflow and insignificant rate of rise in the reservoir pool elevation. The only way to make the consequences of exceeding the "Flood Pool" fully apparent in the routing is to use "simplified" ESRDs -- ones in which the pool elevation would be the only factor used to determine the discharge requirement. The "simplified" ESRD would remove any flexibility in surcharge space usage by automatically forcing the discharge to increase beyond the target flow anytime the pool elevation exceeded the designated "Flood Pool". Under this scenario, at 471.5 ft the discharge would be held to 145,000 cfs but at 471.51 the release would be greater than 145,000 cfs. The "soft" enforcement makes more sense than the "hard" enforcement approach when it comes to reservoir operations. **Table A-3** offers a comparison of maximum water surface versus "Flood Pool" specification for the various scenarios.

c. W Scenarios

TABLE A-3: FLOOD POOL ROUTING SUMMARY [Ŧ]

1-in-N chance per year event	WO1 (Flood Pool 470.0 ft)		WO2 (Flood Pool 470.0 ft)		WO3 (Flood Pool 470.0 ft)		NA1-145 (Flood Pool 470.0 ft)		NA2-145 (Flood Pool 466.0 ft)		NA3-145 (Flood Pool 471.5 ft)		W1-160 (Flood Pool 470.0 ft)		W2-160 (Flood Pool 466.0 ft)		W3-160 (Flood Pool 471.5 ft)	
	Max WS (El, ft)	Peak Outflow (cfs)	Max WS (El, ft)	Peak Outflow (cfs)	Max WS (El, ft)	Peak Outflow (cfs)	Max WS (El, ft)	Peak Outflow (cfs)	Max WS (El, ft)	Peak Outflow (cfs)	Max WS (El, ft)	Peak Outflow (cfs)	Max WS (El, ft)	Peak Outflow (cfs)	Max WS (El, ft)	Peak Outflow (cfs)	Max WS (El, ft)	Peak Outflow (cfs)
2	403.93	30295	403.53	37708	403.53	37708	402.43	30183	403.18	25215	403.18	25215	403.08	25891	401.91	37708	403.18	25215
10	429.80	43692	408.97	90000	408.97	90000	429.13	43127	421.65	71655	421.65	71655	431.09	43519	421.65	71655	421.65	71655
25	442.53	98760	427.80	90000	427.80	90000	442.69	99738	431.43	115000	431.43	115000	444.54	104311	432.02	115000	432.02	115000
50	457.34	115000	443.02	115000	443.02	115000	457.01	115000	442.97	115000	442.97	115000	459.13	115000	444.04	115000	444.04	115000
100	476.35	123107	461.00	115000	461.00	115000	470.81	145000	460.46	115000	460.46	115000	472.32	145000	461.31	115000	461.31	115000
200	476.33	444310	476.65	169173	478.67	138359	476.40	320142	470.02	210332	474.92	145000	476.37	321017	470.02	196633	472.47	160000
250	476.65	476319	475.23	331691	477.27	232803	476.67	412114	470.65	309673	477.90	197562	476.64	408551	470.44	296022	477.15	193667
500	479.62	554268	480.97	627077	481.31	510279	479.01	512982	472.08	594159	478.32	558062	479.04	513195	471.57	594159	478.03	534386

Notes:

[Ŧ] *The gray shaded area depicts encroachment into the remaining surcharge storage space above the "Flood Pool" mark; Dam Safety operation takes the highest priority above the "Flood Pool" mark.*

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A-7 Risk Analysis (HEC- FDA Inputs)

Corps engineering guidance (EM 1110-2-1619, "Risk-Based Analysis for Flood Damage Reduction Studies") and planning guidance (ER 1105-2-100, "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures" and ER 1105-2-101, "Risk Analysis for Flood Damage Reduction Studies") require that risk analyses be used to quantify the project performance of the various scenarios. The hydrologic data provided to Economics as input for the HEC-FDA program includes the unregulated inflow exceedance probability function and the curves defining the relationship between unregulated inflow and reservoir discharge. The uncertainty in the hydrology is defined by the confidence limits, derived via statistics. The uncertainty in reservoir discharge is derived by changing the parameters used in the reservoir routings. The risk analysis scenarios reflect the operating conditions ranging from the most likely to occur (BASE) to the most extreme operating conditions likely to produce the largest (MAXIMUM) or smallest (MINIMUM) expected release. The BASE condition assumptions and results are previously described for the W01, W02, W03, NA1, NA2, and NA3 scenarios. Generally, the operational criteria are developed based on actual flood operations, the analysis of historical data, and discussion between representatives of the Corps, SAFCA, and Reclamation. **Table A-4** presents selected assumptions used to create the different scenarios.

TABLE A-4: RISK ANALYSIS OPERATIONAL ASSUMPTIONS [1, 2]

Uncertainty Parameters	Alternative	Discharge Scenario		
		BASE (Normal)	**MAXIMUM (Upper Limit)**	**MINIMUM (Lower Limit)**
Initial Encroachment [3] (acre-feet)	WO & NA	0	50,000	0
Extra Space in Folsom Lake (acre-feet)	WO & NA	0	0	100,000
Available Upstream Reservoir Space (acre-feet)	WO & NA	0	0	150,000
Starting Storage (acre-feet)	WO & NA	367,000	417,000	429,000
Response Time Delay [4] (hours)	WO	8	8	8
	NA	4	8	0
Main Dam River Outlets Operation During Concurrent Spillway Operation (percent gate opening)	WO & NA	60	0	60

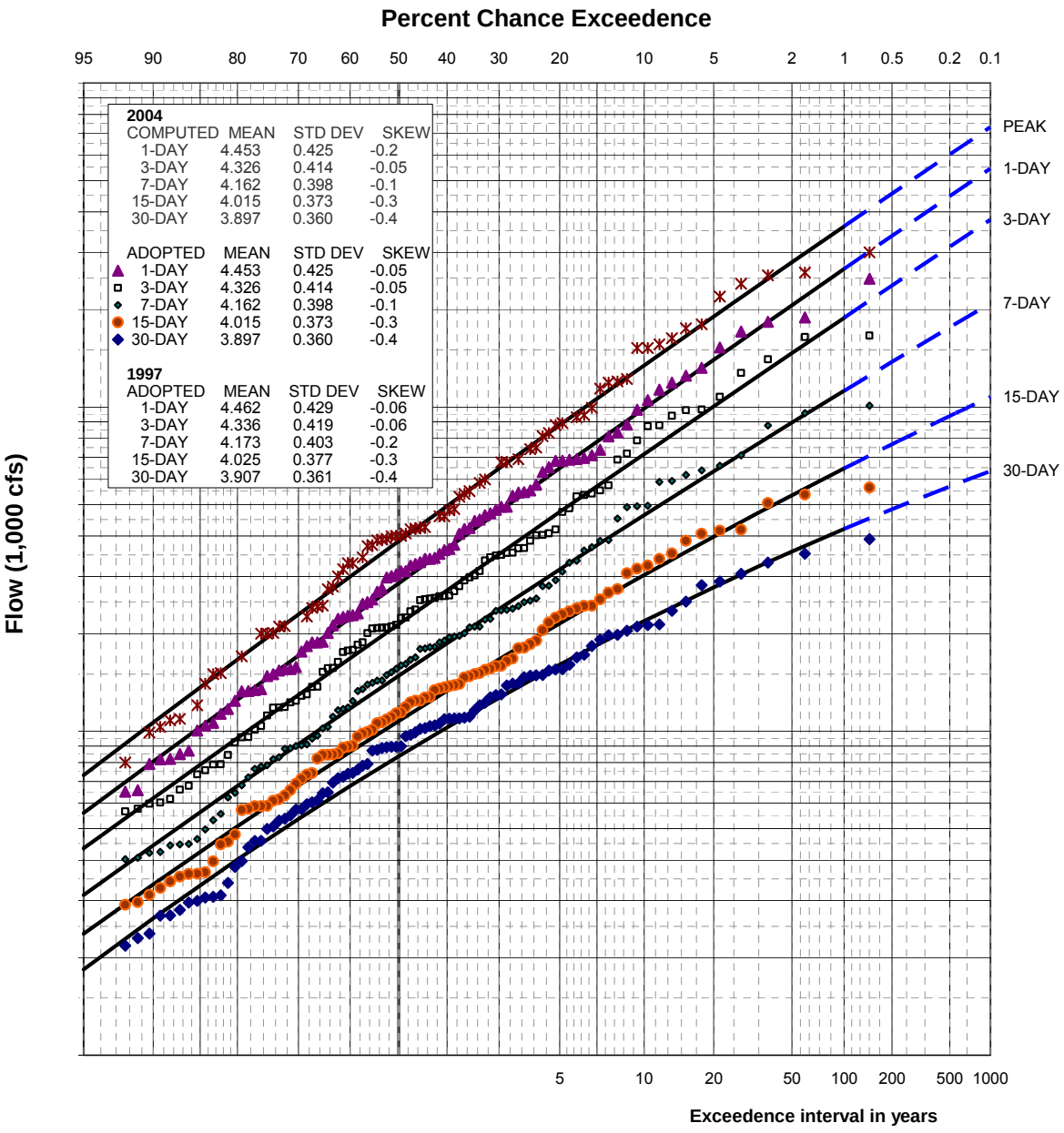
KEY
Cfs – cubic feet per second

Notes:
1. *Discharge is presumed through only one power penstock due to maintenance work during the flood season (per Reclamation).*
2. *Application of the uncertainty parameters may sometimes result in anomalies for the smaller or more frequent events. The settings meant to induce the largest or smallest discharge may actually result in the reverse. This issue appears intermittently.*
3. *Encroachment is relative to the allowable storage as determined from the water control diagram (dependent on upstream storage space).*
4. *Lag in matching Release to previous hour Inflow – while discharge is less than the normal objective release target.*

A-8 Conclusion

Water Management produced routings for two different scenarios. The without-project (WO) condition reflects the American River levee system prior to any improvements or repair work. The no-action (NA) condition reflects the existing state of the American River levees with the improvements made as authorized by WRDA 1996 and 1999. The NA condition will result in the ability of the downstream channel to sustain 145,000 cfs (or 160,000 cfs as reported in the 2007 PAC Report). The 50%-, 20%-, 4%-, 2%-, 1%-, 0.5%, 0.2%-annual chance flood events were routed through Folsom Dam for the various WO and NA scenarios. The routing results were given to Hydraulic Design for the floodplains development and to Economics for the economic benefit analyses. The hydrographs provided to Hydraulic Design are shown in **Figures A-4 through A-6**.

Figure A-10 through A-23 provides a snapshot of the data provided to Economics in a variety of ways. **Figure A-10 through A-13** presents the set of WO, NA, and W results (BASE condition only) as regulated frequency curves. This allows one to view the increase in project performance as improvements are made to Folsom Dam. **Figure A-14** consolidates the results of all the routings (BASE condition only) as "inflow versus outflow curves" to allow comparisons across the different set of routings. **Figure A-15 through A-23** presents the uncertainty band around the discharge for any given event. Note that the uncertainty range required some adjustment around the more frequent event where the points crossed. Generally, the anomalies (MAX < BASE < MIN) where the points cross occur for events with less than 1-in-5 yr chance exceedance. In these instances, the MAX discharge is lower than BASE due to the inability to match inflow quickly (8 hour lag). This handicap is a benefit or plus for the smaller flood events. The MIN discharge is large than BASE due to the ability to match inflow quickly (1 hour lag). This advantage (rapid response) is a detriment or negative for the smaller, more frequent events. The initial starting storage also is a factor in this aspect. A full summary of the routings can be found in **Tables A-5** through **A-31**. The reservoir routings covered herein were developed for planning purposes only. These scenarios are hypothetical and would not be built or implemented as stand-alone projects. All reservoir elevations provided herein use the NGVD29 vertical datum.



NOTES:

1. Adjusted USGS gage 11446500 to account for daily change in storage at upstream reservoirs (potential channel, out-of-channel, or storage losses neglected).
2. Median plotting positions.
3. Computed Probability
4. No adjustments for outliers.
4. Drainage area: 1,888 sq. mi.
5. Period of record: 1905-2004.

AMERICAN RIVER WATERSHED PROJECT
COMMON FEATURES
GENERAL REEVALUATION REPORT

RAIN FLOOD FREQUENCY CURVES
AMERICAN RIVER AT FAIR OAKS
UNREGULATED CONDITIONS

FIGURE A-2

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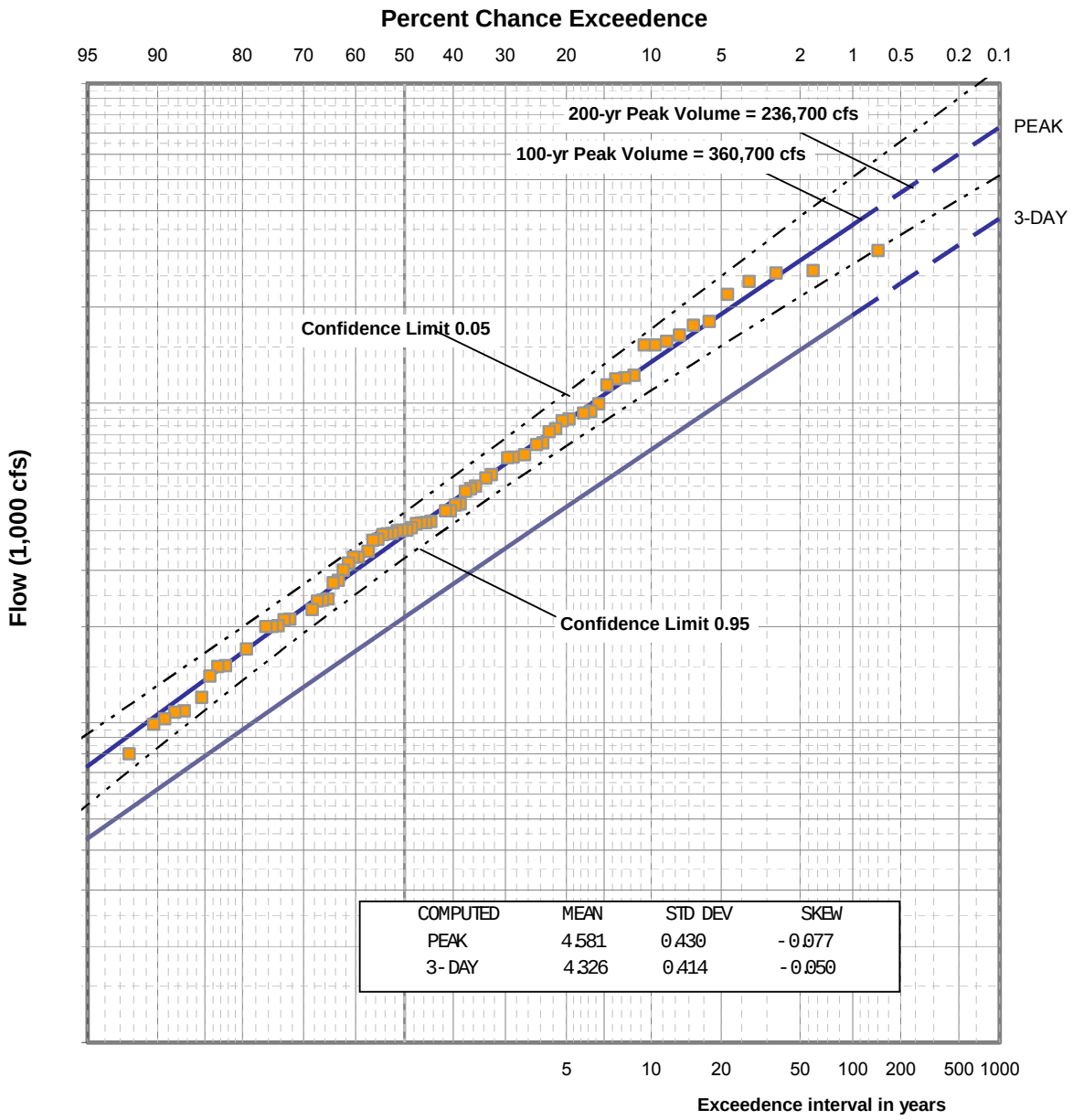

NOTES:

1. Adjusted USGS gage 11446500 to account for daily change in storage at upstream reservoirs (potential channel, out-of-channel, or storage losses neglected).
2. Median plotting positions.
3. Computed Probability
4. No adjustments for outliers.
5. Confidence limits based on station statistics
6. Drainage area: 1,888 sq. mi.
7 Period of record: 1905-2004.

AMERICAN RIVER WATERSHED PROJECT

COMMON FEATURES

UNREGULATED PEAK AND MEAN 3-DAY RAIN FLOOD FREQUENCY CURVES AMERICAN RIVER AT FAIR OAKS

FIGURE A-3

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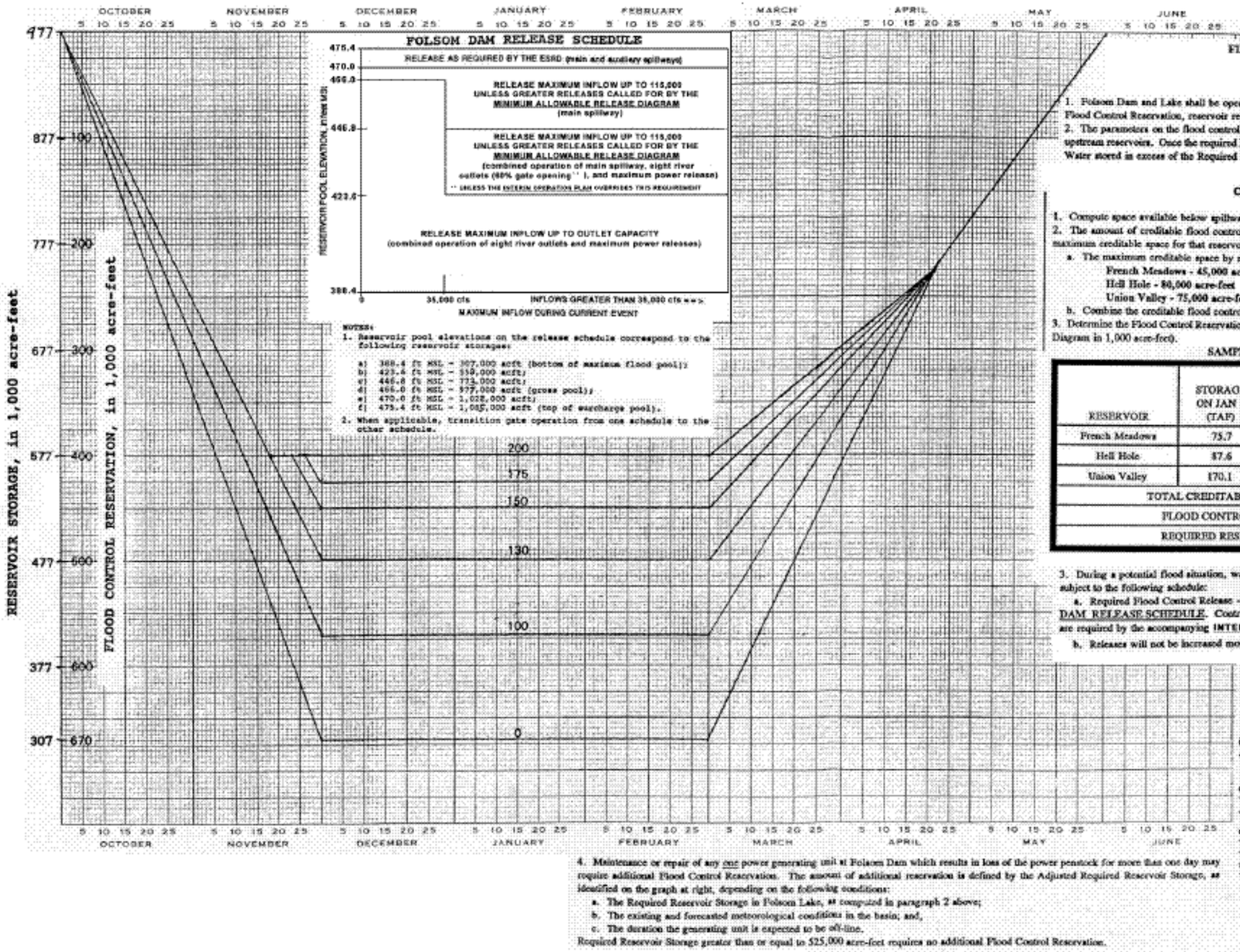

NOTES:
1. Reservoir pool elevations on the release schedule correspond to the following reservoir storages:
   a) 388.4 ft MSL = 307,000 acft (bottom of maximum flood pool);
   b) 423.6 ft MSL = 559,000 acft;
   c) 446.8 ft MSL = 774,000 acft;
   d) 466.0 ft MSL = 977,000 acft (gross pool);
   e) 470.0 ft MSL = 1,028,000 acft;
   f) 475.4 ft MSL = 1,085,000 acft (top of surcharge pool).
2. When applicable, transition gate operation from one schedule to the other schedule.

FLOOD CONTROL DIAGRAM FOR FOLSOM DAM AND LAKE

USE OF DIAGRAM

1. Folsom Dam and Lake shall be operated for flood control in accordance with the Flood Control Diagram. When water is stored within the Flood Control Reservation, reservoir releases must be in accordance with requirements of this diagram.
2. The parameters on the flood control diagram define the required Flood Control Reservation, on any given day, based on available space in the upstream reservoirs. Once the required Flood Control Reservation is computed, the Required Reservoir Storage for flood control can be determined. Water stored in excess of the Required Reservoir Storage must be evacuated. Computation of the parameter is discussed below:

FOLSOM DAM AND LAKE
COMPUTATION OF REQUIRED RESERVOIR STORAGE

1. Compute space available below spillway crest, in acre-feet, for the following reservoirs: French Meadows, Hell Hole and Union Valley.
2. The amount of creditable flood control transfer space in each reservoir is then computed by taking the smaller of the space available or the maximum creditable space for that reservoir.
   a. The maximum creditable space by reservoir is as follows:
      French Meadows - 45,000 acre-feet
      Hell Hole - 80,000 acre-feet
      Union Valley - 75,000 acre-feet
   b. Combine the creditable flood control transfer space for each reservoir to compute the total creditable space.
3. Determine the Flood Control Reservation at Folsom Lake by applying the creditable flood control transfer space (parameter on the Flood Control Diagram in 1,000 acre-feet).

SAMPLE COMPUTATION OF REQUIRED RESERVOIR STORAGE

RESERVOIR	STORAGE ON JAN 1 (TAF)	STORAGE AT SPILLWAY CREST (TAF)	SPACE AVAILABLE (TAF)	MAXIMUM CREDITABLE SPACE (TAF)	CREDITABLE FLOOD CONTROL TRANSFER SPACE (TAF)
French Meadows	75.7	110.7	35	45	35
Hell Hole	87.6	207.6	120	80	80
Union Valley	170.1	235.1	65	75	65
TOTAL CREDITABLE FLOOD CONTROL TRANSFER SPACE (TAF)					180
FLOOD CONTROL RESERVATION AT FOLSOM LAKE (TAF)					420
REQUIRED RESERVOIR STORAGE AT FOLSOM LAKE (TAF)					557

3. During a potential flood situation, water stored within the Flood Control Reservation, defined herein, shall be released as rapidly as possible subject to the following schedule:
   a. Required Flood Control Release - Promptly release inflow up to 115,000 cfs, while inflows are increasing, as discussed in the FOLSOM DAM RELEASE SCHEDULE. Control flows in the American River below the dam to not more than 115,000 cfs, except when larger releases are required by the accompanying **INTERIM OPERATION PLAN.**
   b. Releases will not be increased more than 15,000 cfs or decreased more than 10,000 cfs during any 2 hour period.

4. Maintenance or repair of any one power generating unit at Folsom Dam which results in loss of the power penstock for more than one day may require additional Flood Control Reservation. The amount of additional reservation is defined by the Adjusted Required Reservoir Storage, as identified on the graph at right, depending on the following conditions:
   a. The Required Reservoir Storage in Folsom Lake, as computed in paragraph 2 above;
   b. The existing and forecasted meteorological conditions in the basin; and,
   c. The duration the generating unit is expected to be off-line.

Required Reservoir Storage greater than or equal to 525,000 acre-feet requires no additional Flood Control Reservation.

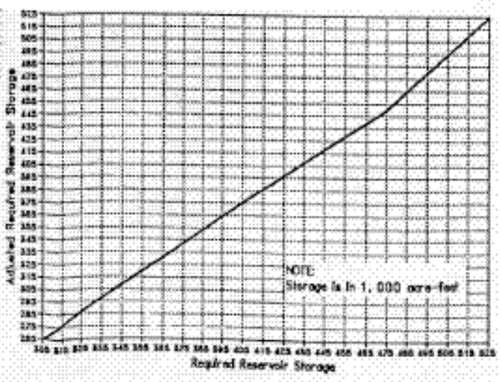

FIGURE A-4
WATER CONTROL DIAGRAM -- HISTORICAL
EXISTING CONDITION 400/670

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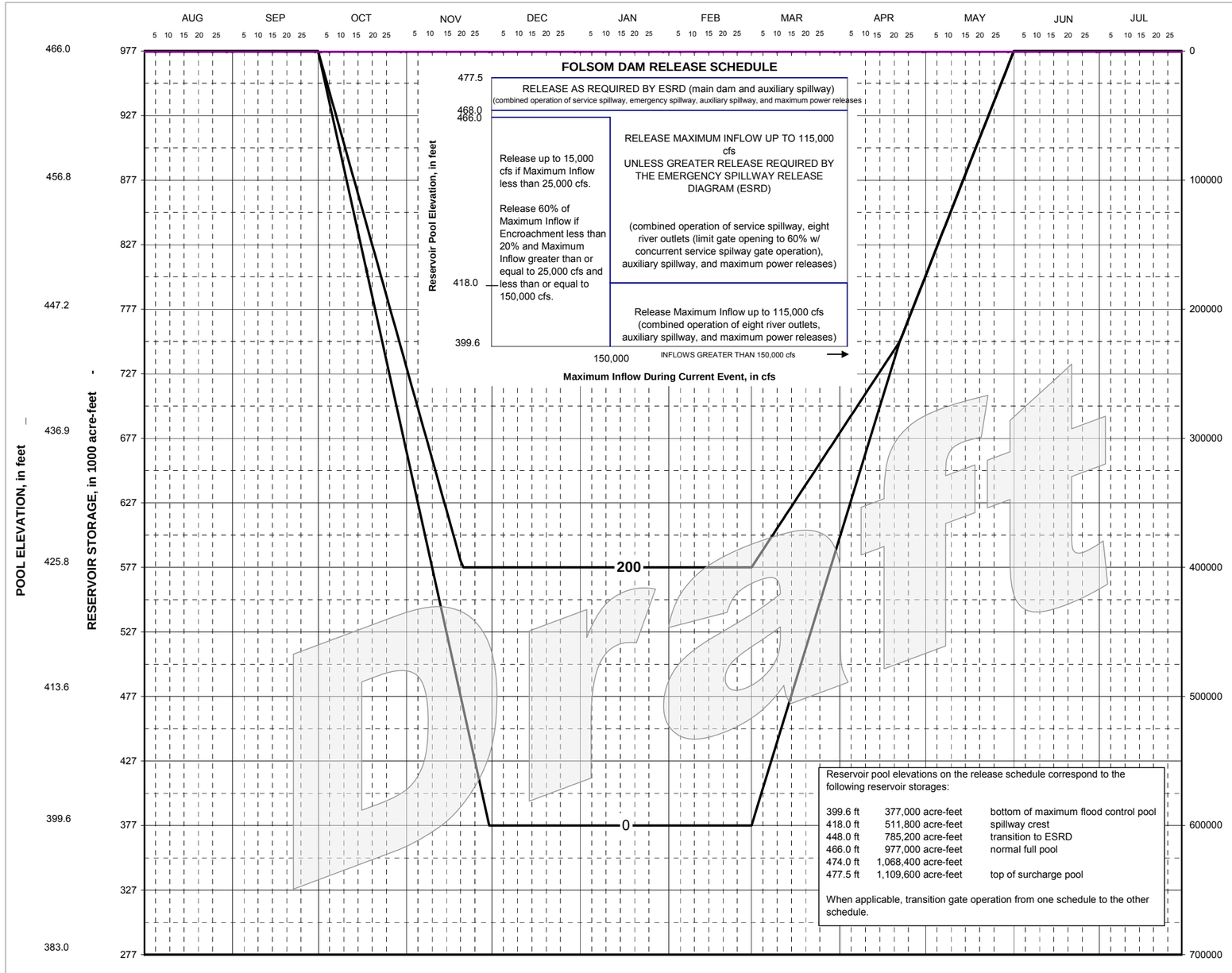

FLOOD CONTROL DIAGRAM

USE OF DIAGRAM

1. Folsom Dam and Lake shall be operated for flood control in accordance with the Flood Control Diagram. When water is stored within the Flood Control Reservation, reservoir releases must be in accordance with the requirements of this diagram.

2. The parameters on the flood control diagram define the required Flood Control Reservation, on any given day, based on available space in the upstream reservoirs. Once the required Flood Control Reservation is computed, the Required Reservoir Storage for flood control can be determined. Water stored in excess of the Required Reservoir Storage must be evacuated. Computation of the parameter is discussed below:

COMPUTATION OF REQUIRED FLOOD RESERVATION STORAGE

1. Compute space available below spillway crest, in acre-feet, for the following reservoirs: French Meadows, Hell Hole and Union Valley.

2. The amount of creditable flood control transfer space in each reservoir is then computed by taking the smaller of the space available or the maximum creditable space for that reservoir.

   a. The maximum creditable space by reservoir is as follows:
   French Meadows 45,000 acre-feet
   Hell Hole 80,000 acre-feet
   Union Valley 75,000 acre-feet

   b. Combine the creditable flood control transfer space for each reservoir to compute the total creditable space.

   c. Determine the Flood Control Reservation at Folsom Lake by applying the creditable flood control transfer space (parameter on the Flood Control Diagram in 1,000 acre-feet).

SAMPLE COMPUTATION OF REQUIRED RESERVOIR STORAGE

RESERVOIR	STORAGE ON JAN 1 (TAF)	STORAGE @ SPILLWAY CREST (TAF)	SPACE AVAILABLE (TAF)	MAXIMUM CREDITABLE SPACE (TAF)	CREDITABLE FLOOD CONTROL TRANSFER SPACE (TAF)
FRENCH MEADOWS	65.7	110.7	45	45	45
HELL HOLE	87.6	207.6	120	80	80
UNION VALLEY	160.1	235.1	75	75	75
TOTAL CREDITABLE FLOOD CONTROL TRANSFER SPACE (TAF)					200
FLOOD CONTROL RESERVATION AT FOLSOM LAKE (TAF)					577
REQUIRED RESERVOIR STORAGE AT FOLSOM LAKE (TAF)					577

RELEASE SCHEDULE

3. During a potential flood situation, water stored within the Flood Control Reservation, defined herein, shall be released as rapidly as possible subject to the following schedule:

   a. Required flood Control Release - Promptly release inflow up to 115,000 cfs while inflows are increasing, as discussed in the FOLSOM DAM RELEASE SCHEDULE. Control flows in the American River below the dam to not more than 115,000 cfs, except when larger releases are required by the accompanying EMERGENCY SPILLWAY RELEASE DIAGRAM (ESRD). Once the reservoir pool begins falling, maintain releases in excess of inflow until water stored in the Flood Control Reservation is evacuated.

   b. Releases will not be increased more than 30,000 cfs or decreased more than 10,000 cfs during any 2-hour period.

FIGURE A-5
WATER CONTROL DIAGRAM -- HYPOTHETICAL
FUTURE CONDITION 400/600

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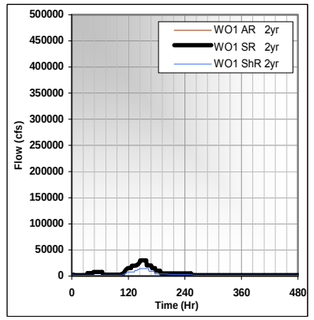

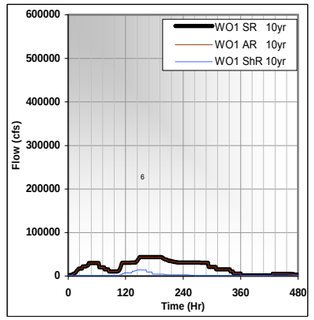

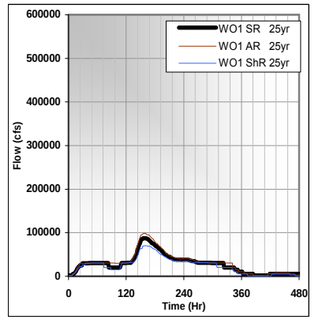

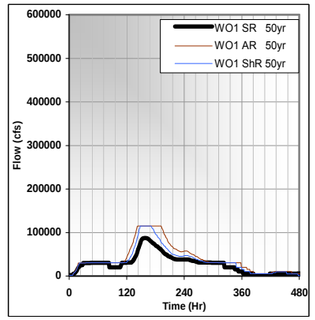

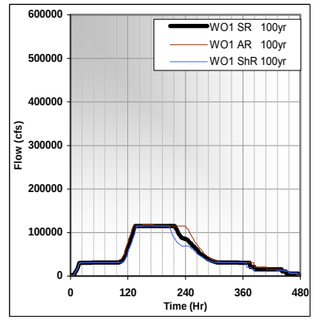

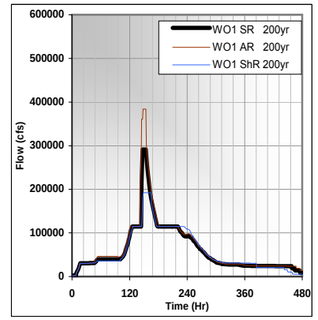

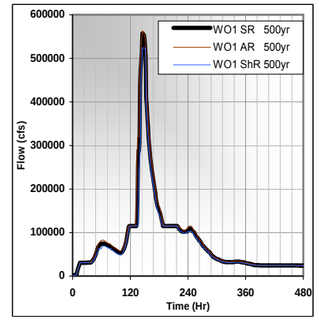

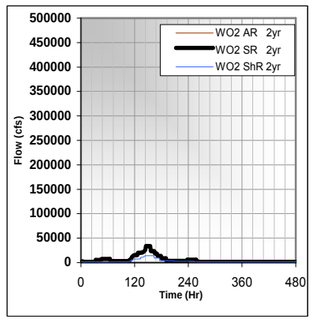

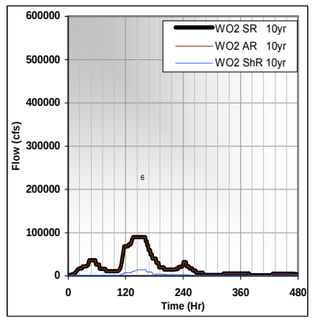

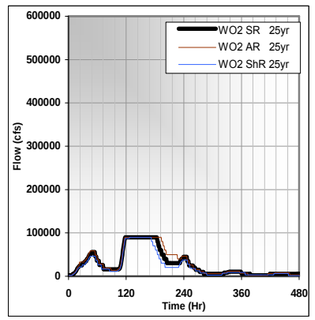

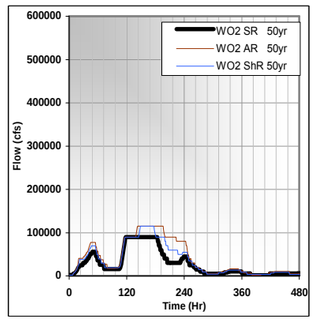

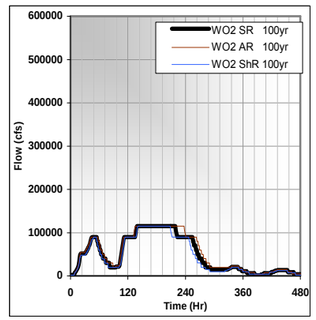

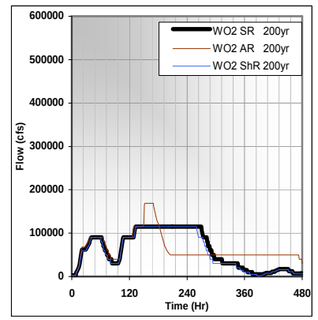

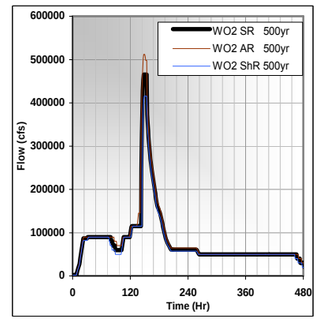

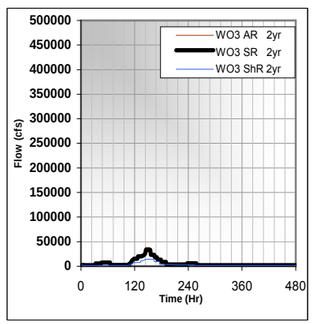

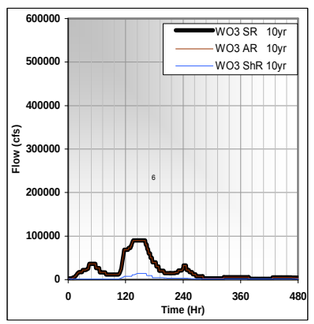

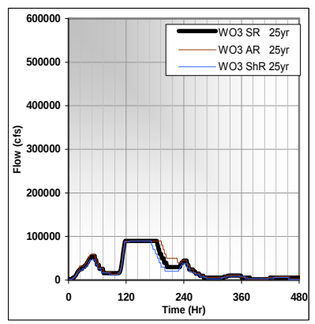

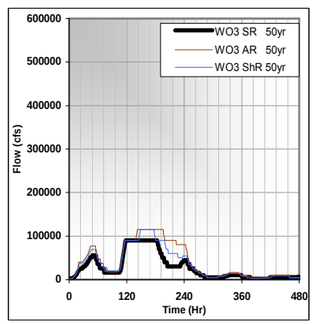

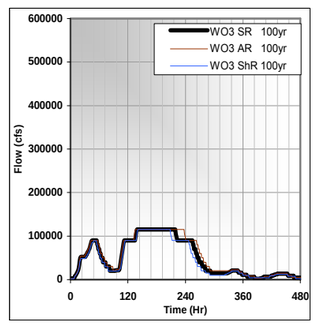

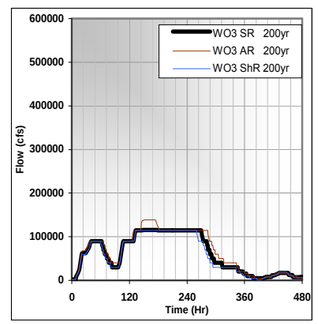

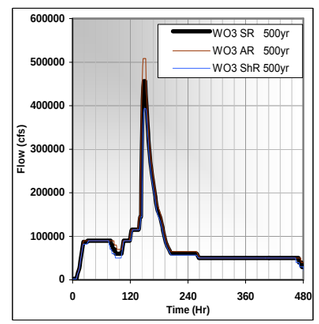

Key

SR Sacramento River
AR American River
ShR Shanghai River

FIGURE A-8: DISCHARGE HYDROGRAPHS – BASE – EXISTING CONDITION

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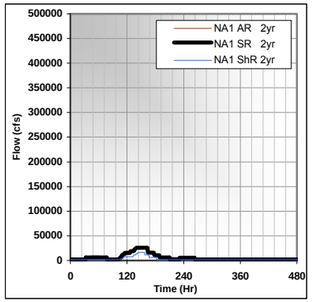

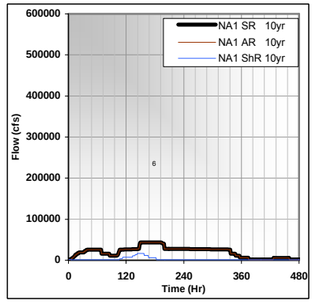

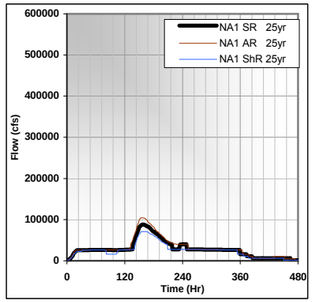

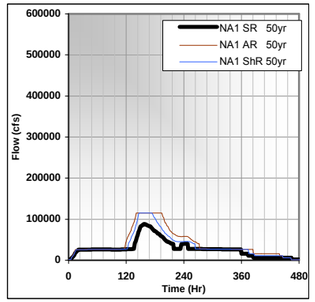

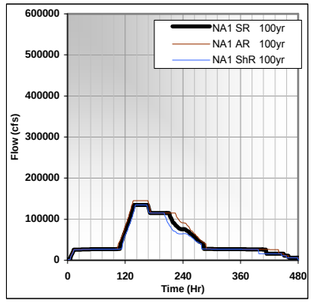

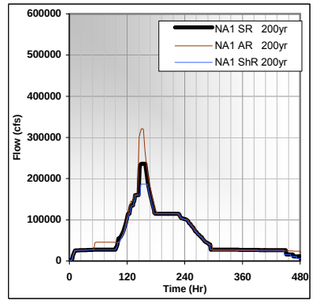

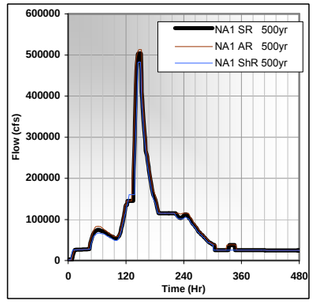

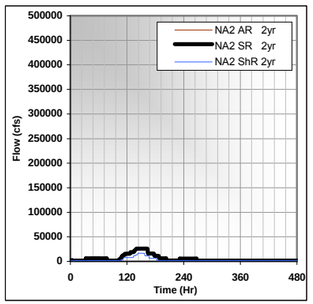

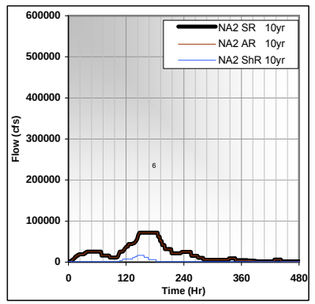

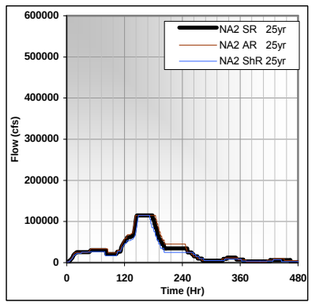

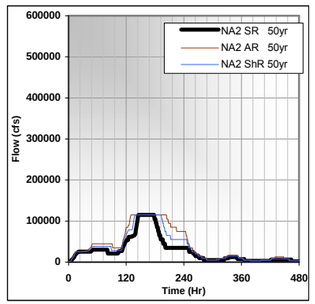

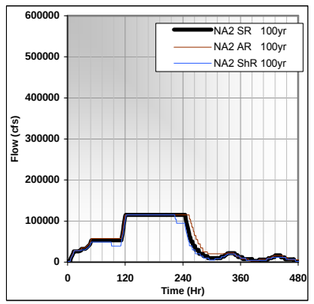

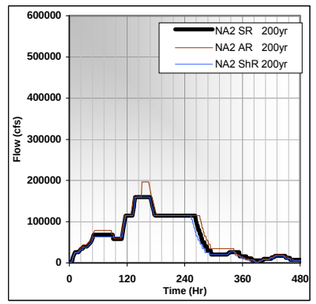

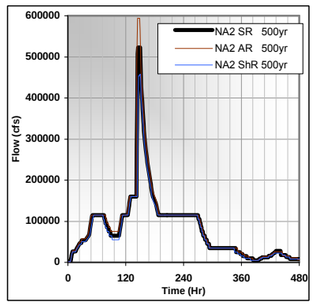

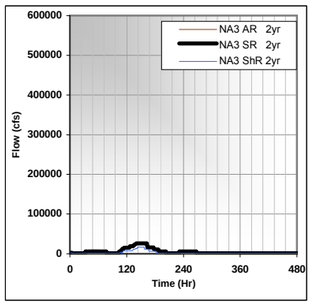

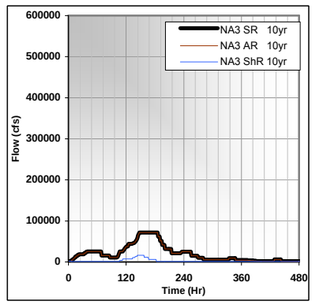

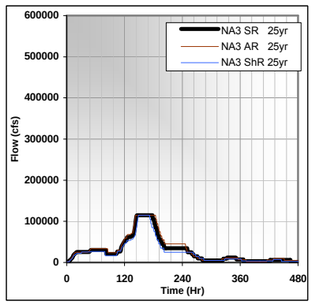

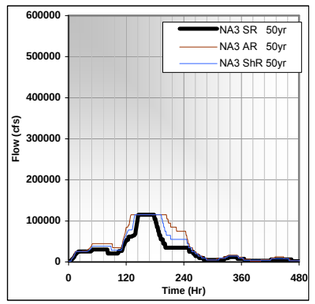

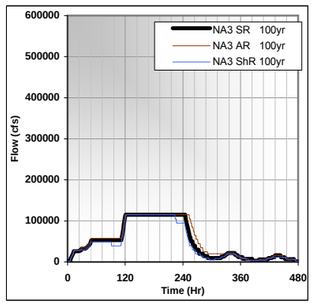

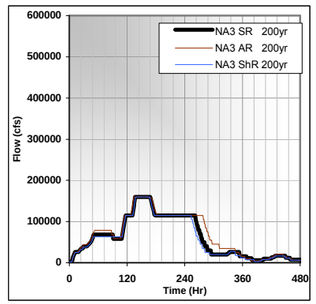

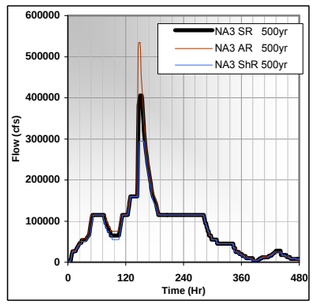

Key

SR Sacramento River
AR American River
ShR Shanghai River

FIGURE A-9: DISCHARGE HYDROGRAPHS – BASE – FUTURE WITHOUT-PROJECT (NO ACTION)

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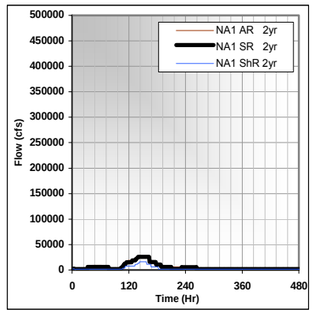

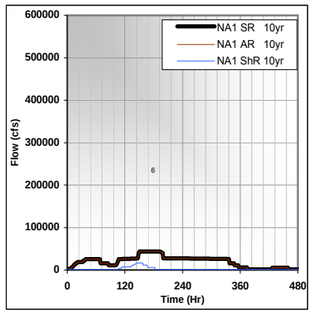

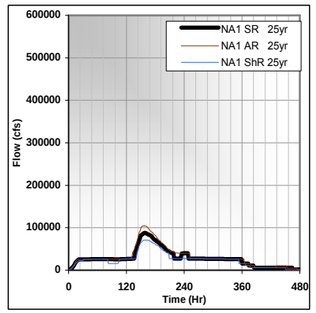

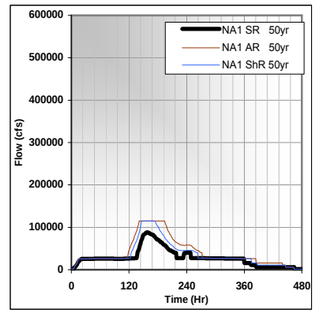

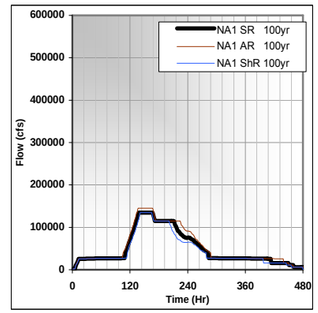

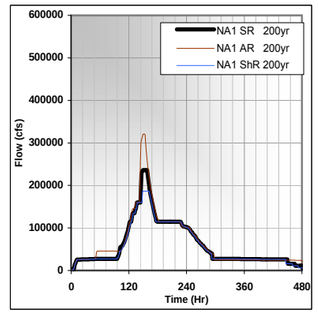

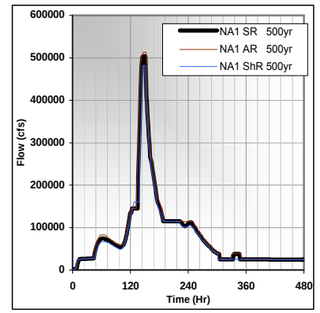

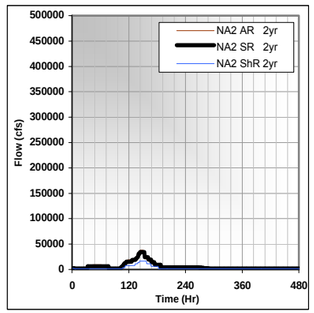

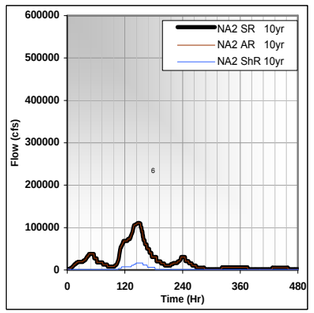

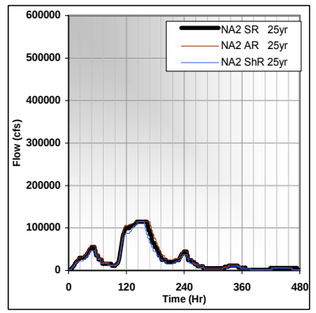

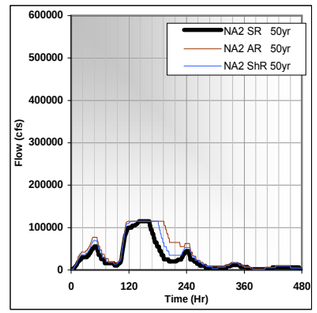

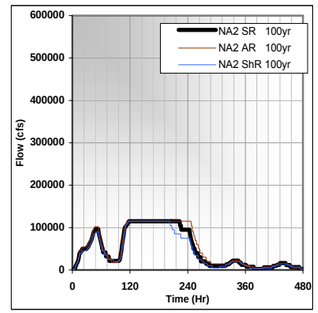

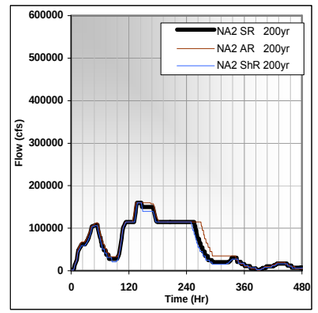

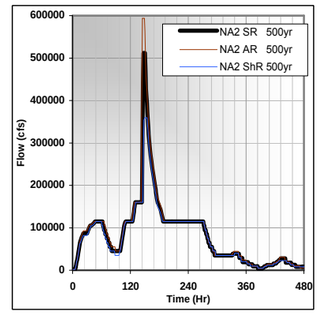

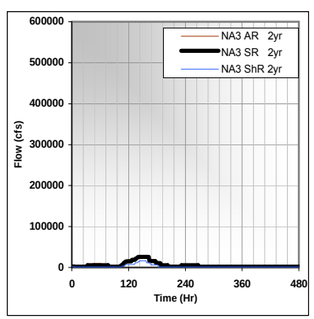

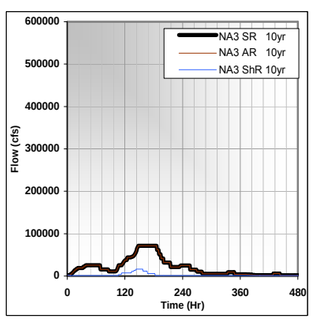

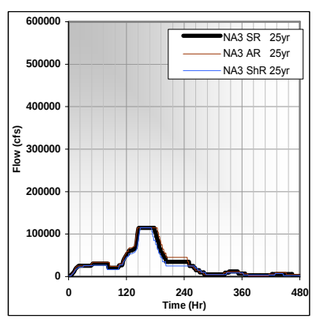

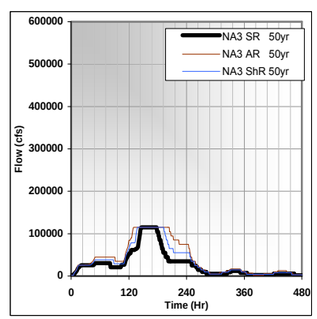

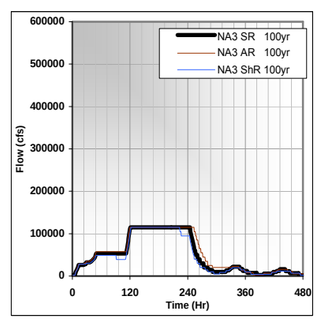

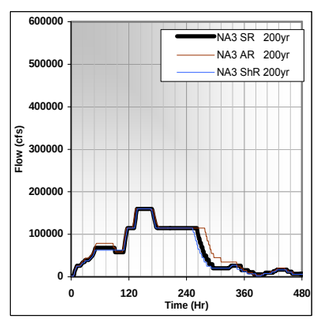

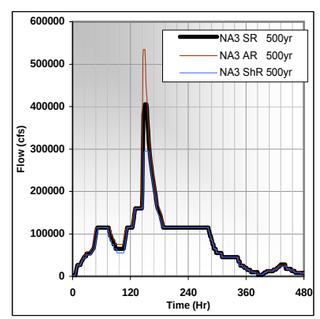

Key

SR Sacramento River
AR American River
ShR Shanghai River

FIGURE A-10: DISCHARGE HYDROGRAPHS – BASE – WITH-PROJECT

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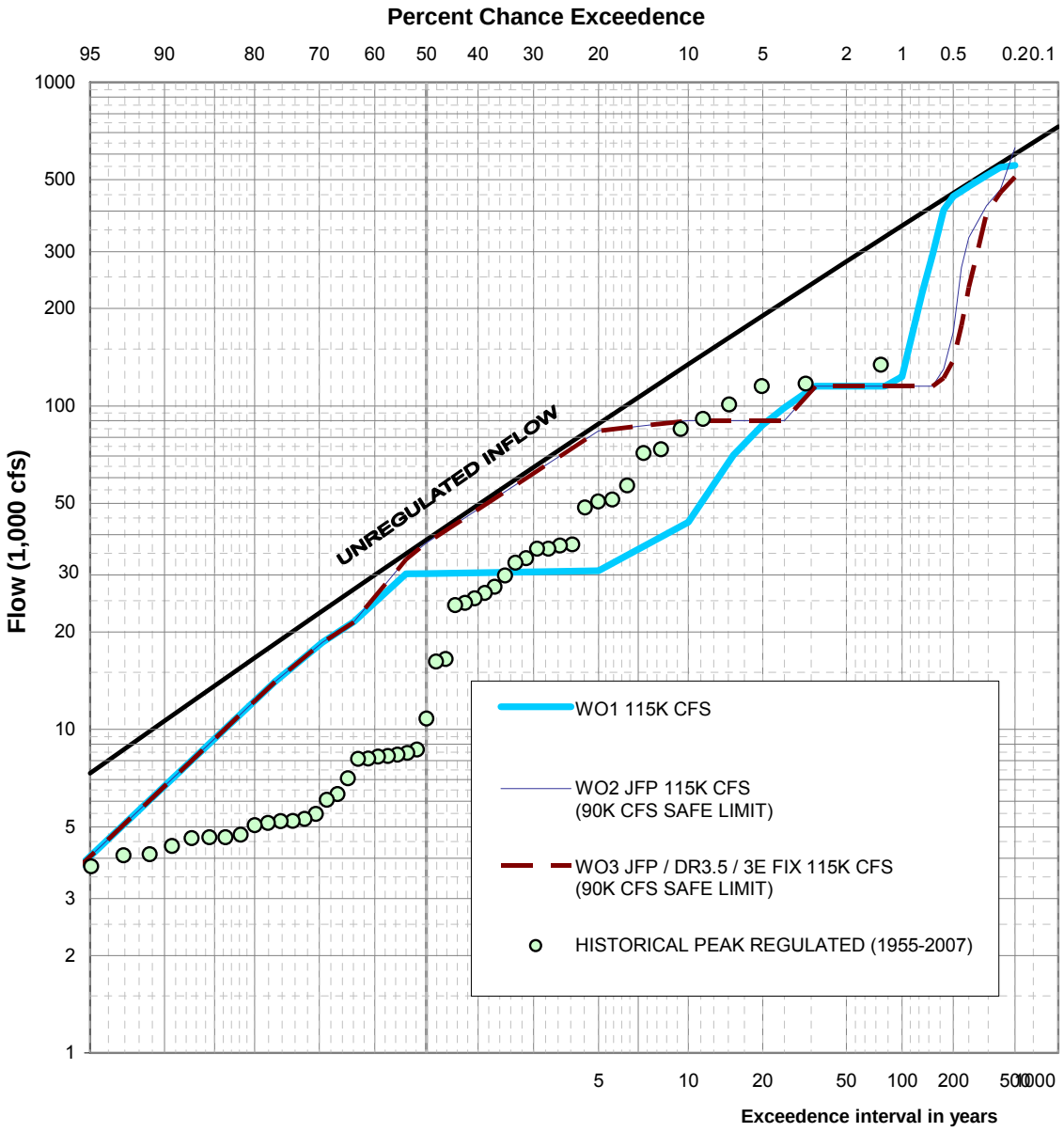

NOTES:

1. Adjusted USGS gage 11446500 to accoiunt for daily change in storage at upstream reservoirs (potential channel, out-of-channel, or storage losses neglected).
2. Median plotting positions
3. No adjustments for outliers.
4. Drainage area: 1,888 sq. mi.
5. Period of record: 1905-2004 (Unregulated).

AMERICAN RIVER WATERSHED PROJECT
COMMON FEATURES GRR

REGULATED FREQUENCY CURVES
FOLSOM DAM
EXISTING CONDITION
(WITHOUT-PROJECT)

FIGURE A-11

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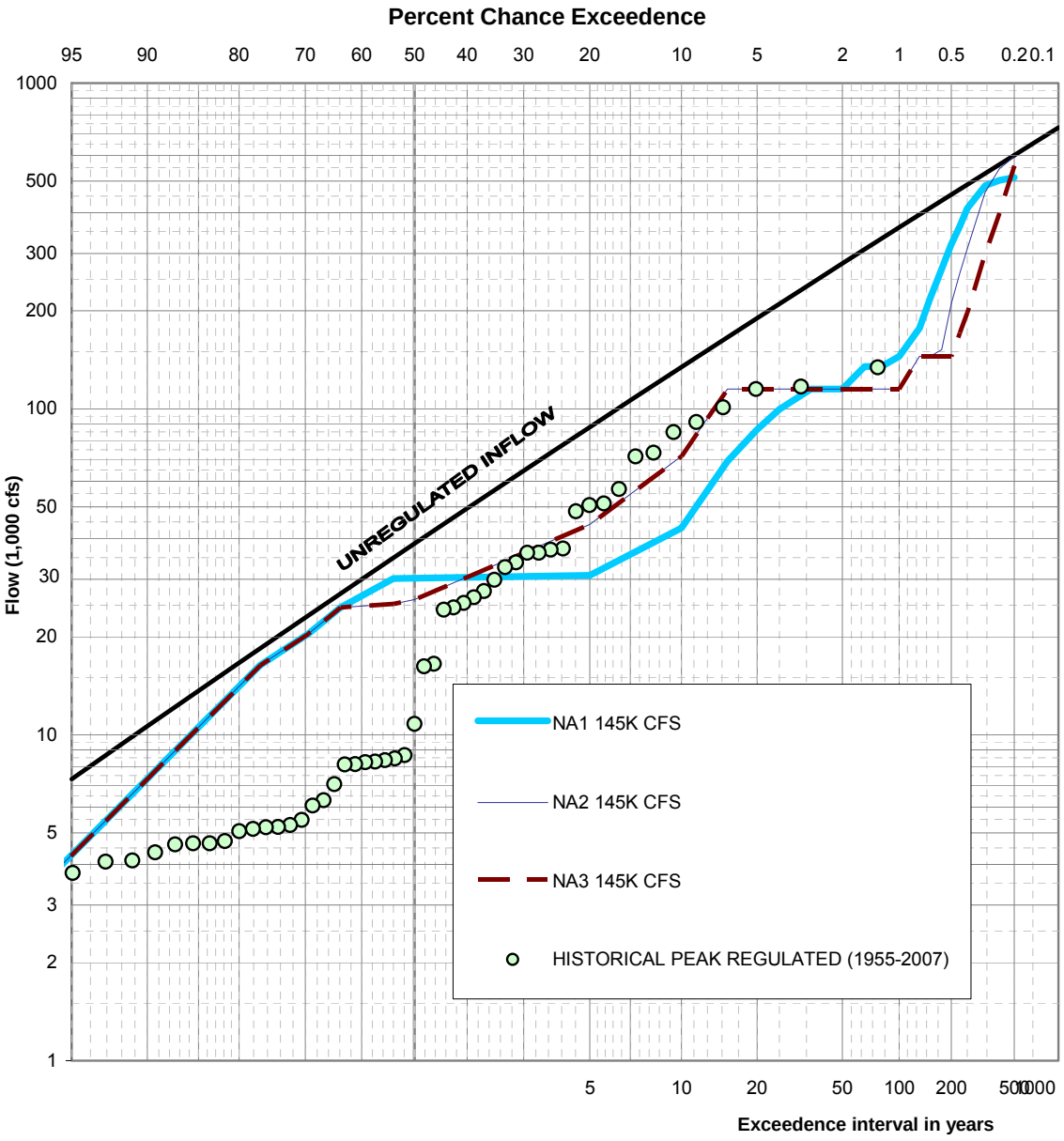

NOTES:

1. Adjusted USGS gage 11446500 to accoiunt for daily change in storage at upstream reservoirs (potential channel, out-of-channel, or storage losses neglected).
2. Median plotting positions
3. No adjustments for outliers.
4. Drainage area: 1,888 sq. mi.
5. Period of record: 1905-2004 (Unregulated).

AMERICAN RIVER WATERSHED PROJECT
COMMON FEATURES GRR

REGULATED FREQUENCY CURVES
FOLSOM DAM
FUTURE WITHOUT-PROJECT
(NO ACTION)

FIGURE A-12

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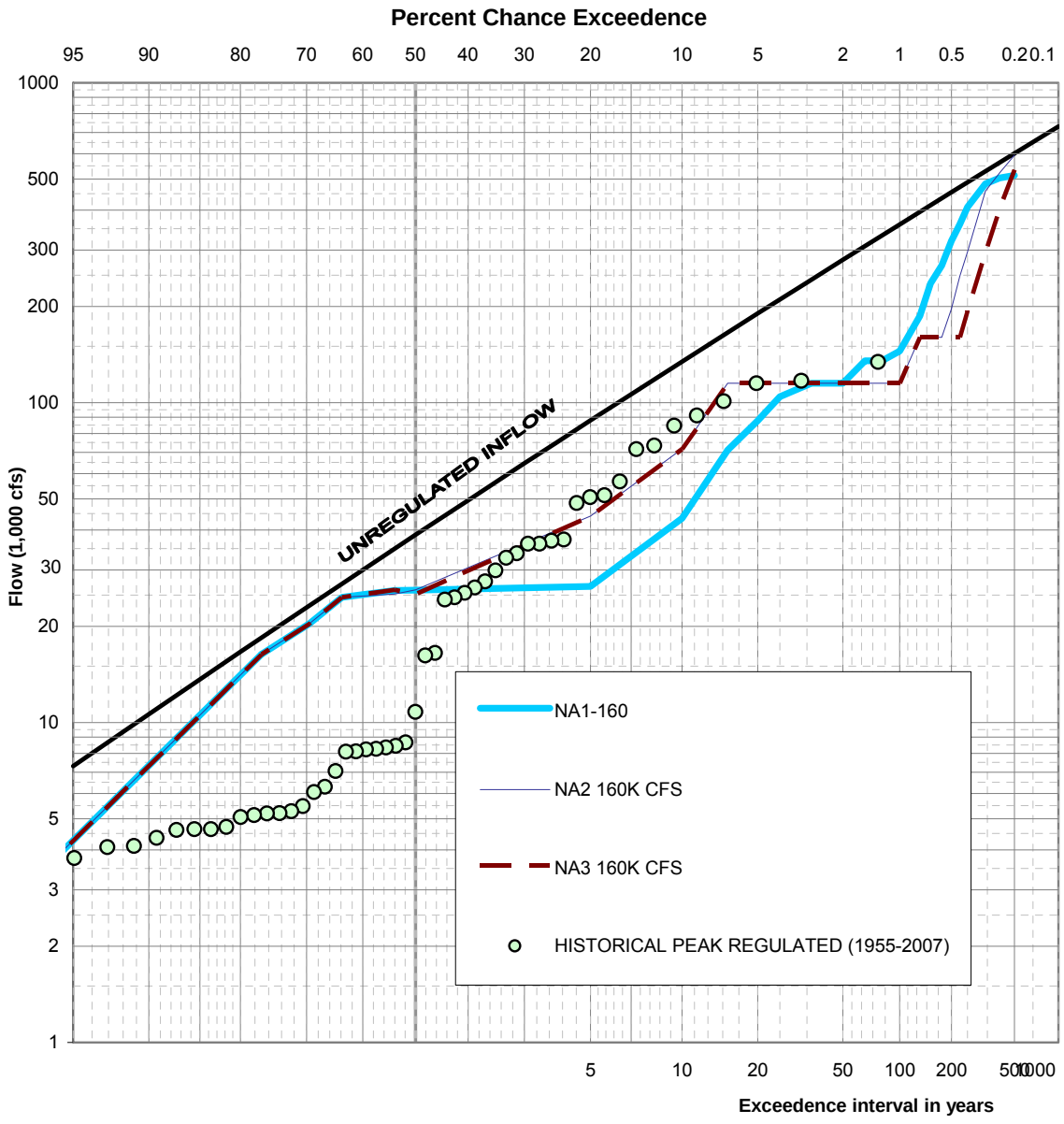

NOTES:

1. Adjusted USGS gage 11446500 to accoiunt for daily change in storage at upstream reservoirs (potential channel, out-of-channel, or storage losses neglected).
2. Median plotting positions
3. No adjustments for outliers.
4. Drainage area: 1,888 sq. mi.
5. Period of record: 1905-2004 (Unregulated).

AMERICAN RIVER WATERSHED PROJECT
COMMON FEATURES GRR

REGULATED FREQUENCY CURVES
FOLSOM DAM
FUTURE PROJECT

FIGURE A-13

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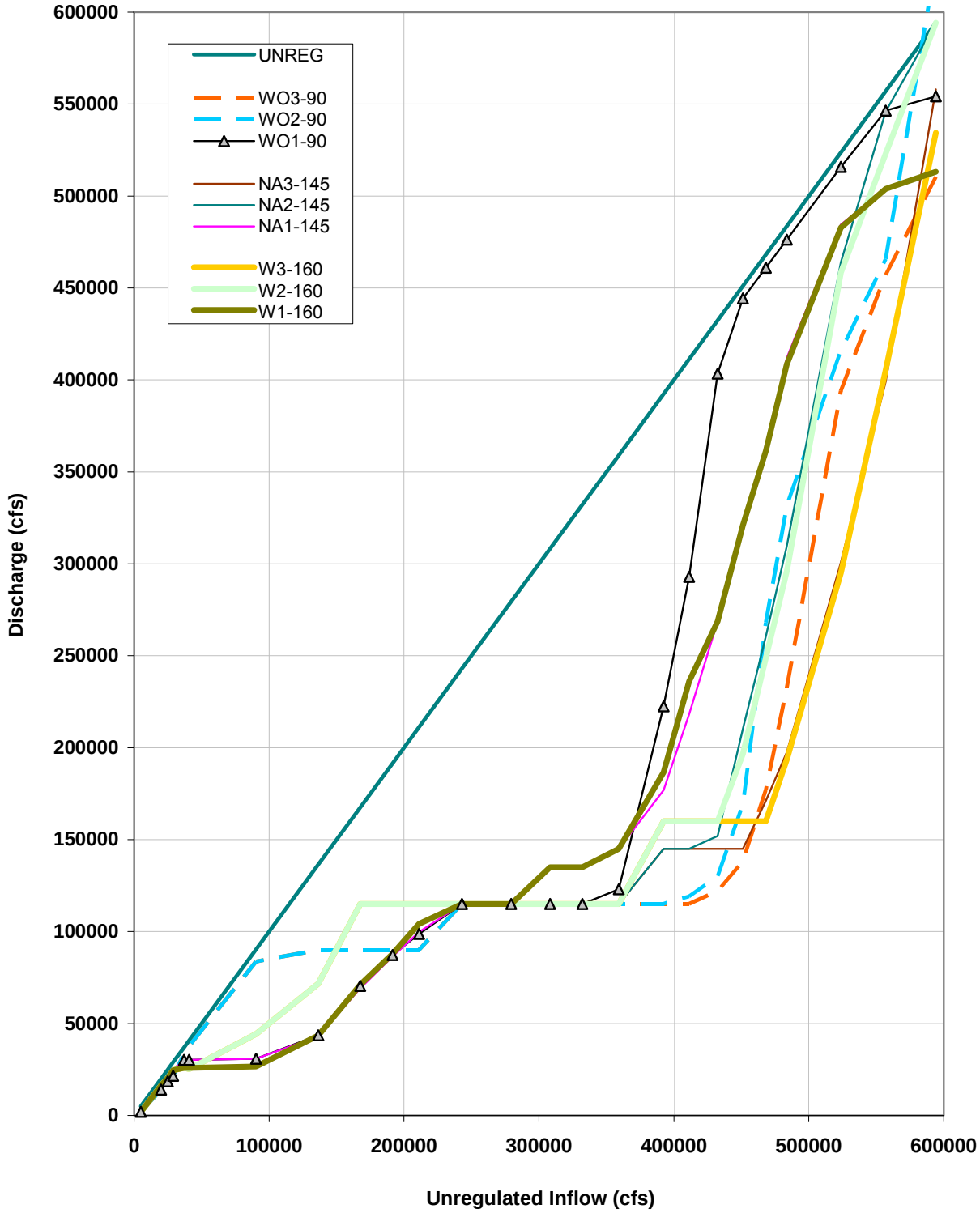

FIGURE A-14: INFLOW-OUTFLOW TRANSFORM – BASE – COMPARISON

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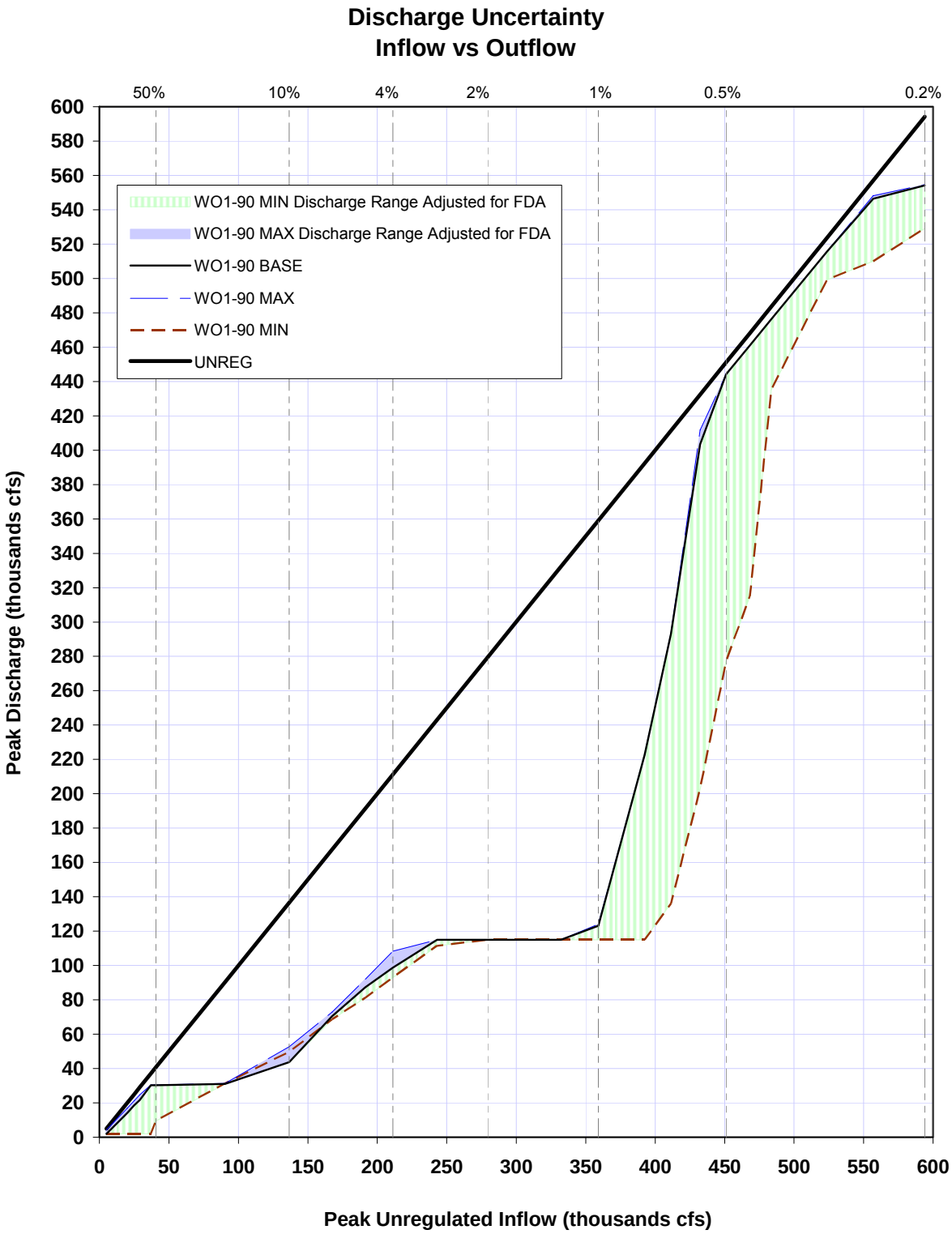

FIGURE A-15: DISCHARGE UNCERTAINTY – WO1 WITHOUT-PROJECT – 115,000 CFS

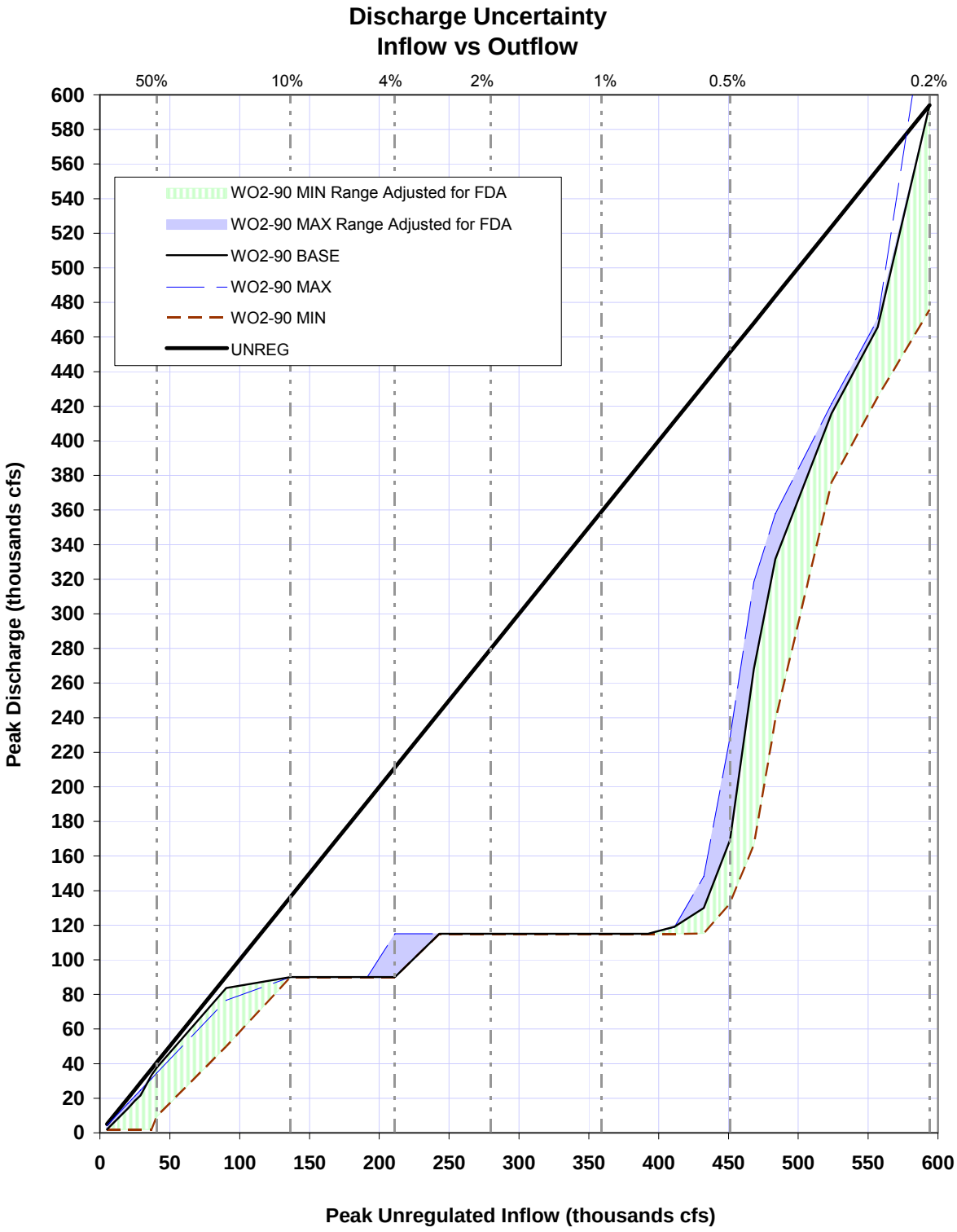

FIGURE A-16: DISCHARGE UNCERTAINTY – WO2 WITHOUT-PROJECT – 115,000 CFS

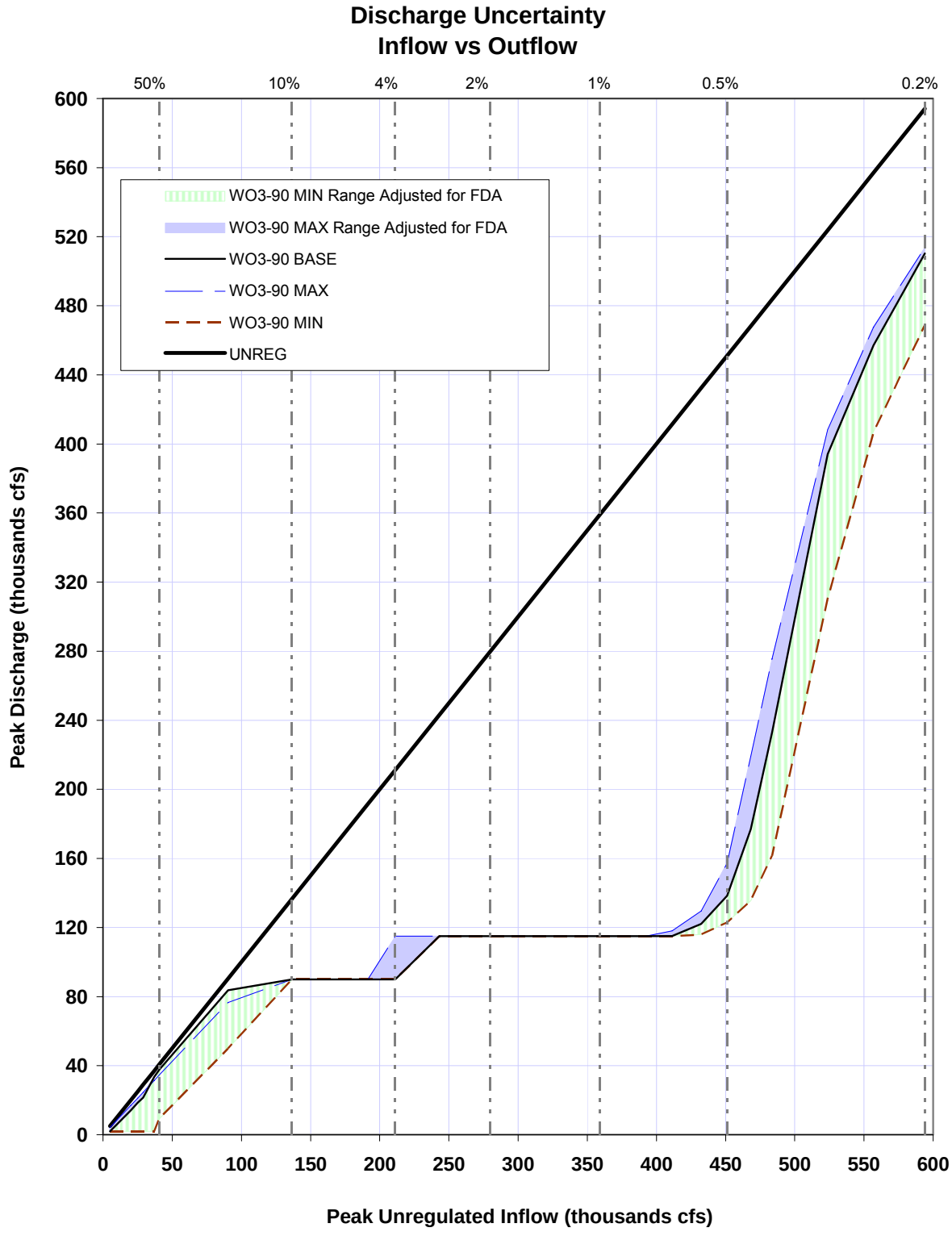

FIGURE A-17: DISCHARGE UNCERTAINTY – WO3 WITHOUT-PROJECT – 115,000 CFS

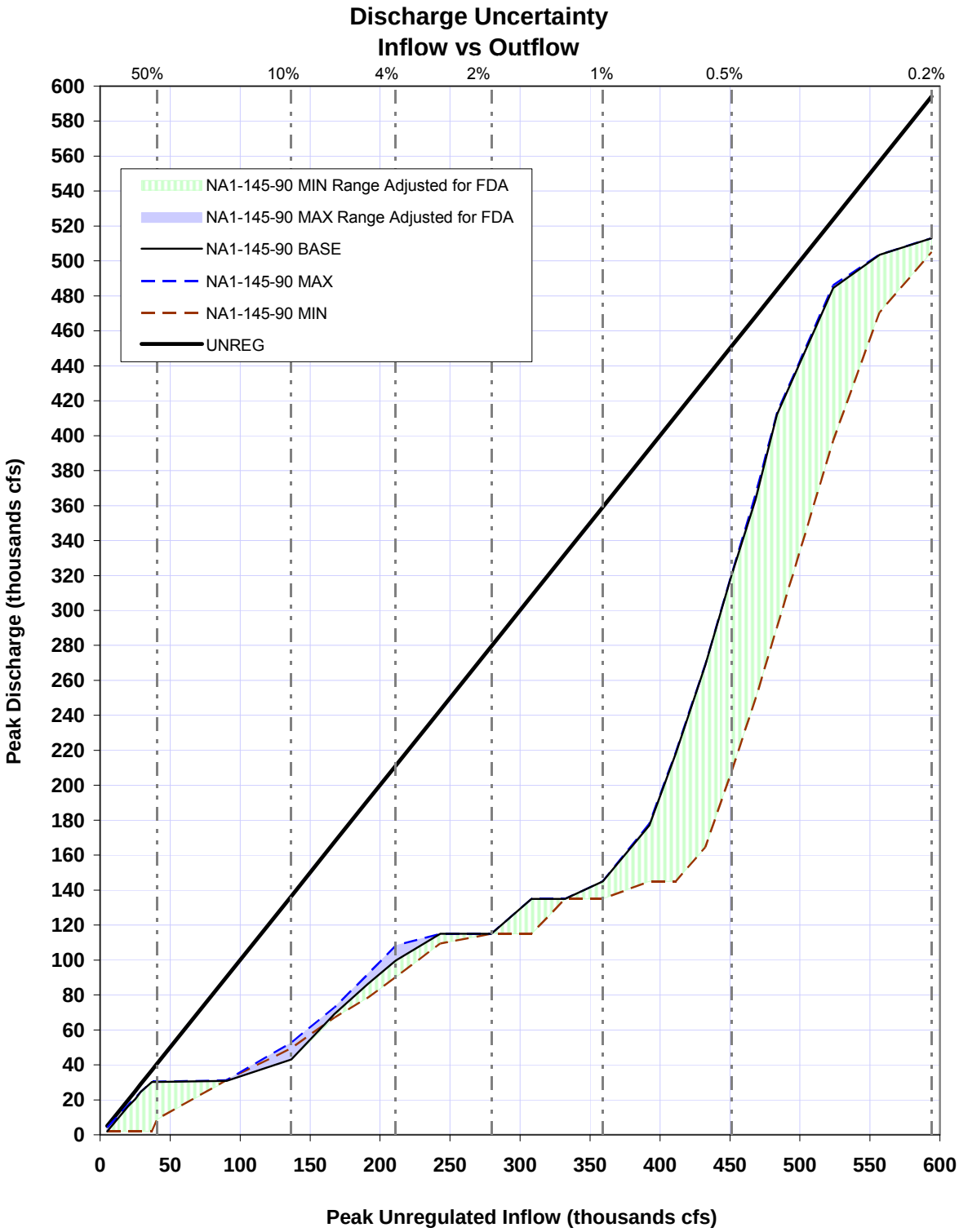

FIGURE A-18: DISCHARGE UNCERTAINTY – NA1 NO ACTION (FUTURE WITHOUT-PROJECT) – 145,000 CFS

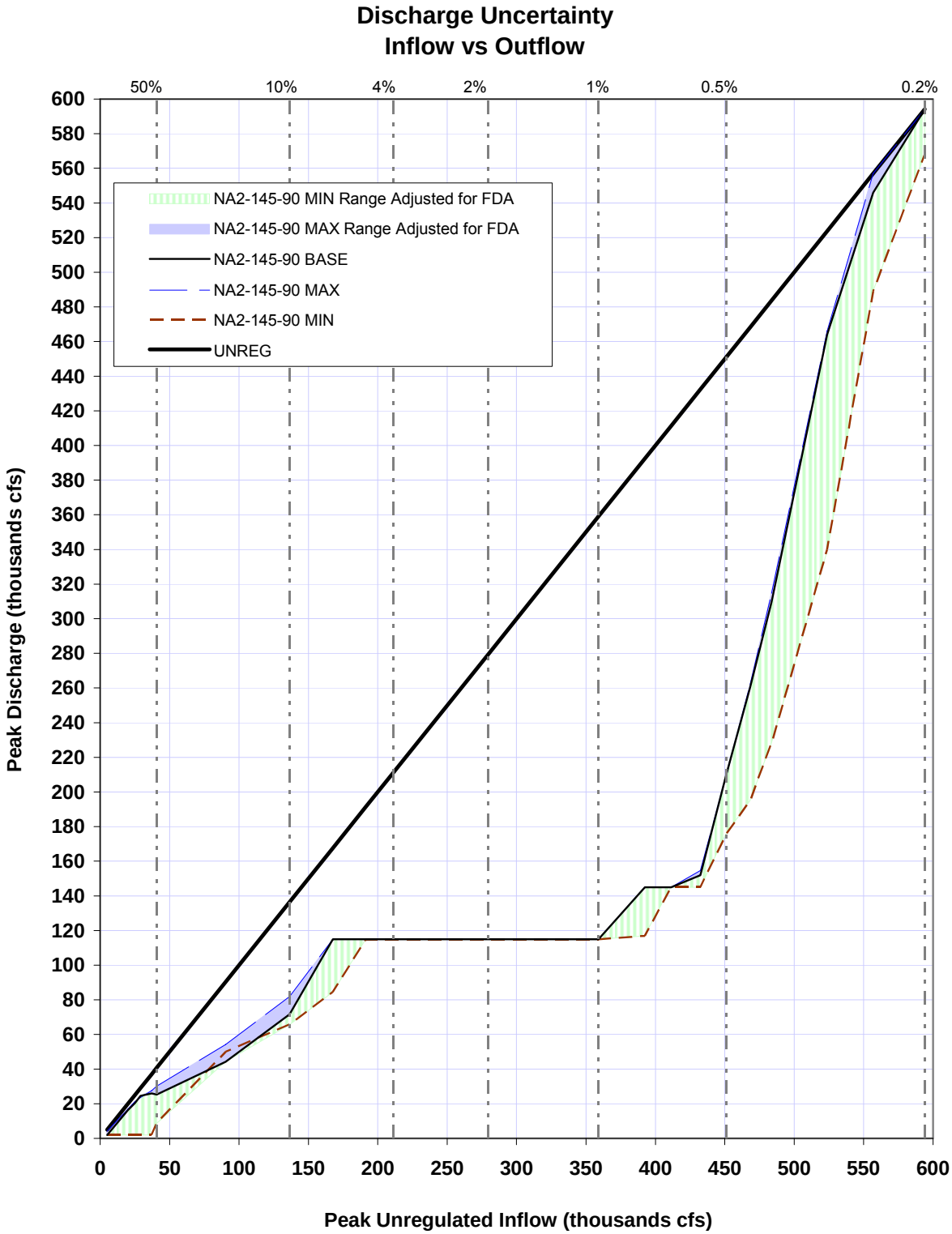

FIGURE A-19: DISCHARGE UNCERTAINTY – NA2 NO ACTION (FUTURE WITHOUT-PROJECT) – 145,000 CFS

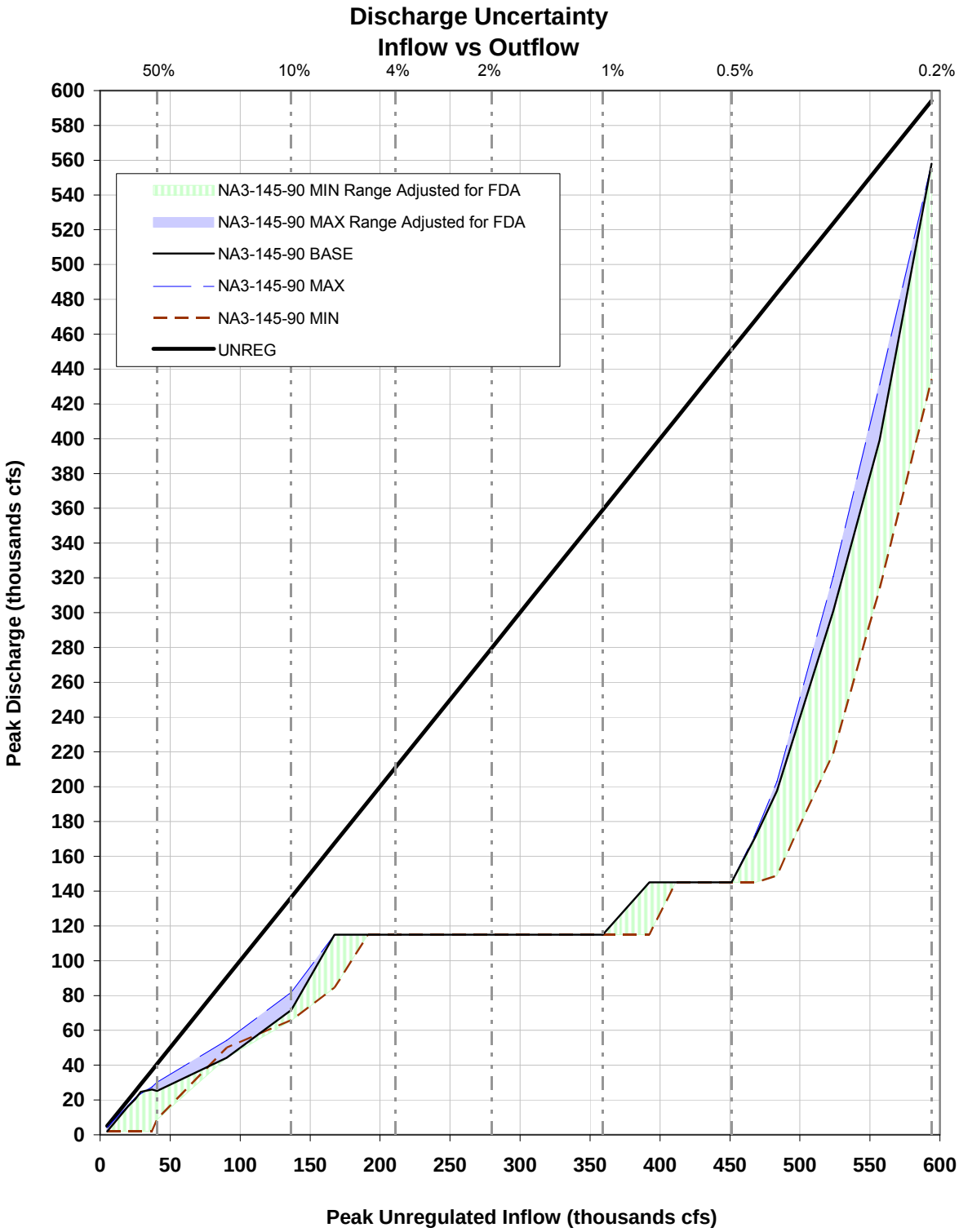

FIGURE A-20: DISCHARGE UNCERTAINTY – NA3 NO ACTION (FUTURE WITHOUT-PROJECT) – 145,000 CFS

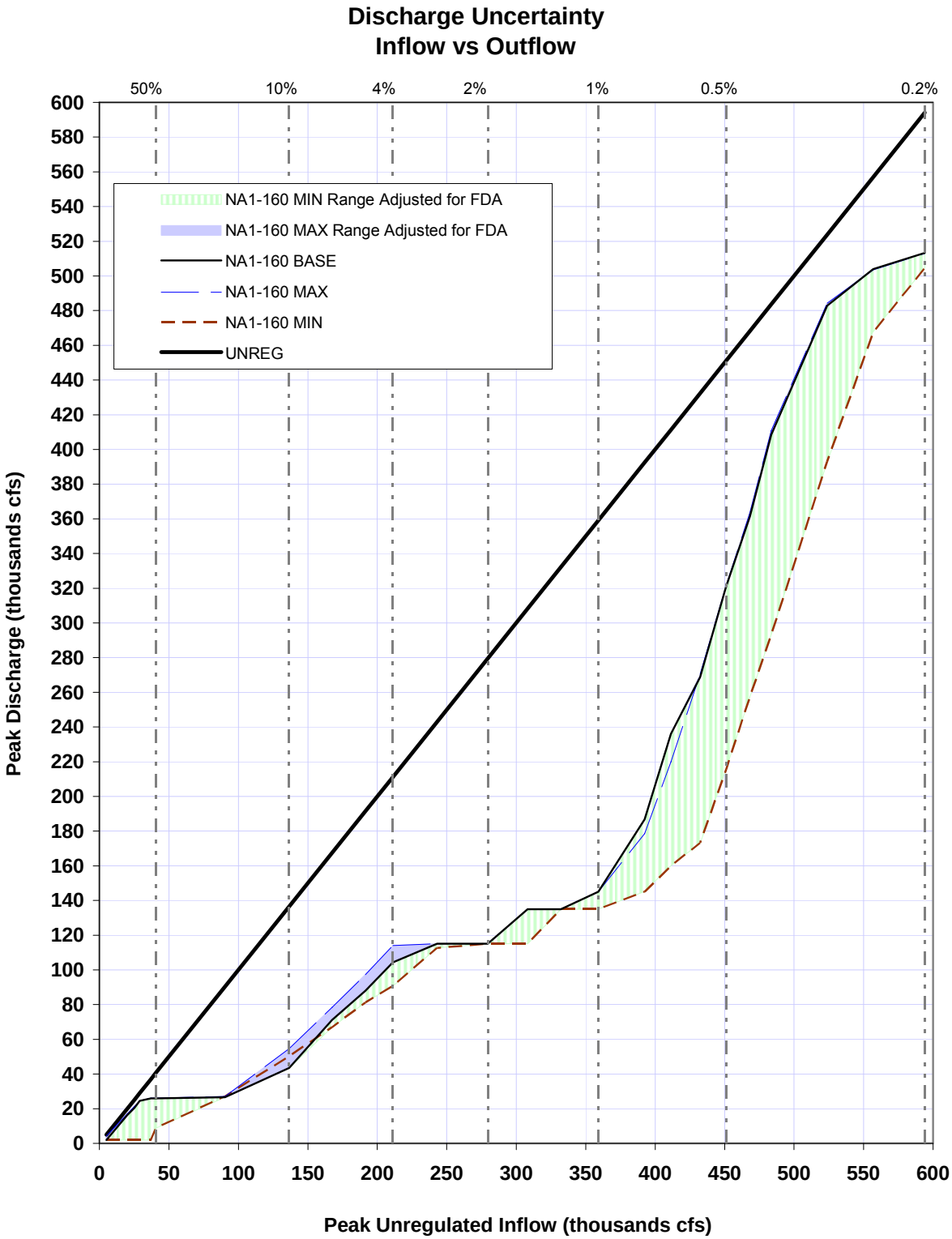

FIGURE A-21: DISCHARGE UNCERTAINTY – W1 WITH-PROJECT – 160,000 CFS

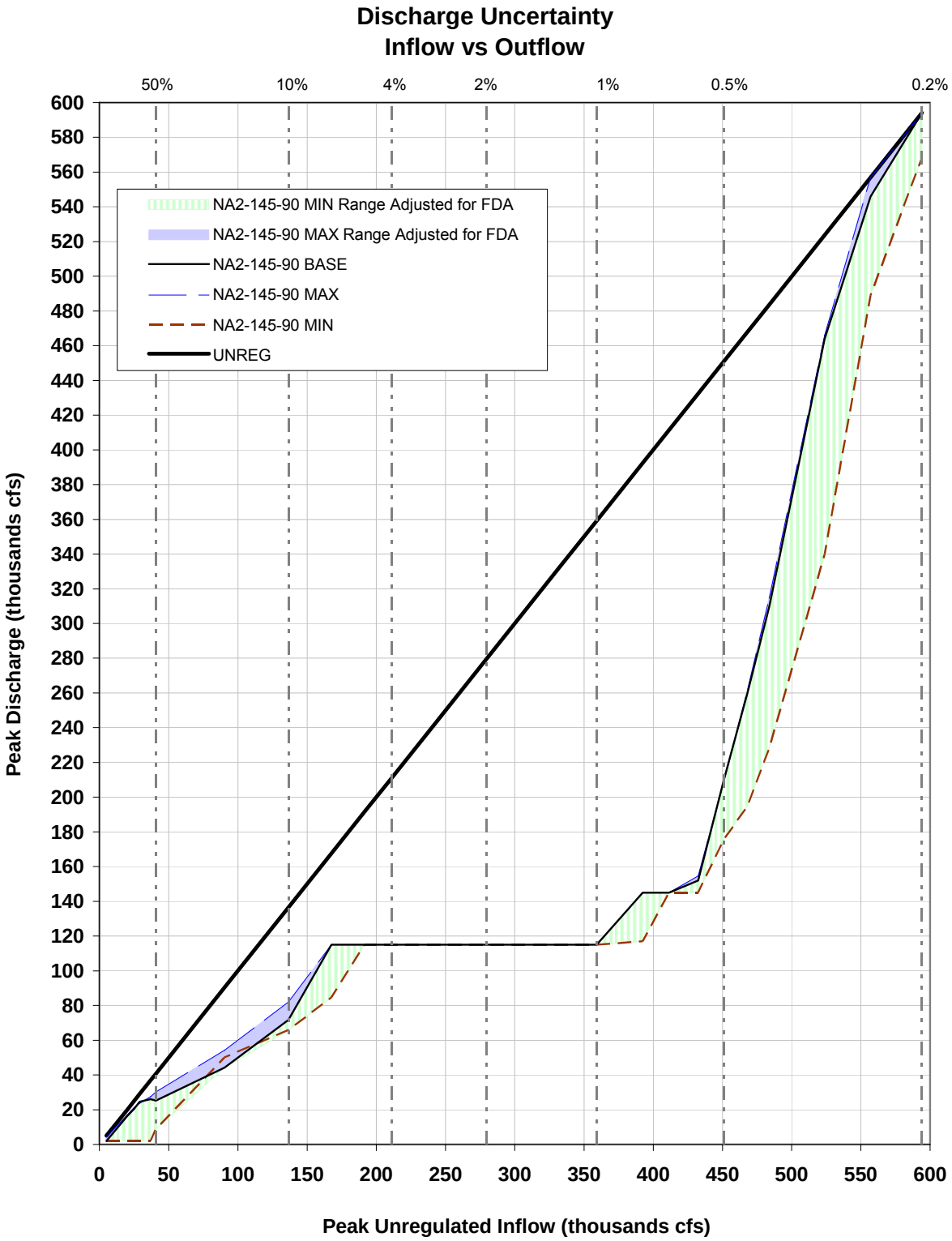

FIGURE A-22: DISCHARGE UNCERTAINTY – W2 WITH-PROJECT – 160,000 CFS

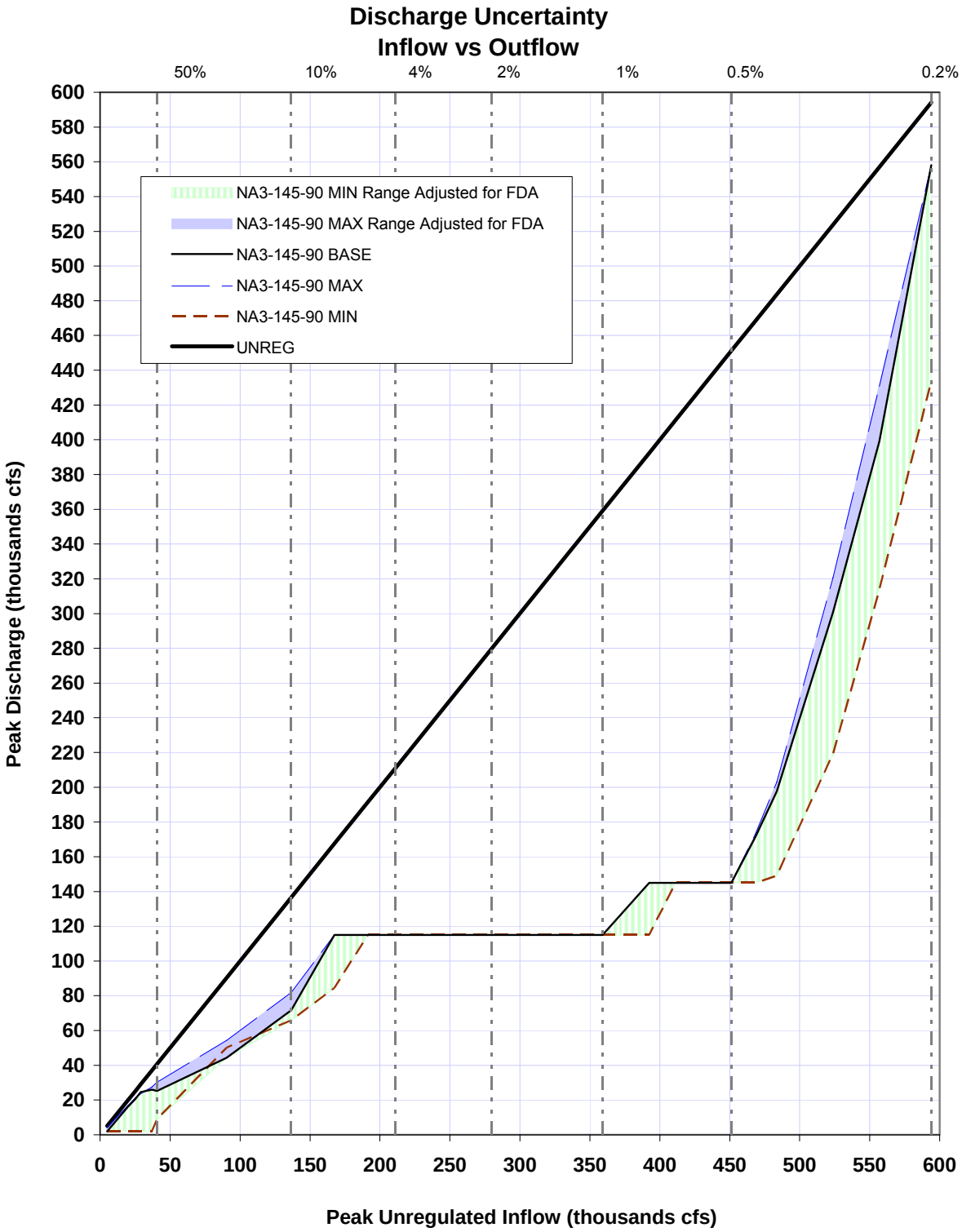

FIGURE A-23: DISCHARGE UNCERTAINTY – W3 WITH-PROJECT – 160,000 CFS

TABLE A-5: W01 BASE (R000_800CF_No Fix_115_FP470_P1_20080914)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.83	391.87	20002	20002	14057	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.49	389.60	25004	25004	18558	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	403.38	395.66	29000	29000	21525	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.75	398.21	37002	37002	30284	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	403.93	399.44	40722	40722	30295	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	416.82	494.78	90369	90369	30928	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	429.80	602.86	136522	136522	43692	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	435.17	651.53	167533	167533	70490	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	439.45	691.72	191482	191482	87307	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	442.53	721.38	211227	211227	98760	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	448.80	783.74	243016	243016	115000	0	0.00	0	0	0	23	23	0	0	0	0	0	0
50	457.34	872.50	279485	279485	115000	0	0.00	0	0	0	50	50	0	0	0	0	0	0
65	464.38	948.85	308218	308218	115000	0	0.00	0	0	0	68	68	0	0	0	0	0	0
80	470.37	1016.12	332148	332148	115000	0	0.00	0	0	33	84	84	0	0	0	0	0	0
100	**476.35**	**1085.39**	**359078**	**359078**	**123107**	**0**	**0.00**	**0**	**0**	**52**	**105**	**91**	**0**	**0**	**0**	**0**	**0**	**0**
130	475.79	1078.77	392399	392399	222593	0	0.00	0	0	46	100	85	22	0	14	0	20	0
150	476.38	1085.73	411351	411351	292965	0	0.00	0	0	42	96	81	24	0	18	0	-6	28
175	474.78	1066.96	432395	432395	403445	0	0.00	0	0	27	90	74	27	0	21	10	56	146
200	**476.33**	**1085.18**	**451163**	**451163**	**444310**	**0**	**0.00**	**0**	**0**	**27**	**92**	**76**	**29**	**0**	**23**	**12**	**-6**	**88**
225	476.68	1089.26	468139	468139	461029	0	0.00	0	0	28	94	78	33	0	25	14	74	70
250	476.65	1088.92	483665	483665	476319	0	0.00	0	0	28	93	78	34	0	27	16	68	100
325	477.59	1099.94	523757	523757	515802	0	0.00	0	0	31	97	83	38	0	31	20	55	101
400	478.55	1111.42	556967	556967	546433	0	0.00	0	0	34	100	88	42	0	35	22	38	96
500	479.62	1124.16	594159	594159	554268	0	0.00	0	0	39	109	93	48	0	40	26	31	85

TABLE A-6: W01 MAX (R000_800CF_No Fix_115_FP470_P1_20080914)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.76	419.28	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.90	420.25	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	407.01	421.03	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.22	422.55	37002	37002	30425	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.31	423.19	40722	40722	30425	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	417.33	498.81	90369	90369	31248	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	429.70	601.95	136522	136522	52675	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	435.68	656.20	167533	167533	72904	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	440.67	703.42	191482	191482	92040	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	444.39	739.61	211227	211227	108290	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	450.77	803.74	243016	243016	115000	0	0.00	0	0	0	30	30	0	0	0	0	0	0
50	458.92	889.35	279485	279485	115000	0	0.00	0	0	0	54	54	0	0	0	0	0	0
65	465.45	960.66	308218	308218	115000	0	0.00	0	0	0	71	71	0	0	0	0	0	0
80	470.97	1022.96	332148	332148	115000	0	0.00	0	0	36	86	86	0	0	0	0	0	0
100	**476.32**	**1085.03**	**359078**	**359078**	**124034**	**0**	**0.00**	**0**	**0**	**52**	**105**	**91**	**0**	**0**	**0**	**0**	**0**	**0**
130	475.79	1078.80	392399	392399	222320	0	0.00	0	0	46	100	85	22	0	14	0	20	0
150	476.39	1085.81	411351	411351	293316	0	0.00	0	0	42	96	81	24	0	18	0	-6	28
175	474.87	1068.07	432395	432395	411752	0	0.00	0	0	26	90	74	27	0	21	10	57	150
200	**476.37**	**1085.67**	**451163**	**451163**	**444310**	**0**	**0.00**	**0**	**0**	**28**	**93**	**77**	**29**	**0**	**23**	**12**	**-6**	**89**
225	476.67	1089.18	468139	468139	461029	0	0.00	0	0	28	94	78	33	0	25	14	68	70
250	476.66	1089.00	483665	483665	476319	0	0.00	0	0	28	94	78	34	0	27	16	49	99
325	477.74	1101.76	523757	523757	515802	0	0.00	0	0	31	97	83	38	0	32	20	53	95
400	478.68	1112.95	556967	556967	548181	0	0.00	0	0	36	101	88	42	0	36	22	32	98
500	479.76	1125.81	594159	594159	554678	0	0.00	0	0	39	111	93	49	0	40	26	53	81

TABLE A-7: W01 MIN (R000_800CF_No Fix_115_FP470_P1_20080914)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.84	464.05	40722	38674	9546	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	417.31	498.68	90369	84059	31233	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	428.58	592.07	136522	126249	49521	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	434.39	644.26	167533	154598	68674	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	437.99	677.88	191482	176491	81089	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	440.84	705.03	211227	194541	92975	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	445.30	748.65	243016	223601	111456	0	0.00	0	0	0	0	0	0	0	0	0	0	0
50	451.35	809.74	279485	256938	115000	0	0.00	0	0	0	32	32	0	0	0	0	0	0
65	456.85	867.28	308218	283204	115000	0	0.00	0	0	0	50	50	0	0	0	0	0	0
80	461.62	918.59	332148	305080	115000	0	0.00	0	0	0	62	62	0	0	0	0	0	0
100	**466.62**	**973.78**	**359078**	**329825**	**115000**	**0**	**0.00**	**0**	**0**	**14**	**75**	**75**	**0**	**0**	**0**	**0**	**0**	**0**
130	474.76	1066.72	392399	360850	115000	0	0.00	0	0	49	105	94	0	0	0	0	0	0
150	476.90	1091.89	411351	381289	135890	0	0.00	0	0	54	116	104	0	0	0	0	0	0
175	475.90	1080.08	432395	407507	203141	0	0.00	0	0	48	105	92	22	0	13	0	29	0
200	**475.92**	**1080.38**	**451163**	**429875**	**277213**	**0**	**0.00**	**0**	**0**	**41**	**97**	**84**	**25**	**0**	**18**	**0**	**73**	**27**
225	475.85	1079.48	468139	448786	314895	0	0.00	0	0	36	97	83	27	0	21	10	97	0
250	475.00	1069.51	483665	465352	435147	0	0.00	0	0	23	89	75	29	0	23	11	162	58
325	475.98	1080.98	523757	506439	499294	0	0.00	0	0	23	92	77	33	0	27	15	-6	147
400	476.25	1084.24	556967	540033	509928	0	0.00	0	0	27	96	81	39	0	31	19	106	156
500	477.41	1097.86	594159	577133	529188	0	0.00	0	0	31	104	88	45	0	36	22	70	132

TABLE A-8: W02 BASE (R060_800FM_No Fix_115_FP470_P1_20080908)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.83	391.87	20002	20002	14057	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.49	389.60	25004	25004	18558	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	403.38	395.66	29000	29000	21525	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.67	397.61	37002	37002	33505	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	403.53	396.67	40722	40722	37708	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	403.99	399.85	90369	90369	83680	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	408.97	435.18	136522	136522	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	415.21	482.19	167533	167533	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	421.58	532.97	191482	191482	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	427.80	585.26	211227	211227	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	433.71	638.02	243016	243016	115000	0	0.00	0	0	0	29	29	0	0	0	0	0	0
50	443.02	726.21	279485	279485	115000	0	0.00	0	0	0	54	54	0	0	0	0	0	0
65	449.41	789.86	308218	308218	115000	0	0.00	0	0	0	68	68	0	0	0	0	0	0
80	454.76	845.21	332148	332148	115000	0	0.00	0	0	0	81	81	0	0	0	0	0	0
100	**461.00**	**911.80**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**102**	**102**	**0**	**0**	**0**	**0**	**0**	**0**
130	467.81	987.06	392399	392399	115000	0	0.00	0	0	23	127	127	0	0	0	0	0	0
150	472.83	1044.29	411351	411351	115000	0	0.00	0	0	43	138	126	0	0	0	0	0	0
175	476.38	1085.74	432395	432395	129972	0	0.00	0	0	54	147	133	0	0	0	0	0	0
200	**476.65**	**1088.93**	**451163**	**451163**	**169173**	**0**	**0.00**	**0**	**0**	**152**	**53**	**14**	**20**	**0**	**0**	**0**	**3**	**0**
225	474.79	1067.11	468139	468139	268061	0	0.00	0	0	80	56	15	24	0	17	0	55	0
250	475.23	1072.29	483665	483665	331691	0	0.00	0	0	62	58	14	25	0	19	8	-5	45
325	478.02	1105.13	523757	523757	415711	0	0.00	0	0	62	62	15	30	0	24	13	-6	80
400	479.76	1125.81	556967	556967	465830	0	0.00	0	0	63	65	15	34	0	28	16	-5	80
500	480.97	1140.34	594159	594159	627077	25	0.47	0	0	47	68	13	40	0	32	20	-2	77

TABLE A-9: W02 MAX (R060_800FM_No Fix_115_FP470_P1_20080908)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.76	419.28	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.90	420.25	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	407.01	421.03	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.22	422.55	37002	37002	31387	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.31	423.19	40722	40722	34542	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	408.59	432.46	90369	90369	76656	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	412.41	460.77	136522	136522	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	418.11	505.04	167533	167533	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	423.57	549.39	191482	191482	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	428.52	591.54	211227	211227	115000	0	0.00	0	0	0	10	10	0	0	0	0	0	0
35	434.66	646.79	243016	243016	115000	0	0.00	0	0	0	32	32	0	0	0	0	0	0
50	443.71	732.89	279485	279485	115000	0	0.00	0	0	0	55	55	0	0	0	0	0	0
65	450.81	804.21	308218	308218	115000	0	0.00	0	0	0	72	72	0	0	0	0	0	0
80	456.24	860.80	332148	332148	115000	0	0.00	0	0	0	86	86	0	0	0	0	0	0
100	**463.05**	**934.22**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**113**	**113**	**0**	**0**	**0**	**0**	**0**	**0**
130	470.95	1022.74	392399	392399	115000	0	0.00	0	0	37	135	135	0	0	0	0	0	0
150	475.46	1074.96	411351	411351	118897	0	0.00	0	0	51	146	130	0	0	0	0	0	0
175	476.56	1087.80	432395	432395	148180	0	0.00	0	0	53	149	132	0	0	0	0	0	0
200	**474.94**	**1068.80**	**451163**	**451163**	**228405**	**0**	**0.00**	**0**	**0**	**99**	**57**	**17**	**22**	**0**	**15**	**0**	**53**	**0**
225	474.96	1069.02	468139	468139	318472	0	0.00	0	0	63	59	17	26	0	18	6	64	38
250	476.00	1081.29	483665	483665	357755	0	0.00	0	0	59	60	16	26	0	20	9	-5	57
325	478.22	1107.42	523757	523757	421382	0	0.00	0	0	63	64	16	31	0	25	14	-6	80
400	479.93	1127.86	556967	556967	470310	0	0.00	0	0	62	66	15	35	0	29	17	-5	77
500	481.08	1141.63	594159	594159	663803	33	0.58	0	0	47	70	14	41	0	33	21	-2	78

TABLE A-10: W02 MIN (R060_800FM_No Fix_115_FP470_P1_20080908)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.84	464.05	40722	38674	9546	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	415.33	483.15	90369	84059	50000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	418.32	506.69	136522	126249	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	421.73	534.18	167533	154598	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	425.96	569.46	191482	176491	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	429.85	603.33	211227	194541	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	434.59	646.18	243016	223601	115000	0	0.00	0	0	0	22	22	0	0	0	0	0	0
50	441.93	715.57	279485	256938	115000	0	0.00	0	0	0	46	46	0	0	0	0	0	0
65	448.57	781.34	308218	283204	115000	0	0.00	0	0	0	63	63	0	0	0	0	0	0
80	453.72	834.34	332148	305080	115000	0	0.00	0	0	0	79	79	0	0	0	0	0	0
100	**460.26**	**903.83**	**359078**	**329825**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**100**	**100**	**0**	**0**	**0**	**0**	**0**	**0**
130	467.01	978.09	392399	360850	115000	0	0.00	0	0	16	127	127	0	0	0	0	0	0
150	469.43	1005.36	411351	381289	115000	0	0.00	0	0	32	134	134	0	0	0	0	0	0
175	474.36	1062.07	432395	407507	115124	0	0.00	0	0	50	147	130	0	0	0	0	0	0
200	**476.58**	**1088.06**	**451163**	**429875**	**132562**	**0**	**0.00**	**0**	**0**	**55**	**152**	**136**	**0**	**0**	**0**	**0**	**0**	**0**
225	476.63	1088.71	468139	448786	166144	0	0.00	0	0	155	55	15	20	0	0	0	3	0
250	474.88	1068.11	483665	465352	238763	0	0.00	0	0	95	57	16	24	0	17	0	50	15
325	476.43	1086.35	523757	506439	375796	0	0.00	0	0	55	61	15	28	0	22	10	-6	68
400	478.35	1108.97	556967	540033	425258	0	0.00	0	0	57	64	15	33	0	26	14	-1	84
500	480.11	1129.97	594159	577133	475823	0	0.00	0	0	47	68	15	39	0	30	17	-2	83

TABLE A-11: W03 BASE (R060_800DR3.5e_115_FP470_P1_20080907)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.83	391.87	20002	20002	14057	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.49	389.60	25004	25004	18558	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	403.38	395.66	29000	29000	21525	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.67	397.61	37002	37002	33505	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	403.53	396.67	40722	40722	37708	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	403.99	399.85	90369	90369	83680	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	408.97	435.18	136522	136522	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	415.21	482.19	167533	167533	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	421.58	532.97	191482	191482	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	427.80	585.26	211227	211227	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	433.71	638.02	243016	243016	115000	0	0.00	0	0	0	29	29	0	0	0	0	0	0
50	443.02	726.21	279485	279485	115000	0	0.00	0	0	0	54	54	0	0	0	0	0	0
65	449.41	789.86	308218	308218	115000	0	0.00	0	0	0	68	68	0	0	0	0	0	0
80	454.76	845.21	332148	332148	115000	0	0.00	0	0	0	81	81	0	0	0	0	0	0
100	**461.00**	**911.80**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**102**	**102**	**0**	**0**	**0**	**0**	**0**	**0**
130	467.81	987.06	392399	392399	115000	0	0.00	0	0	23	127	127	0	0	0	0	0	0
150	472.81	1044.11	411351	411351	115088	0	0.00	0	0	43	138	126	0	0	0	0	0	0
175	476.78	1090.42	432395	432395	122131	0	0.00	0	0	55	149	135	0	0	0	0	0	0
200	**478.67**	**1112.80**	**451163**	**451163**	**138359**	**0**	**0.00**	**0**	**0**	**60**	**154**	**140**	**0**	**0**	**0**	**0**	**0**	**0**
225	478.38	1109.31	468139	468139	176952	0	0.00	0	0	162	56	15	24	0	0	0	15	0
250	477.27	1096.17	483665	483665	232803	0	0.00	0	0	150	58	14	25	0	18	0	34	0
325	477.72	1101.50	523757	523757	394043	0	0.00	0	0	72	62	15	30	0	24	13	-6	75
400	479.49	1122.65	556967	556967	457102	0	0.00	0	0	76	65	15	34	0	28	16	-5	74
500	481.31	1144.50	594159	594159	510279	0	0.00	0	0	77	68	14	40	0	32	20	-2	75
PMF	486.00	1201.47	905770	905770	1105372	214	2.00	0	0	131	134	18	93	0	61	49	247	146

TABLE A-12: W03 MAX (R060_800DR3.5e_115_FP470_P1_20080907)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.76	419.28	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.90	420.25	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	407.01	421.03	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.22	422.55	37002	37002	31387	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.31	423.19	40722	40722	34542	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	408.59	432.46	90369	90369	76656	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	412.41	460.77	136522	136522	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	418.11	505.04	167533	167533	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	423.57	549.39	191482	191482	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	428.52	591.54	211227	211227	115000	0	0.00	0	0	0	10	10	0	0	0	0	0	0
35	434.66	646.79	243016	243016	115000	0	0.00	0	0	0	32	32	0	0	0	0	0	0
50	443.71	732.89	279485	279485	115000	0	0.00	0	0	0	55	55	0	0	0	0	0	0
65	450.81	804.21	308218	308218	115000	0	0.00	0	0	0	72	72	0	0	0	0	0	0
80	456.24	860.80	332148	332148	115000	0	0.00	0	0	0	86	86	0	0	0	0	0	0
100	**463.05**	**934.22**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**113**	**113**	**0**	**0**	**0**	**0**	**0**	**0**
130	470.95	1022.74	392399	392399	115000	0	0.00	0	0	37	135	135	0	0	0	0	0	0
150	475.37	1073.85	411351	411351	118010	0	0.00	0	0	51	146	130	0	0	0	0	0	0
175	477.72	1101.61	432395	432395	129653	0	0.00	0	0	57	152	135	0	0	0	0	0	0
200	**478.72**	**1113.42**	**451163**	**451163**	**157288**	**0**	**0.00**	**0**	**0**	**60**	**156**	**138**	**0**	**0**	**0**	**0**	**0**	**0**
225	477.50	1098.98	468139	468139	219082	0	0.00	0	0	151	59	18	25	0	17	0	24	0
250	476.79	1090.52	483665	483665	275466	0	0.00	0	0	105	60	16	26	0	20	0	53	7
325	478.10	1106.01	523757	523757	408380	0	0.00	0	0	73	64	16	31	0	25	13	74	61
400	479.87	1127.11	556967	556967	467639	0	0.00	0	0	77	66	15	35	0	29	16	71	59
500	481.43	1147.07	594159	594159	513811	0	0.00	0	0	78	70	15	41	0	33	21	-2	72

TABLE A-13: W03 MIN (R060_800DR3.5e_115_FP470_P1_20080907)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.84	464.05	40722	38674	9546	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	415.33	483.15	90369	84059	50000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	418.32	506.69	136522	126249	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	421.73	534.18	167533	154598	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	425.96	569.46	191482	176491	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	429.85	603.33	211227	194541	90000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	434.59	646.18	243016	223601	115000	0	0.00	0	0	0	22	22	0	0	0	0	0	0
50	441.93	715.57	279485	256938	115000	0	0.00	0	0	0	46	46	0	0	0	0	0	0
65	448.57	781.34	308218	283204	115000	0	0.00	0	0	0	63	63	0	0	0	0	0	0
80	453.72	834.34	332148	305080	115000	0	0.00	0	0	0	79	79	0	0	0	0	0	0
100	**460.26**	**903.83**	**359078**	**329825**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**100**	**100**	**0**	**0**	**0**	**0**	**0**	**0**
130	467.01	978.09	392399	360850	115000	0	0.00	0	0	16	127	127	0	0	0	0	0	0
150	469.43	1005.36	411351	381289	115000	0	0.00	0	0	32	134	134	0	0	0	0	0	0
175	474.21	1060.36	432395	407507	115938	0	0.00	0	0	49	146	128	0	0	0	0	0	0
200	**477.18**	**1095.22**	**451163**	**429875**	**122877**	**0**	**0.00**	**0**	**0**	**57**	**154**	**138**	**0**	**0**	**0**	**0**	**0**	**0**
225	478.80	1114.32	468139	448786	135427	0	0.00	0	0	61	158	143	0	0	0	0	0	0
250	479.05	1117.37	483665	465352	161583	0	0.00	0	0	171	57	16	23	0	0	0	0	0
325	476.54	1087.58	523757	506439	310409	0	0.00	0	0	83	61	15	28	0	22	9	55	38
400	478.05	1105.51	556967	540033	406670	0	0.00	0	0	64	64	15	33	0	26	14	-1	78
500	479.89	1127.38	594159	577133	468932	0	0.00	0	0	68	68	16	39	0	30	16	77	70

TABLE A-14: NA1-145 BASE (R000_800CF_No Fix_145_FP470_P1_20080919)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.39	388.94	20002	20002	16328	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.53	389.84	25004	25004	20411	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	402.78	391.51	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.17	394.19	37002	37002	30237	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	402.43	389.16	40722	40722	30183	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	415.74	486.34	90369	90369	30848	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	429.13	596.95	136522	136522	43127	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	434.65	646.67	167533	167533	69092	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	439.01	687.48	191482	191482	86500	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	442.69	722.96	211227	211227	99738	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	448.44	780.03	243016	243016	115000	0	0.00	0	0	0	22	22	0	0	0	0	0	0
50	457.01	868.92	279485	279485	115000	0	0.00	0	0	0	49	49	0	0	0	0	0	0
65	461.09	912.80	308218	308218	135000	0	0.00	0	0	0	61	61	0	0	0	0	0	0
80	466.44	971.77	332148	332148	135000	0	0.00	0	0	9	74	74	0	0	0	0	0	0
100	**470.81**	**1021.10**	**359078**	**359078**	**145000**	**0**	**0.00**	**0**	**0**	**39**	**92**	**92**	**0**	**0**	**0**	**0**	**0**	**0**
130	475.31	1073.15	392399	392399	177012	0	0.00	0	0	49	105	105	20	1	0	0	14	0
150	475.74	1078.26	411351	411351	218286	0	0.00	0	0	49	106	106	23	0	16	0	18	0
175	476.07	1082.12	432395	432395	268700	0	0.00	0	0	47	104	103	25	0	19	0	-6	16
200	**476.40**	**1086.00**	**451163**	**451163**	**320142**	**0**	**0.00**	**0**	**0**	**45**	**104**	**102**	**28**	**0**	**21**	**11**	**65**	**42**
225	476.58	1088.08	468139	468139	363164	0	0.00	0	0	41	103	102	31	0	24	12	48	42
250	476.67	1089.18	483665	483665	412114	0	0.00	0	0	36	101	99	32	0	26	14	-5	47
325	477.17	1095.00	523757	523757	484550	0	0.00	0	0	35	102	101	37	0	30	18	56	49
400	477.83	1102.80	556967	556967	503557	0	0.00	0	0	38	107	107	41	0	35	21	37	46
500	479.01	1116.85	594159	594159	512982	0	0.00	0	0	42	129	115	47	0	39	25	30	52

TABLE A-15: NA1-145 MAX (R000_800CF_No Fix_145_FP470_P1_20080919)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.74	419.09	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.86	419.97	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	406.97	420.78	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.19	422.35	37002	37002	30423	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.29	423.06	40722	40722	30424	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	417.33	498.81	90369	90369	31248	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	429.70	601.95	136522	136522	52675	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	435.68	656.20	167533	167533	72904	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	440.67	703.42	191482	191482	92040	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	444.39	739.61	211227	211227	108290	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	450.77	803.74	243016	243016	115000	0	0.00	0	0	0	30	30	0	0	0	0	0	0
50	458.92	889.35	279485	279485	115000	0	0.00	0	0	0	54	54	0	0	0	0	0	0
65	462.29	925.84	308218	308218	135000	0	0.00	0	0	0	65	65	0	0	0	0	0	0
80	467.20	980.23	332148	332148	135000	0	0.00	0	0	16	78	78	0	0	0	0	0	0
100	**471.07**	**1024.11**	**359078**	**359078**	**145000**	**0**	**0.00**	**0**	**0**	**40**	**92**	**92**	**0**	**0**	**0**	**0**	**0**	**0**
130	475.32	1073.28	392399	392399	178071	0	0.00	0	0	48	105	105	20	0	0	0	13	0
150	475.75	1078.35	411351	411351	218943	0	0.00	0	0	49	106	106	23	0	17	0	14	0
175	476.08	1082.17	432395	432395	269028	0	0.00	0	0	47	104	103	25	0	19	0	-6	15
200	**476.41**	**1086.03**	**451163**	**451163**	**320618**	**0**	**0.00**	**0**	**0**	**45**	**104**	**102**	**28**	**0**	**22**	**11**	**56**	**42**
225	476.59	1088.23	468139	468139	366078	0	0.00	0	0	40	104	102	31	0	24	12	50	42
250	476.67	1089.19	483665	483665	413033	0	0.00	0	0	36	102	99	32	0	26	14	-5	46
325	477.19	1095.24	523757	523757	485904	0	0.00	0	0	35	102	101	37	0	31	18	45	47
400	477.84	1102.98	556967	556967	503676	0	0.00	0	0	39	108	108	41	0	35	21	36	47
500	479.02	1116.98	594159	594159	513077	0	0.00	0	0	42	126	115	48	0	39	25	44	52

TABLE A-16: NA1-145 MIN (R000_800CF_No Fix_145_FP470_P1_20080919)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.98	465.10	40722	38674	8916	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	417.13	497.21	90369	84059	31233	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	428.58	592.07	136522	126249	49521	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	433.77	638.60	167533	154598	67040	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	437.47	672.98	191482	176491	78462	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	440.35	700.34	211227	194541	90191	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	444.94	745.01	243016	223601	109419	0	0.00	0	0	0	0	0	0	0	0	0	0	0
50	451.06	806.80	279485	256938	115000	0	0.00	0	0	0	31	31	0	0	0	0	0	0
65	456.61	864.68	308218	283204	115000	0	0.00	0	0	0	48	48	0	0	0	0	0	0
80	458.74	887.48	332148	305080	135000	0	0.00	0	0	0	56	56	0	0	0	0	0	0
100	**463.26**	**936.53**	**359078**	**329825**	**135000**	**0**	**0.00**	**0**	**0**	**0**	**68**	**68**	**0**	**0**	**0**	**0**	**0**	**0**
130	468.87	998.98	392399	360850	145000	0	0.00	0	0	26	84	84	0	0	0	0	0	0
150	472.83	1044.26	411351	381289	145000	0	0.00	0	0	47	103	103	0	0	0	0	0	0
175	475.66	1077.28	432395	407507	164525	0	0.00	0	0	52	118	118	14	1	0	0	2	0
200	**475.58**	**1076.33**	**451163**	**429875**	**207706**	**0**	**0.00**	**0**	**0**	**50**	**117**	**117**	**23**	**0**	**17**	**0**	**4**	**0**
225	475.81	1079.03	468139	448786	249188	0	0.00	0	0	48	118	118	25	0	19	0	-5	5
250	476.10	1082.45	483665	465352	290568	0	0.00	0	0	45	106	106	27	0	21	0	-5	21
325	476.63	1088.66	523757	506439	397225	0	0.00	0	0	36	105	104	32	0	26	13	-6	92
400	476.97	1092.73	556967	540033	470504	0	0.00	0	0	32	104	103	37	0	30	18	-1	63
500	478.01	1105.02	594159	577133	505120	0	0.00	0	0	36	121	110	43	0	34	21	-2	50

TABLE A-17: NA2-145 BASE (R060_800FM_No Fix_145_FP466_P1_20080916)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.39	388.94	20002	20002	16328	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.53	389.84	25004	25004	20411	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	402.78	391.51	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.59	397.11	37002	37002	26005	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	403.18	394.30	40722	40722	25215	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	413.74	470.92	90369	90369	44261	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	421.65	533.58	136522	136522	71655	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	424.92	560.66	167533	167533	115000	0	0.00	0	0	0	26	26	0	0	0	0	0	0
20	428.02	587.24	191482	191482	115000	0	0.00	0	0	0	36	36	0	0	0	0	0	0
25	431.43	617.37	211227	211227	115000	0	0.00	0	0	0	45	45	0	0	0	0	0	0
35	437.15	669.98	243016	243016	115000	0	0.00	0	0	0	57	57	0	0	0	0	0	0
50	442.97	725.68	279485	279485	115000	0	0.00	0	0	0	75	75	0	0	0	0	0	0
65	449.11	786.85	308218	308218	115000	0	0.00	0	0	0	103	103	0	0	0	0	0	0
80	453.74	834.47	332148	332148	115000	0	0.00	0	0	0	127	127	0	0	0	0	0	0
100	**460.46**	**906.02**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**137**	**137**	**0**	**0**	**0**	**0**	**0**	**0**
130	461.49	917.22	392399	392399	145000	0	0.00	0	0	0	144	125	0	0	0	0	0	0
150	466.34	970.57	411351	411351	145000	0	0.00	0	0	11	153	134	0	0	0	0	0	0
175	469.94	1011.13	432395	432395	151924	0	0.00	0	0	33	160	142	0	0	0	0	0	0
200	**470.02**	**1012.12**	**451163**	**451163**	**210332**	**0**	**0.00**	**0**	**0**	**25**	**160**	**142**	**21**	**0**	**15**	**0**	**0**	**0**
225	470.31	1015.33	468139	468139	260498	0	0.00	0	0	21	160	143	25	0	18	0	-5	19
250	470.65	1019.31	483665	483665	309673	0	0.00	0	0	18	160	144	26	0	20	9	-5	35
325	471.23	1025.87	523757	523757	464074	0	0.00	0	0	13	183	144	30	0	24	13	-6	111
400	471.61	1030.22	556967	556967	545951	0	0.00	0	0	12	189	146	34	0	28	16	-5	176
500	472.08	1035.62	594159	594159	594159	0	0.00	0	0	14	196	150	40	0	32	20	-2	153
PMF	477.51	1099.03	905770	905770	812199	0	0.00	0	0	57	255	129	85	0	55	43	0	146

TABLE A-18: NA2-145 MAX (R060_800FM_No Fix_145_FP466_P1_20080916)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.74	419.09	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.86	419.97	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	406.97	420.78	29000	29000	23588	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.19	422.35	37002	37002	27464	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.29	423.06	40722	40722	30225	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	414.02	473.00	90369	90369	54221	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	423.56	549.32	136522	136522	81913	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	427.18	579.96	167533	167533	115000	0	0.00	0	0	0	28	28	0	0	0	0	0	0
20	430.25	606.84	191482	191482	115000	0	0.00	0	0	0	38	38	0	0	0	0	0	0
25	433.17	633.13	211227	211227	115000	0	0.00	0	0	0	47	47	0	0	0	0	0	0
35	438.57	683.35	243016	243016	115000	0	0.00	0	0	0	59	59	0	0	0	0	0	0
50	444.11	736.88	279485	279485	115000	0	0.00	0	0	0	77	77	0	0	0	0	0	0
65	450.07	796.61	308218	308218	115000	0	0.00	0	0	0	105	105	0	0	0	0	0	0
80	456.02	858.42	332148	332148	115000	0	0.00	0	0	0	128	128	0	0	0	0	0	0
100	**461.90**	**921.63**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**139**	**139**	**0**	**0**	**0**	**0**	**0**	**0**
130	460.99	911.73	392399	392399	145000	0	0.00	0	0	0	142	124	0	0	0	0	0	0
150	466.51	972.53	411351	411351	145000	0	0.00	0	0	14	153	135	0	0	0	0	0	0
175	469.98	1011.59	432395	432395	154629	0	0.00	0	0	32	178	142	0	0	0	0	0	0
200	**470.03**	**1012.15**	**451163**	**451163**	**209579**	**0**	**0.00**	**0**	**0**	**25**	**180**	**142**	**21**	**0**	**15**	**0**	**0**	**0**
225	470.31	1015.44	468139	468139	262069	0	0.00	0	0	21	182	143	25	0	18	0	-5	10
250	470.71	1019.97	483665	483665	314605	0	0.00	0	0	18	183	143	26	0	20	9	-5	25
325	471.20	1025.58	523757	523757	466105	0	0.00	0	0	13	187	144	31	0	25	14	-6	100
400	471.75	1031.94	556967	556967	556967	0	0.00	0	0	13	193	145	35	0	29	17	-5	143
500	471.90	1033.55	594159	594159	594159	0	0.00	0	0	13	201	150	40	0	32	21	-2	140

TABLE A-19: NA2-145 MIN (R060_800FM_No Fix_145_FP466_P1_20080916)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.98	465.10	40722	38674	8916	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	416.16	489.65	90369	84059	50000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	424.05	553.36	136522	126249	65753	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	428.10	587.92	167533	154598	84559	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	428.64	592.60	191482	176491	115000	0	0.00	0	0	0	25	25	0	0	0	0	0	0
25	431.48	617.85	211227	194541	115000	0	0.00	0	0	0	33	33	0	0	0	0	0	0
35	436.67	665.48	243016	223601	115000	0	0.00	0	0	0	48	48	0	0	0	0	0	0
50	442.99	725.90	279485	256938	115000	0	0.00	0	0	0	62	62	0	0	0	0	0	0
65	448.29	778.56	308218	283204	115000	0	0.00	0	0	0	81	81	0	0	0	0	0	0
80	451.74	813.77	332148	305080	115000	0	0.00	0	0	0	106	106	0	0	0	0	0	0
100	**458.45**	**884.30**	**359078**	**329825**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**131**	**131**	**0**	**0**	**0**	**0**	**0**	**0**
130	465.67	963.13	392399	360850	116941	0	0.00	0	0	0	146	118	0	0	0	0	0	0
150	463.97	944.31	411351	381289	145000	0	0.00	0	0	0	146	127	0	0	0	0	0	0
175	468.50	994.84	432395	407507	145000	0	0.00	0	0	31	156	138	0	0	0	0	0	0
200	**470.21**	**1014.21**	**451163**	**429875**	**175825**	**0**	**0.00**	**0**	**0**	**32**	**159**	**141**	**19**	**1**	**0**	**0**	**5**	**0**
225	470.28	1015.10	468139	448786	194960	0	0.00	0	0	29	160	144	21	0	0	0	0	0
250	470.16	1013.63	483665	465352	228088	0	0.00	0	0	23	161	146	23	0	17	0	-5	0
325	470.84	1021.39	523757	506439	339880	0	0.00	0	0	17	162	147	28	0	22	10	-6	67
400	471.55	1029.61	556967	540033	488931	0	0.00	0	0	13	162	148	33	0	26	14	-1	119
500	471.80	1032.40	594159	577133	568037	0	0.00	0	0	12	180	150	39	0	30	17	-2	229

TABLE A-20: NA3-145 BASE (R060_800DR3.5e_145_FP471.5_P1_20080916)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.39	388.94	20002	20002	16328	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.53	389.84	25004	25004	20411	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	402.78	391.51	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.59	397.11	37002	37002	26005	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	403.18	394.30	40722	40722	25215	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	413.74	470.92	90369	90369	44261	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	421.65	533.58	136522	136522	71655	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	424.92	560.66	167533	167533	115000	0	0.00	0	0	0	26	26	0	0	0	0	0	0
20	428.02	587.24	191482	191482	115000	0	0.00	0	0	0	36	36	0	0	0	0	0	0
25	431.43	617.37	211227	211227	115000	0	0.00	0	0	0	45	45	0	0	0	0	0	0
35	437.15	669.98	243016	243016	115000	0	0.00	0	0	0	57	57	0	0	0	0	0	0
50	442.97	725.68	279485	279485	115000	0	0.00	0	0	0	75	75	0	0	0	0	0	0
65	449.11	786.85	308218	308218	115000	0	0.00	0	0	0	103	103	0	0	0	0	0	0
80	453.74	834.47	332148	332148	115000	0	0.00	0	0	0	127	127	0	0	0	0	0	0
100	**460.46**	**906.02**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**137**	**137**	**0**	**0**	**0**	**0**	**0**	**0**
130	461.49	917.22	392399	392399	145000	0	0.00	0	0	0	144	125	0	0	0	0	0	0
150	466.26	969.69	411351	411351	145000	0	0.00	0	0	7	152	133	0	0	0	0	0	0
175	469.90	1010.67	432395	432395	145000	0	0.00	0	0	34	160	142	0	0	0	0	0	0
200	**474.92**	**1068.57**	**451163**	**451163**	**145000**	**0**	**0.00**	**0**	**0**	**53**	**171**	**153**	**0**	**0**	**0**	**0**	**0**	**0**
225	477.03	1093.42	468139	468139	171154	0	0.00	0	0	56	173	156	19	1	0	0	4	0
250	477.36	1097.31	483665	483665	197562	0	0.00	0	0	56	174	158	23	0	0	0	7	0
325	477.22	1095.62	523757	523757	300796	0	0.00	0	0	48	196	157	28	0	22	10	-6	78
400	477.90	1103.69	556967	556967	399130	0	0.00	0	0	39	201	158	32	0	26	14	-5	100
500	478.32	1108.60	594159	594159	558062	0	0.00	0	0	28	205	159	38	0	30	18	-2	151

TABLE A-21: NA3-145 MAX (R060_800DR3.5e_145_FP471.5_P1_20080916)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.74	419.09	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.86	419.97	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	406.97	420.78	29000	29000	23588	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.19	422.35	37002	37002	27464	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.29	423.06	40722	40722	30225	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	414.02	473.00	90369	90369	54221	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	423.56	549.32	136522	136522	81913	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	427.18	579.96	167533	167533	115000	0	0.00	0	0	0	28	28	0	0	0	0	0	0
20	430.25	606.84	191482	191482	115000	0	0.00	0	0	0	38	38	0	0	0	0	0	0
25	433.17	633.13	211227	211227	115000	0	0.00	0	0	0	47	47	0	0	0	0	0	0
35	438.57	683.35	243016	243016	115000	0	0.00	0	0	0	59	59	0	0	0	0	0	0
50	444.11	736.88	279485	279485	115000	0	0.00	0	0	0	77	77	0	0	0	0	0	0
65	450.07	796.61	308218	308218	115000	0	0.00	0	0	0	105	105	0	0	0	0	0	0
80	456.02	858.42	332148	332148	115000	0	0.00	0	0	0	128	128	0	0	0	0	0	0
100	**461.90**	**921.63**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**139**	**139**	**0**	**0**	**0**	**0**	**0**	**0**
130	460.99	911.73	392399	392399	145000	0	0.00	0	0	0	142	124	0	0	0	0	0	0
150	466.41	971.34	411351	411351	145000	0	0.00	0	0	9	151	133	0	0	0	0	0	0
175	470.14	1013.42	432395	432395	145000	0	0.00	0	0	34	179	143	0	0	0	0	0	0
200	**#N/A**	**#N/A**	**451163**	**451163**	**#N/A**	**#N/A**	**#N/A**	**0**	**0**	**15**	**74**	**#N/A**	**5**	**#N/A**	**0**	**0**	**#N/A**	**#N/A**
225	477.06	1093.72	468139	468139	172840	0	0.00	0	0	56	195	156	19	0	0	0	4	0
250	477.19	1095.30	483665	483665	202925	0	0.00	0	0	55	197	157	23	0	17	0	1	0
325	477.39	1097.70	523757	523757	320734	0	0.00	0	0	47	199	156	29	0	22	11	100	35
400	478.01	1104.97	556967	556967	430723	0	0.00	0	0	37	205	157	32	0	26	14	-5	100
500	478.08	1105.79	594159	594159	558062	0	0.00	0	0	27	210	159	38	0	30	18	-2	167

TABLE A-22: NA3-145 MIN (R060_800DR3.5e_145_FP471.5_P1_20080916)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.98	465.10	40722	38674	8916	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	416.16	489.65	90369	84059	50000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	424.05	553.36	136522	126249	65753	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	428.10	587.92	167533	154598	84559	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	428.64	592.60	191482	176491	115000	0	0.00	0	0	0	25	25	0	0	0	0	0	0
25	431.48	617.85	211227	194541	115000	0	0.00	0	0	0	33	33	0	0	0	0	0	0
35	436.67	665.48	243016	223601	115000	0	0.00	0	0	0	48	48	0	0	0	0	0	0
50	442.99	725.90	279485	256938	115000	0	0.00	0	0	0	62	62	0	0	0	0	0	0
65	448.29	778.56	308218	283204	115000	0	0.00	0	0	0	81	81	0	0	0	0	0	0
80	451.74	813.77	332148	305080	115000	0	0.00	0	0	0	106	106	0	0	0	0	0	0
100	**458.45**	**884.30**	**359078**	**329825**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**131**	**131**	**0**	**0**	**0**	**0**	**0**	**0**
130	465.98	966.59	392399	360850	115000	0	0.00	0	0	0	147	147	0	0	0	0	0	0
150	463.97	944.31	411351	381289	145000	0	0.00	0	0	0	146	127	0	0	0	0	0	0
175	468.21	991.54	432395	407507	145000	0	0.00	0	0	23	155	137	0	0	0	0	0	0
200	**471.93**	**1033.95**	**451163**	**429875**	**145000**	**0**	**0.00**	**0**	**0**	**44**	**164**	**146**	**0**	**0**	**0**	**0**	**0**	**0**
225	474.23	1060.55	468139	448786	145000	0	0.00	0	0	52	169	153	0	0	0	0	0	0
250	476.87	1091.48	483665	465352	145000	0	0.00	0	0	60	176	161	0	0	0	0	0	0
325	481.26	1143.79	523757	506439	182469	0	0.00	0	0	69	184	169	22	0	0	0	10	0
400	485.04	1189.63	556967	540033	406641	80	1.04	0	0	61	182	168	25	0	17	6	167	63
500	486.04	1201.93	594159	577133	670948	220	2.04	0	0	49	197	167	32	0	23	10	-2	440

TABLE A-23: NA1-160 BASE (R000_800CF_No Fix_160_FP470_P1_20081214)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.39	388.94	20002	20002	16328	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.53	389.84	25004	25004	20411	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	402.78	391.51	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.60	397.18	37002	37002	25945	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	403.08	393.58	40722	40722	25891	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	418.26	506.23	90369	90369	26643	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	431.09	614.37	136522	136522	43519	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	436.58	664.64	167533	167533	71079	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	440.71	703.82	191482	191482	87949	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	444.54	741.14	211227	211227	104311	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	450.77	803.76	243016	243016	115000	0	0.00	0	0	0	28	28	0	0	0	0	0	0
50	459.13	891.67	279485	279485	115000	0	0.00	0	0	0	54	54	0	0	0	0	0	0
65	462.93	932.91	308218	308218	135000	0	0.00	0	0	0	65	65	0	0	0	0	0	0
80	468.15	990.91	332148	332148	135000	0	0.00	0	0	23	78	78	0	0	0	0	0	0
100	**472.32**	**1038.47**	**359078**	**359078**	**145000**	**0**	**0.00**	**0**	**0**	**43**	**96**	**96**	**0**	**0**	**0**	**0**	**0**	**0**
130	475.29	1072.93	392399	392399	186741	0	0.00	0	0	48	104	102	30	10	0	0	22	0
150	475.86	1079.58	411351	411351	236150	0	0.00	0	0	48	105	102	32	8	17	0	36	5
175	476.03	1081.62	432395	432395	268705	0	0.00	0	0	48	105	103	34	9	19	0	82	17
200	**476.37**	**1085.66**	**451163**	**451163**	**321017**	**0**	**0.00**	**0**	**0**	**45**	**104**	**102**	**37**	**9**	**22**	**11**	**53**	**42**
225	476.56	1087.85	468139	468139	361431	0	0.00	0	0	41	104	102	40	9	24	12	64	42
250	476.64	1088.84	483665	483665	408551	0	0.00	0	0	38	103	100	41	9	26	14	71	46
325	477.14	1094.64	523757	523757	482854	0	0.00	0	0	35	102	101	48	12	30	18	86	49
400	477.86	1103.24	556967	556967	503865	0	0.00	0	0	38	107	107	41	0	35	21	36	48
500	479.04	1117.15	594159	594159	513195	0	0.00	0	0	43	129	115	48	0	39	25	32	51

TABLE A-24: NA1-160 MAX (R000_800CF_No Fix_160_FP470_P1_20081214)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.74	419.09	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.86	419.97	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	406.97	420.78	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.19	422.35	37002	37002	26113	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.29	423.06	40722	40722	26125	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	419.62	517.12	90369	90369	27084	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	431.28	616.04	136522	136522	54716	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	438.30	680.77	167533	167533	78433	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	443.02	726.15	191482	191482	97176	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	446.43	759.84	211227	211227	114092	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	452.77	824.45	243016	243016	115000	0	0.00	0	0	0	34	34	0	0	0	0	0	0
50	460.96	911.37	279485	279485	115000	0	0.00	0	0	0	59	59	0	0	0	0	0	0
65	464.23	947.20	308218	308218	135000	0	0.00	0	0	0	69	68	0	0	0	0	0	0
80	468.90	999.41	332148	332148	135000	0	0.00	0	0	27	82	80	0	0	0	0	0	0
100	**472.51**	**1040.60**	**359078**	**359078**	**145000**	**0**	**0.00**	**0**	**0**	**44**	**96**	**96**	**0**	**0**	**0**	**0**	**0**	**0**
130	475.13	1071.01	392399	392399	178470	0	0.00	0	0	48	102	102	30	10	0	0	9	0
150	475.70	1077.77	411351	411351	219943	0	0.00	0	0	48	104	103	32	9	17	0	45	0
175	476.05	1081.83	432395	432395	270444	0	0.00	0	0	48	105	103	34	9	19	0	86	15
200	**476.38**	**1085.69**	**451163**	**451163**	**321521**	**0**	**0.00**	**0**	**0**	**45**	**104**	**102**	**37**	**9**	**22**	**11**	**51**	**42**
225	476.57	1087.95	468139	468139	363644	0	0.00	0	0	41	104	102	40	9	24	12	69	42
250	476.65	1088.93	483665	483665	410822	0	0.00	0	0	37	102	99	41	9	26	14	77	46
325	477.16	1094.95	523757	523757	484299	0	0.00	0	0	35	103	101	48	11	31	18	48	48
400	477.82	1102.73	556967	556967	503510	0	0.00	0	0	38	107	107	51	10	35	21	49	46
500	479.01	1116.84	594159	594159	512982	0	0.00	0	0	43	127	115	57	9	39	25	36	52

TABLE A-25: NA1-160 MIN (R000_800CF_No Fix_160_FP470_P1_20081214)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.98	465.10	40722	38674	8916	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	418.60	508.91	90369	84059	27017	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	430.16	606.08	136522	126249	50159	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	435.32	652.92	167533	154598	66881	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	438.84	685.88	191482	176491	81222	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	441.67	713.08	211227	194541	90784	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	446.19	757.45	243016	223601	112689	0	0.00	0	0	0	0	0	0	0	0	0	0	0
50	452.28	819.34	279485	256938	115000	0	0.00	0	0	0	33	33	0	0	0	0	0	0
65	457.86	877.97	308218	283204	115000	0	0.00	0	0	0	50	50	0	0	0	0	0	0
80	459.50	895.65	332148	305080	135000	0	0.00	0	0	0	56	56	0	0	0	0	0	0
100	**464.68**	**952.16**	**359078**	**329825**	**135000**	**0**	**0.00**	**0**	**0**	**0**	**70**	**70**	**0**	**0**	**0**	**0**	**0**	**0**
130	470.22	1014.37	392399	360850	145000	0	0.00	0	0	34	87	87	0	0	0	0	0	0
150	471.89	1033.48	411351	381289	160000	0	0.00	0	0	45	99	98	22	24	0	0	0	0
175	475.26	1072.52	432395	407507	173176	0	0.00	0	0	50	111	111	31	10	0	0	8	0
200	**475.59**	**1076.50**	**451163**	**429875**	**215563**	**0**	**0.00**	**0**	**0**	**50**	**110**	**110**	**33**	**9**	**17**	**0**	**27**	**0**
225	475.83	1079.24	468139	448786	257292	0	0.00	0	0	48	107	106	34	8	20	0	65	28
250	476.10	1082.41	483665	465352	293291	0	0.00	0	0	46	107	106	36	8	22	0	65	49
325	476.60	1088.34	523757	506439	392913	0	0.00	0	0	36	106	105	40	8	26	14	90	61
400	476.93	1092.23	556967	540033	467440	0	0.00	0	0	32	105	104	49	12	30	17	74	65
500	477.96	1104.34	594159	577133	504670	0	0.00	0	0	36	124	111	55	12	34	20	87	52

TABLE A-26: NA2-160 BASE (R060_800FM_No Fix_160_FP466_P1_20090106)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.39	388.94	20002	20002	16328	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.53	389.84	25004	25004	20411	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	402.78	391.51	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.59	397.11	37002	37002	26005	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	403.18	394.30	40722	40722	25215	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	413.74	470.92	90369	90369	44261	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	421.65	533.58	136522	136522	71655	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	425.56	566.08	167533	167533	115000	0	0.00	0	0	0	24	24	0	0	0	0	0	0
20	428.70	593.15	191482	191482	115000	0	0.00	0	0	0	33	33	0	0	0	0	0	0
25	432.02	622.68	211227	211227	115000	0	0.00	0	0	0	42	42	0	0	0	0	0	0
35	437.51	673.33	243016	243016	115000	0	0.00	0	0	0	56	56	0	0	0	0	0	0
50	444.04	736.19	279485	279485	115000	0	0.00	0	0	0	75	75	0	0	0	0	0	0
65	449.69	792.72	308218	308218	115000	0	0.00	0	0	0	101	101	0	0	0	0	0	0
80	454.35	840.92	332148	332148	115000	0	0.00	0	0	0	125	125	0	0	0	0	0	0
100	**461.31**	**915.15**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**134**	**134**	**0**	**0**	**0**	**0**	**0**	**0**
130	459.65	897.26	392399	392399	160000	0	0.00	0	0	0	137	121	30	31	0	0	0	0
150	464.33	948.31	411351	411351	160000	0	0.00	0	0	0	146	131	32	33	0	0	0	0
175	467.74	986.26	432395	432395	160000	0	0.00	0	0	26	156	141	30	31	0	0	0	0
200	**470.09**	**1012.88**	**451163**	**451163**	**196633**	**0**	**0.00**	**0**	**0**	**26**	**157**	**143**	**37**	**17**	**0**	**0**	**37**	**0**
225	470.16	1013.72	468139	468139	248894	0	0.00	0	0	21	156	143	40	16	17	0	85	3
250	470.44	1016.88	483665	483665	296022	0	0.00	0	0	18	157	144	41	16	19	0	128	7
325	471.17	1025.16	523757	523757	458379	0	0.00	0	0	13	176	144	44	14	24	13	127	110
400	471.32	1026.88	556967	556967	523129	0	0.00	0	0	13	183	146	47	13	28	16	120	127
500	471.57	1029.74	594159	594159	594159	0	0.00	0	0	12	191	149	53	14	31	20	175	146
PMF	477.46	1098.49	905770	905770	811646	0	0.00	0	0	58	246	124	109	18	56	44	100	139

TABLE A-27: NA2-160 MAX (R060_800FM_No Fix_160_FP466_P1_20090106)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.74	419.09	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.86	419.97	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	406.97	420.78	29000	29000	23588	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.19	422.35	37002	37002	27464	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.29	423.06	40722	40722	30225	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	415.59	485.14	90369	90369	54221	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	423.58	549.49	136522	136522	81913	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	427.91	586.22	167533	167533	115000	0	0.00	0	0	0	26	26	0	0	0	0	0	0
20	430.94	612.96	191482	191482	115000	0	0.00	0	0	0	36	36	0	0	0	0	0	0
25	434.32	643.67	211227	211227	115000	0	0.00	0	0	0	45	45	0	0	0	0	0	0
35	439.26	689.88	243016	243016	115000	0	0.00	0	0	0	59	59	0	0	0	0	0	0
50	446.18	757.39	279485	279485	115000	0	0.00	0	0	0	78	78	0	0	0	0	0	0
65	451.66	812.98	308218	308218	115000	0	0.00	0	0	0	104	104	0	0	0	0	0	0
80	457.54	874.57	332148	332148	115000	0	0.00	0	0	0	126	126	0	0	0	0	0	0
100	**462.60**	**929.22**	**359078**	**359078**	**115155**	**0**	**0.00**	**0**	**0**	**0**	**136**	**106**	**0**	**0**	**0**	**0**	**0**	**0**
130	461.22	914.25	392399	392399	160000	0	0.00	0	0	0	136	123	30	31	0	0	0	0
150	464.46	949.80	411351	411351	160000	0	0.00	0	0	0	145	131	32	33	0	0	0	0
175	467.90	988.09	432395	432395	160000	0	0.00	0	0	27	154	141	30	31	0	0	0	0
200	**470.10**	**1012.99**	**451163**	**451163**	**195966**	**0**	**0.00**	**0**	**0**	**26**	**176**	**143**	**37**	**17**	**0**	**0**	**33**	**0**
225	470.20	1014.16	468139	468139	254566	0	0.00	0	0	20	177	143	40	16	17	0	92	2
250	470.35	1015.82	483665	483665	288029	0	0.00	0	0	18	179	144	41	16	19	0	118	7
325	471.14	1024.90	523757	523757	452926	0	0.00	0	0	13	185	145	44	14	24	14	175	94
400	471.33	1027.02	556967	556967	540048	0	0.00	0	0	12	189	146	47	13	28	17	175	120
500	471.55	1029.62	594159	594159	594159	0	0.00	0	0	13	197	149	53	13	32	21	175	107

TABLE A-28: NA2-160 MIN (R060_800FM_No Fix_160_FP466_P1_20090106)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.98	465.10	40722	38674	8916	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	416.16	489.65	90369	84059	50000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	424.05	553.36	136522	126249	65753	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	428.30	589.62	167533	154598	84559	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	429.46	599.84	191482	176491	115000	0	0.00	0	0	0	23	23	0	0	0	0	0	0
25	432.18	624.13	211227	194541	115000	0	0.00	0	0	0	31	31	0	0	0	0	0	0
35	437.35	671.86	243016	223601	115000	0	0.00	0	0	0	45	45	0	0	0	0	0	0
50	443.50	730.90	279485	256938	115000	0	0.00	0	0	0	61	61	0	0	0	0	0	0
65	448.76	783.26	308218	283204	115000	0	0.00	0	0	0	80	80	0	0	0	0	0	0
80	452.90	825.76	332148	305080	115000	0	0.00	0	0	0	116	116	0	0	0	0	0	0
100	**459.22**	**892.62**	**359078**	**329825**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**129**	**129**	**0**	**0**	**0**	**0**	**0**	**0**
130	466.33	970.48	392399	360850	121233	0	0.00	0	0	9	143	119	0	0	0	0	0	0
150	463.02	933.87	411351	381289	160000	0	0.00	0	0	0	140	125	27	28	0	0	0	0
175	467.23	980.56	432395	407507	160000	0	0.00	0	0	23	150	137	25	26	0	0	0	0
200	**470.09**	**1012.92**	**451163**	**429875**	**176230**	**0**	**0.00**	**0**	**0**	**30**	**153**	**140**	**33**	**14**	**0**	**0**	**6**	**0**
225	470.13	1013.35	468139	448786	198409	0	0.00	0	0	26	154	143	36	15	0	0	35	0
250	470.11	1013.14	483665	465352	227979	0	0.00	0	0	23	156	146	38	15	17	0	68	0
325	470.67	1019.48	523757	506439	327556	0	0.00	0	0	17	158	147	42	14	22	10	125	38
400	471.18	1025.30	556967	540033	463776	0	0.00	0	0	13	159	149	47	14	26	14	125	114
500	471.42	1028.03	594159	577133	544670	0	0.00	0	0	12	175	151	52	14	29	17	175	177

TABLE A-29: NA3-160 BASE (R060_800DR3.5e_160_FP471.5_P1_20081215)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	399.42	369.20	5000	5000	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	402.39	388.94	20002	20002	16328	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.53	389.84	25004	25004	20411	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	402.78	391.51	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	403.59	397.11	37002	37002	26005	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	403.18	394.30	40722	40722	25215	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	413.74	470.92	90369	90369	44261	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	421.65	533.58	136522	136522	71655	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	425.56	566.08	167533	167533	115000	0	0.00	0	0	0	24	24	0	0	0	0	0	0
20	428.70	593.15	191482	191482	115000	0	0.00	0	0	0	33	33	0	0	0	0	0	0
25	432.02	622.68	211227	211227	115000	0	0.00	0	0	0	42	42	0	0	0	0	0	0
35	437.51	673.33	243016	243016	115000	0	0.00	0	0	0	56	56	0	0	0	0	0	0
50	444.04	736.19	279485	279485	115000	0	0.00	0	0	0	75	75	0	0	0	0	0	0
65	449.69	792.72	308218	308218	115000	0	0.00	0	0	0	101	101	0	0	0	0	0	0
80	454.35	840.92	332148	332148	115000	0	0.00	0	0	0	125	125	0	0	0	0	0	0
100	**461.31**	**915.15**	**359078**	**359078**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**134**	**134**	**0**	**0**	**0**	**0**	**0**	**0**
130	459.65	897.26	392399	392399	160000	0	0.00	0	0	0	137	121	30	31	0	0	0	0
150	464.33	948.31	411351	411351	160000	0	0.00	0	0	0	146	131	32	33	0	0	0	0
175	467.47	983.26	432395	432395	160000	0	0.00	0	0	17	153	138	35	36	0	0	0	0
200	**472.47**	**1040.14**	**451163**	**451163**	**160000**	**0**	**0.00**	**0**	**0**	**46**	**164**	**150**	**32**	**33**	**0**	**0**	**0**	**0**
225	476.20	1083.60	468139	468139	160000	0	0.00	0	0	57	170	157	34	35	0	0	0	0
250	477.15	1094.82	483665	483665	193667	0	0.00	0	0	54	170	157	41	19	0	0	18	0
325	477.08	1093.97	523757	523757	294943	0	0.00	0	0	48	189	157	44	16	22	0	78	4
400	477.78	1102.31	556967	556967	405477	0	0.00	0	0	38	195	158	47	15	26	14	100	81
500	478.03	1105.25	594159	594159	534386	0	0.00	0	0	28	202	160	53	16	29	17	107	150

TABLE A-30: NA3-160 MAX (R060_800DR3.5e_160_FP471.5_P1_20081215)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	406.42	416.85	5000	5000	4242	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	406.74	419.09	20002	20002	16967	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	406.86	419.97	25004	25004	21210	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	406.97	420.78	29000	29000	24600	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	407.19	422.35	37002	37002	26113	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	407.29	423.06	40722	40722	26125	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	419.62	517.12	90369	90369	27084	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	431.28	616.04	136522	136522	54716	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	438.30	680.77	167533	167533	78433	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	443.02	726.15	191482	191482	97176	0	0.00	0	0	0	0	0	0	0	0	0	0	0
25	446.43	759.84	211227	211227	114092	0	0.00	0	0	0	0	0	0	0	0	0	0	0
35	452.77	824.45	243016	243016	115000	0	0.00	0	0	0	34	34	0	0	0	0	0	0
50	460.96	911.37	279485	279485	115000	0	0.00	0	0	0	59	59	0	0	0	0	0	0
65	464.23	947.20	308218	308218	135000	0	0.00	0	0	0	69	68	0	0	0	0	0	0
80	468.90	999.41	332148	332148	135000	0	0.00	0	0	27	82	80	0	0	0	0	0	0
100	**472.51**	**1040.59**	**359078**	**359078**	**145000**	**0**	**0.00**	**0**	**0**	**44**	**96**	**96**	**0**	**0**	**0**	**0**	**0**	**0**
130	475.46	1074.96	392399	392399	187473	0	0.00	0	0	49	103	103	20	0	0	0	5	0
150	475.86	1079.56	411351	411351	229570	0	0.00	0	0	49	104	103	23	0	17	0	-6	6
175	476.20	1083.56	432395	432395	279376	0	0.00	0	0	47	104	102	26	0	20	0	47	8
200	**476.47**	**1086.84**	**451163**	**451163**	**329343**	**0**	**0.00**	**0**	**0**	**44**	**104**	**102**	**28**	**0**	**22**	**11**	**-6**	**41**
225	476.60	1088.35	468139	468139	376509	0	0.00	0	0	40	103	101	31	0	24	12	-5	42
250	476.70	1089.55	483665	483665	421762	0	0.00	0	0	37	102	99	33	0	26	14	56	48
325	477.24	1095.85	523757	523757	488365	0	0.00	0	0	35	103	101	37	0	31	19	-6	42
400	477.87	1103.32	556967	556967	503936	0	0.00	0	0	38	107	107	42	0	35	21	45	48
500	479.04	1117.22	594159	594159	513243	0	0.00	0	0	43	127	115	48	0	39	25	30	51

TABLE A-31: NA3-160 MIN (R060_800DR3.5e_160_FP471.5_P1_20081215)

1 in X chance per year	Peak Elev	Storage	Peak Unreg Inflow	Peak Regulated Inflow	Peak Discharge	Crest Overflow	Amount above top of dam	Duration Pool >= PE 480.5 ft	Duration Pool >= PE 471 ft	Duration Pool >= PE 466 ft	Event Total Duration Q >= 115 tcfs	Main Wave Duration Q >= 115 tcfs	Event Total Duration Q >= 160 tcfs	Main Wave Duration Q = 160 tcfs	Event Total Duration Q >= 200 tcfs	Event Total Duration Q >= 300 tcfs	Max ROI 160-220k cfs	Max ROI >220k cfs
	Ft	TAF	Ft	cfs	cfs	cfs	ft	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	cfs	cfs
1.01569	386.34	290.07	5000	6419	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.2977	398.86	365.50	20002	20133	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.4393	402.75	391.34	25004	24305	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.5655	405.77	412.26	29000	27959	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
1.8517	411.50	453.90	37002	35274	2000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
2	412.98	465.10	40722	38674	8916	0	0.00	0	0	0	0	0	0	0	0	0	0	0
5	416.16	489.65	90369	84059	50000	0	0.00	0	0	0	0	0	0	0	0	0	0	0
10	424.05	553.36	136522	126249	65753	0	0.00	0	0	0	0	0	0	0	0	0	0	0
15	428.30	589.62	167533	154598	84559	0	0.00	0	0	0	0	0	0	0	0	0	0	0
20	429.46	599.84	191482	176491	115000	0	0.00	0	0	0	23	23	0	0	0	0	0	0
25	432.18	624.13	211227	194541	115000	0	0.00	0	0	0	31	31	0	0	0	0	0	0
35	437.35	671.86	243016	223601	115000	0	0.00	0	0	0	45	45	0	0	0	0	0	0
50	443.50	730.90	279485	256938	115000	0	0.00	0	0	0	61	61	0	0	0	0	0	0
65	448.76	783.26	308218	283204	115000	0	0.00	0	0	0	80	80	0	0	0	0	0	0
80	452.90	825.76	332148	305080	115000	0	0.00	0	0	0	116	116	0	0	0	0	0	0
100	**459.22**	**892.62**	**359078**	**329825**	**115000**	**0**	**0.00**	**0**	**0**	**0**	**129**	**129**	**0**	**0**	**0**	**0**	**0**	**0**
130	467.26	980.92	392399	360850	115000	0	0.00	0	0	19	144	144	0	0	0	0	0	0
150	463.02	933.87	411351	381289	160000	0	0.00	0	0	0	140	125	27	28	0	0	0	0
175	467.04	978.39	432395	407507	160000	0	0.00	0	0	14	147	134	31	32	0	0	0	0
200	**470.56**	**1018.21**	**451163**	**429875**	**160000**	**0**	**0.00**	**0**	**0**	**36**	**155**	**142**	**33**	**34**	**0**	**0**	**0**	**0**
225	472.71	1042.91	468139	448786	160000	0	0.00	0	0	49	162	151	31	32	0	0	0	0
250	474.90	1068.38	483665	465352	160000	0	0.00	0	0	55	168	158	33	35	0	0	0	0
325	477.32	1096.76	523757	506439	214967	0	0.00	0	0	57	173	162	42	17	18	0	40	0
400	477.15	1094.84	556967	540033	310772	0	0.00	0	0	47	172	162	47	16	24	11	89	15
500	477.79	1102.40	594159	577133	420080	0	0.00	0	0	34	187	163	52	16	27	14	125	96

US Army Corps of Engineers
Sacramento District

American River Watershed
Common Features Project
Natomas Post-Authorization Change Report

Appendix B3

Dry and Arcade Creeks Flow Frequency Curves and Synthetic 8-Flood Series Hydrographs Upstream of Steelhead Creek

January 2010

AMERICAN RIVER WATERSHED COMMON FEATURES PROJECT
NATOMAS POST-AUTHORIZATION CHANGE REPORT

APPENDIX B3
DRY AND ARCADE CREEKS FLOW FREQUENCY CURVES AND SYNTHETIC 8-FLOOD SERIES HYDROGRAPHS UPSTREAM OF STEELHEAD CREEK

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Attachments

Peer Review Statement of Findings, dated November 13, 1996

Peer Review Cover Letter, dated May 22, 1996

Peer Review Appendix 3: Peak Flow Frequency Relationships for Dry Creek at Vernon Street and Arcade Creek at American River, 1996

Cover photo: Dry Creek upstream of the confluence of Magpie and Robla creeks

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APPENDIX B3
DRY AND ARCADE CREEKS FLOW FREQUENCY CURVES AND SYNTHETIC 8-FLOOD SERIES HYDROGRAPHS UPSTREAM OF STEELHEAD CREEK

1. STUDY BACKGROUND AND SCOPE

This report presents the hydrologic peak flow frequency analysis of flows on Dry and Arcade creeks for the synthetic 8-flood series hydrographs. The synthetic 8-flood series consists of the 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2% chance floods on Dry and Arcade creeks. The flow frequency analysis includes updating the peak flow record to 2009 as well as developing or revising flow frequency curves for the 1-, 3-, 5-, and 10-day durations.

This analysis is being conducted in response to questions raised about the influence high peak flows upstream on the Steelhead Creek tributaries would have on Steelhead Creek flood stages. (Steelhead Creek is also known as Natomas East Main Drainage Canal (NEMDC)). Included in the analysis is a revision of the synthetic 8-flood series hydrographs presented in the American River Common Features General Reevaluation Report (AR CF GRR) Appendix A, Synthetic Hydrology Technical Documentation (**Reference 1**). Future modeling for the AR CF GRR will include hydraulic modeling up the NEMDC tributaries, for Dry Creek upstream to the Placer-Sacramento County line, and for Arcade Creek upstream to the Sacramento County gage on Arcade Creek at Winding Way.

The revised synthetic 8-flood series hydrographs include balanced hydrographs with higher peaks for Dry Creek at Vernon Street (Roseville) and Arcade Creek at the "near Del Paso Heights" gage, based on the updated flow frequency curves for those locations. The total 8-flood series hydrographs for downstream locations on Dry and Arcade creeks also have higher peak flows, only because the Vernon Street and Del Paso Heights hydrographs have been revised. The 8-flood series hydrographs for downstream local flows on Dry and Arcade creeks, as well as the other NEMDC tributaries, were not revised: there were no stream gages to calibrate to for the higher flood flows. Also, the higher flood peaks on Dry and Arcade creeks are produced by greater and more intense rainfall on the higher eastside elevations of these watersheds, and not by more intense rainfall on the flat valley floor. **Plate 1**, the General Map, shows the locations of Steelhead Creek (NEMDC) and its tributaries, Dry Creek, Arcade Creek, Upper NEMDC, and Old Magpie Creek. **Plate 2** shows locations of the index points for Dry Creek and **Plate 3** those index points for Arcade Creek for which hydrographs were developed.

2. DRY CREEK HYDROLOGY/HYDRAULICS PEER REVIEW AND CONCENSUS EFFORT

2.1 Peer Review Background. An intense storm hit Sacramento and western Placer counties on the evening of January 9 through the early morning hours of January 10, 1995. Overflow from the streams in the area caused severe flooding in both counties. Peak flows on Dry and Arcade creeks for the January 1995 storm are the largest of record for those streams. Sacramento area government agencies initiated a post storm analysis, the Dry Creek Hydrology/Hydraulics Peer Review and Consensus Effort (Peer Review). Agencies and consulting engineering firms involved in the Peer Review included the U.S. Army Corps of Engineers; Sacramento County Water Resources Division; Sacramento Area Flood Control Agency (SAFCA); Placer County Flood Control & Water Conservation District; City of Sacramento Utilities Department; and the engineering firms of Ensign & Buckley Consulting Engineers; DC Consulting; Montgomery Watson Consulting Engineers; Borcalli & Associates; HYDMET, Incorporated; CH2M Hill; and Murray, Burns, & Keinlen. Appendix 3 (**Reference 2**) of the draft hydrology report presented an analysis of the peak flow frequency relationships for Dry Creek at Vernon Street, and Arcade Creek at American River. The Peer Review Statement of Findings, dated 6 November 1996 (**Reference 3**), includes a peak flow frequency curve for Dry Creek at Vernon Street in Roseville, California.

2.2 Dry Creek at Vernon Street Peak Flow Frequency Curve. The California State Department of Water Resources (DWR) operated a stream gage (gage A00040) on Dry Creek in Roseville upstream of the SPRR culverts for water years 1950 to 1966. The drainage area at this location is 78.2 square miles. In 1966 the gage was discontinued and relocated (as gage A00047) to upstream of Douglas Boulevard, with a drainage area of 57.9 square miles. Gage A00047 is referred to in the record as both "Dry Creek at Roseville above Douglas Boulevard" and "Dry Creek at Royer Park." This gage was discontinued in 1984 and moved to Vernon Street, about 1,500 feet upstream of the SPRR bridge. This gage, A00041, "Dry Creek below Roseville," with a drainage area of about 78 square miles, was damaged by the February 1986 flood and discontinued. Records for the three stream gages are incomplete. The City of Roseville established a gage at the Vernon Street location in 1987 (Sensor ID #1603) as part of the ALERT (Automated Local Evaluation in Real Time) system (**Reference 4**) to provide local stream and weather information during storm events. The City of Roseville also operates an ALERT gage at the Royer Park location (Sensor ID #1630).

As part of the Peer Review, a peak flow frequency curve was developed for the Dry Creek at Vernon Street location for water years 1950 to 1995 using peak flow records for the DWR gages A00040, A00041, and A00047. Peak flows for 1968 to 1975 and 1978 to 1981 were developed for the Vernon Street location based on a drainage area relationship between the Vernon Street gage and the upstream Royer Park gage. With so much missing data for the Vernon Street, SPRR culvert, and Royer Park locations, peak flows between 1950 and 1995 were also estimated from the mean daily flow record,

observed flow on Arcade Creek, storm precipitation, HEC-2 and HEC-RAS modeling, and high water marks in Roseville and downstream near Elverta Road in Sacramento County. See Peer Review Appendix 3, included as an appendix to this report, for additional information.

The 46-year record, using recorded and estimated peak flows, was used with the Corps of Engineers Flood Frequency Analysis program, HEC-FFA (**Reference 5**), to compute statistics for the peak flow frequency curve for Dry Creek at Vernon Street. The FFA program identified 1977 as a low outlier. The FFA final results statistics were almost the same as those for the final Dry Creek at Vernon Street peak flow frequency curve included in the Dry Creek Peer Review Statement of Findings, dated 6 November 1996 (**Reference 3**).

The final Peer Review peak flow frequency curve for Vernon Street includes tabulations for two sets of n-flood series peak flows. One set is for the flow frequency curve, with flows based on the adjusted gage measurements. These flows are very similar to the peak flows computed in the HEC-FFA run. The other n-flood peak flow tabulation is for flood flows from an HEC-1 calibration to the January 1995 flood. **Table 1** lists the n-flood peaks for the HEC-FFA run, the adjusted gage measurements, and the HEC-1 calibration. Part of the process in developing the balanced flood hydrographs was a decision as to which set of n-flood peaks to use for the balanced hydrographs for Dry Creek at Vernon Street.

Files associated with the Peer Review analysis include hydrographs from the HEC-1 calibration for Dry Creek, with n-flood series hydrographs (10-, 2-, 1-, 0.5-, and 0.2%) for various locations on the NEMDC tributaries. These are compiled in a single spreadsheet file referred to elsewhere in this report as "Excel spreadsheet" with n-flood series hydrographs (10-, 2-, 1-, 0.5-, and 0.2% floods) for various locations on the NEMDC tributaries. These hydrographs are from the Peer Review HEC-1 Calibration for Dry Creek. **Table 1** also lists the peak flows for Dry Creek routed to NEMDC from the HEC-1 Calibration.

Table 1
Dry Creek Peak Flow Comparison for Synthetic 8-Flood Series Hydrographs
Peer Review HEC-1 Model and FFA Program

	Flood Event and Peak Flows (cfs)				
Dry Cr. at Vernon St. (78.12 sq mi)	10%	2%	1%	0.50%	0.20%
HEC-1 Calibration	7,300	13,000	15,900	18,700	23,600
Adjusted Gage Measurement	5,640	11,200	14,400	18,300	24,500
HEC-FFA Run	5,620	11,100	14,300	18,200	24,400
	Flood Event and Peak Flows (cfs)				
Dry Cr. at NEMDC (115.8 sq mi)	10%	2%	1%	0.50%	0.20%
HEC-1 Calibration	6,860	12,300	13,900	16,440	21,500

2.3 Arcade Creek Peak Flow Frequency Curve. The USGS operated a stream gage (ID 11447360), Arcade Creek near Del Paso Heights, for water years 1964 to 1978, when the gage was discontinued. This gage was located just upstream of Watt Avenue, with a drainage area of 31.8 square miles. The County of Sacramento has operated a gage, Arcade Creek at Winding Way (Sensor ID 298), from 1961 to present, with some missing years. This gage, also known as the American River College gage, has a drainage area of 28.4 square miles. It is currently part of the ALERT (Automated Local Evaluation in Real Time) system.

As part of the Peer Review, a peak flow frequency curve for water years 1962 to 1995 was computed for Arcade Creek using flow records for the USGS gage combined with the Sacramento County gage. The difference in drainage area between the USGS gage and the upstream Sacramento County gage is only 3.4 square miles. Data for the missing years (1979 to 1981 and 1985) were estimated using peak flows for Dry Creek at Vernon Street.

The 34-year record for the combined gages, including estimated flows, was used with the Corps of Engineers' Flood Frequency Analysis program, HEC-FFA, to compute statistics for the peak flow frequency curve for Arcade Creek at Winding Way/Del Paso Heights. See Peer Review Appendix 3, included as an appendix to this report, for additional information.

Additional files associated with the Peer Review analysis include "HEC-1 flood runs" for the NEMDC tributaries only for the 2- and 1% event storms for the HEC-1 Calibration. The modeling includes hydrographs for Arcade Creek at Winding Way, at the "near Del Paso Heights gage," and at NEMDC. **Table 2** lists the peak flows for these three locations for the 2- and 1% floods, as well as the n-flood series peak flows from the HEC-FFA program. The difference between peak flows at Winding Way and at the downstream Del Paso Heights gage is less than 1%.

Table 2

Arcade Creek Peak Flow Comparison

Peer Review HEC-1 Model and FFA Program

Peer Review HEC-1 Model Results					
	Flood Event and Flows (cfs)				
10%		2%	1%	0.50%	0.20%
Arcade Cr. - Winding Way (28.4 sq mi) Peak (cfs)	N/A	3,960	4,500	N/A	N/A
Arcade Cr. - Del Paso gage (31.8 sq mi) Peak (cfs)	N/A	3,950	4,470	N/A	N/A
Arcade Cr. - NEMDC (40.1 sq mi) Peak (cfs)	N/A	3,860	4,440	N/A	N/A
Peer Review FFA Program Results					
Arcade Creek for Winding Way/ Del Paso Heights gage	3,010	4,260	4,770	5,260	5,900

Note: N/A = flows not available

3. UPDATED PEAK FLOW RECORDS FOR DRY AND ARCADE CREEKS

3.1 Dry Creek at Vernon Street Gage. In 1996, the USGS established a gage (USGS ID 11447293, Dry Creek at Vernon Street Bridge at Roseville, CA) at the Vernon Street location. Only a few days of data were recorded for each of the water years 1997 through 1999. The USGS gage has annual peak flows for 1997 and for 2000 to 2009. The City of Roseville provided peak and mean day flow data for the Vernon Street ALERT gage for 1996, 1998 and 1999. With this information, the peak flow record for the Vernon Street gage was updated from 1995 to 2009.

The annual peak flow record for 60 years, for 1950 to 2009, for Dry Creek at Vernon Street gage, was created using observed and estimated flows based on stage records and high water marks at three DWR gages, a USGS gage, and an ALERT gage. The drainage areas for the DWR gages, A00040 and A00041, the USGS gage, and the ALERT gage are all around 78 square miles. Peak flows observed or estimated for the DWR Royer Park gage and stages downstream at Elverta Road were areally adjusted to the Vernon Street drainage area. The annual peak flows for 1950 to 2009 were used with the HEC-FFA program to compute statistics for the updated record for Dry Creek at Vernon Street. 1977 was identified as a low outlier year. **Table 3** compares the peak flow statistics for Dry Creek at Vernon Street.

Table 3
Dry Creek at Vernon Street
Comparison of Peak Flow Frequency Statistics

	Mean	Standard Deviation	Skew	Years of Record
Peer Review FFA	3.3184	0.3294	0.3	46 (1950 - 1995)
Peer Review Findings Adjusted Gage Measurement	3.3189	0.3301	0.3	46 (1950 - 1995)
Updated Record FFA	3.3367	0.3213	0.4	60 (1950 - 2009)

3.2 Arcade Creek: Winding Way and Del Paso Heights Gages. The peak flow records for Arcade Creek near Del Paso Heights were updated using records from the USGS stream gage, which was reestablished in water year 1996. The annual peak flow record for Arcade Creek includes peak flows from the "near Del Paso Heights" gage for 1964 to 1978 and 1996 to 2008; peak flows for the Sacramento County gage at Winding Way for 1962 and 1963, 1982 to 1984, and 1986 to 1995; and recorded or estimated flows on Dry Creek for 1979 to 1981 and 1985. The 47 years of annual peak flows (1962 to 2008) for Arcade Creek were used with the HEC-FFA program to compute statistics for the updated record. 1976 was identified as a low outlier year. **Table 4** presents a comparison of the peak flow statistics for Arcade Creek.

Table 4
Arcade Creek at Winding Way/Del Paso Heights Gage
Comparison of Peak Flow Frequency Statistics

	Mean	Std. Dev.	Skew	Years of Record
Peer Review FFA	3.1699	0.2504	-0.4	34 (1962 - 1995)
Updated Record FFA	3.1777	0.2326	-0.4	47 (1962 - 2008)

4. MEAN DAILY FLOWS FOR DRY AND ARCADE CREEKS

Flow frequency curves for longer durations for Dry and Arcade creeks are needed in order to develop balanced synthetic 8-flood series hydrographs on those watersheds. The 1996 Peer Review was concerned with computation of the peak flow frequency curves, not the longer duration curves. **Table 5** lists the one-day flows associated with the n-flood peak flows for Dry Creek at Vernon Street and at NEMDC. These one-day flows were computed from the n-flood hydrographs in the Peer Review "Excel spreadsheet" file. **Table 5** also lists the one-day flows associated with the Arcade Creek peak flows in the HEC-1 model for the 2- and 1% storm events.

Table 5

Dry and Arcade Creeks

One-Day Flows Associated with Synthetic 8-Flood Peak Flows

Stream and Index Location	Flood Event and One-Day Flows (avg. cfs)				
	10%	2%	1%	0.50%	0.20%
Dry Cr. at Vernon St. (78.12 sq.mi.)	3,050	5,520	6,770	8,110	10,720
Dry Cr. at NEMDC (115.8 sq.mi.)	3,920	7,120	8,630	10,560	14,790
Arcade Cr. at Winding Way (28.4 sq.mi.)	N/A	1,690	1,960	N/A	N/A
Arcade Cr. at Del Paso Heights gage (31.8 sq.mi.)	N/A	1,700	1,970	N/A	N/A
Arcade Cr. at NEMDC (40.1 sq.mi.)	N/A	1,520	1,850	N/A	N/A

Note: N/A = data not available.

4.1 Dry Creek Flow Duration Data. Much of the Dry Creek daily flow record is missing for periods when flows were very high. For the Corps of Engineers' Dry Creek Hydrology Office Report, revised July 1987 (**Reference 6**), the annual Dry Creek peak and associated one-day flows were either observed or estimated for the DWR stream gage A00040, upstream of the SPRR culvert, near Vernon Street in Roseville. The peak and one-day flows for 1951 to 1966 are based on the gage at this location. Peak and one-day flows for gage A00040 for 1967 to 1982 were based on a drainage area relationship with DWR gage A00047 upstream of Douglas Boulevard in Roseville. The estimated one-day flows for A00040 were not used for every year, but were used for 23 years between 1952 and 1981. **Table 6** lists the estimated peak flows and associated one-day flows used in the revised flow frequency for Dry Creek at Vernon Street. **Table 6** includes a tabulation of the recorded peak, 1-, 3-, 5-, and 10-day annual flows for water years 2000 through 2009 for the USGS gage at Vernon Street.

4.2 Arcade Creek Flow Duration Data. Flow duration data for Arcade Creek at the Del Paso Heights USGS gage are available for water years 1964 to 1978 and 1996 to 2009. Observed and estimated peak flows for Arcade Creek at the Winding Way location (Sacramento County gage) are available for water years 1962 to 1963 and 1979 to 1995. No flow duration data are available for the Winding Way location.

Table 6

Dry Creek at Vernon Street Gage in Roseville

Annual Flow Duration Data

Water Year	Flow Duration and Average Flow (cfs)				
	Peak	1-Day	3-Day	5-Day	10-Day
1950	1,260	N/A	N/A	N/A	N/A
1951	1,980	N/A	N/A	N/A	N/A
1952	2,000	1,350	N/A	N/A	N/A
1953	2,839	2,060	N/A	N/A	N/A
1954	1,095	700	N/A	N/A	N/A
1955	1,230	674	N/A	N/A	N/A
1956	4,000	2,900	N/A	N/A	N/A
1957	1,130	868	N/A	N/A	N/A
1958	4,190	2,010	N/A	N/A	N/A
1959	748	582	N/A	N/A	N/A
1960	2,240	1,300	N/A	N/A	N/A
1961	1,212	800	N/A	N/A	N/A
1962	3,900	3,080	N/A	N/A	N/A
1963	5,800	N/A	N/A	N/A	N/A
1964	2,800	N/A	N/A	N/A	N/A
1965	3,800	2,100	N/A	N/A	N/A
1966	989	682	N/A	N/A	N/A
1967	4,800	N/A	N/A	N/A	N/A
1968	1,087	673	N/A	N/A	N/A
1969	3,700	N/A	N/A	N/A	N/A
1970	1,947	1,361	N/A	N/A	N/A
1971	2,200	N/A	N/A	N/A	N/A
1972	1,049	884	N/A	N/A	N/A
1973	3,000	N/A	N/A	N/A	N/A
1974	2,000	1,290	N/A	N/A	N/A
1975	1,541	1,181	N/A	N/A	N/A
1976	282	78	N/A	N/A	N/A
1977	131	N/A	N/A	N/A	N/A
1978	3,295	2,260	N/A	N/A	N/A
1979	1,392	938	N/A	N/A	N/A
1980	3,894	2,870	N/A	N/A	N/A
1981	1,243	790	N/A	N/A	N/A
1982	6,000	N/A	N/A	N/A	N/A
1983	7,000	N/A	N/A	N/A	N/A
1984	952	N/A	N/A	N/A	N/A
1985	1,300	N/A	N/A	N/A	N/A
1986	13,000	5,930	N/A	N/A	N/A
1987	1,600	N/A	N/A	N/A	N/A
1988	1,446	N/A	N/A	N/A	N/A
1989	1,720	N/A	N/A	N/A	N/A
1990	1,739	N/A	N/A	N/A	N/A
1991	2,128	N/A	N/A	N/A	N/A
1992	2,290	N/A	N/A	N/A	N/A

Water	Flow Duration and Average Flow (cfs)				
Year	Peak	1-Day	3-Day	5-Day	10-Day
1993	2,133	N/A	N/A	N/A	N/A
1994	787	N/A	N/A	N/A	N/A
1995	15,000	7,580	N/A	N/A	N/A
1996	2,215	1,417	N/A	N/A	N/A
1997	7,950	3,550	N/A	N/A	N/A
1998	7,521	4,434	N/A	N/A	N/A
1999	1,771	1,182	N/A	N/A	N/A
2000	4,010	3,020	1,740	1,339	893
2001	983	636	411	317	239
2002	1,120	817	533	464	371
2003	1,730	1,060	586	445	335
2004	1,910	1,220	718	505	437
2005	1,750	1,290	1,010	803	526
2006	7,200	4,200	2,067	1,424	966
2007	2,230	1,140	676	498	297
2008	2,620	1,200	765	530	322
2009	1,268	781	585	438	373

N/A = data not available or not estimated
One-day flows for 1986 and 1995 based on rainfall-runoff modeling for these two flood events. Peaks for 1950 to 1995 developed as detailed in Reference 2, Appendix 3 for Peer Review. One-day flows between 1968 and 1981 developed as described in Section 4.1 of this report.

The peak flow frequency curve developed for the Peer Review used data for the Winding Way and Del Paso Heights locations as if the locations were interchangeable. **Tables 2** and **5** list the 2- and 1% flood peak and associated one-day flow data for Arcade Creek at Winding Way and at the Del Paso Heights gage; the differences in magnitude are less than 1%. For this study, the differences in flow between upstream and downstream location are treated as negligible. **Table 7** tabulates the annual peak and flow duration data for Arcade Creek at Winding Way/Del Paso Heights gage used for the flow frequency analysis presented in this study.

5. DRY CREEK AT VERNON STREET FLOW FREQUENCY ANALYSIS

5.1 Regional Frequency Computation for Dry Creek. The annual peak flows for 60 years of recorded and estimated values for Dry Creek at Vernon Street, Roseville, gage are plotted on **Plate 5**, the annual rainflood frequency curves for Dry Creek at Vernon Street. Considering the lack of annual duration data in the record for Dry Creek, an approach was needed to determine the plotting positions of the previously recorded and estimated annual 1-day flow data in relation to the peak flows. The HEC program, REGFQ (Regional Frequency Computation (**Reference 7**)) was used to develop a reasonable estimate of the plotting positions for those one-day flows. The flows listed in **Table 6** were used as input to the REGFQ computer program. Output from the program is shown on **Plate 4** with the one-day flows from **Table 6** plotted using median plotting positions. The missing one-day flows are indicated as gaps where the REGFQ program made estimates of their magnitudes.

Table 7

Arcade Creek at Winding Way/Del Paso Heights Gage

Flow Duration Data

Water	Flow Duration and Average Flow (cfs)				
Year	Peak	1-Day	3-Day	5-Day	10-Day
1962	2,450	N/A	N/A	N/A	N/A
1963	2,500	N/A	N/A	N/A	N/A
1964	1,400	772	431.7	266.5	134.8
1965	1,450	897	593.3	419.8	250.3
1966	625	360	155.7	103.8	65.4
1967	2,000	1,020	574.7	471.4	360.8
1968	568	289	162.3	112.4	63.5
1969	1,570	1,280	937.0	664.0	517.9
1970	1,600	879	455.3	313.0	247.4
1971	1,630	1,090	537.7	413.6	288.9
1972	590	408	228.0	178.0	115.6
1973	2,170	771	508.7	412.8	363.7
1974	2,050	807	317.0	241.0	197.7
1975	1,300	829	449.7	311.2	206.7
1976	200	153	56.0	51.7	27.2
1977	345	281	69.5	49.4	25.7
1978	2,390	1,270	811.0	599.0	346.3
1979	1,200	N/A	N/A	N/A	N/A
1980	1,700	N/A	N/A	N/A	N/A
1981	800	N/A	N/A	N/A	N/A
1982	3,300	N/A	N/A	N/A	N/A
1983	2,900	N/A	N/A	N/A	N/A
1984	1,650	N/A	N/A	N/A	N/A
1985	700	N/A	N/A	N/A	N/A
1986	3,800	N/A	N/A	N/A	N/A
1987	1,500	N/A	N/A	N/A	N/A
1988	1,180	N/A	N/A	N/A	N/A
1989	1,550	N/A	N/A	N/A	N/A
1990	1,080	N/A	N/A	N/A	N/A
1991	1,650	N/A	N/A	N/A	N/A
1992	2,100	N/A	N/A	N/A	N/A
1993	2,300	N/A	N/A	N/A	N/A
1994	1,250	N/A	N/A	N/A	N/A
1995	4,100	N/A	N/A	N/A	N/A
1996	1,700	1100	589.7	358.6	212.5
1997	2,270	1090	591.3	678.6	381.7
1998	3,320	1910	1,069.3	714.8	462.5
1999	1,040	527	350.0	218.6	133.5
2000	2,430	1790	740.3	549.2	309.0
2001	1,030	281	181.7	141.0	73.8
2002	1,030	543	229.7	213.4	147.7
2003	1,150	578	340.0	250.8	173.7
2004	1,340	492	224.7	149.1	108.9

Water	Flow Duration and Average Flow (cfs)				
Year	Peak	1-Day	3-Day	5-Day	10-Day
2005	1,000	661	420.3	322.4	191.7
2006	3,460	1890	835.3	538.2	373.9
2007	1,030	438	300.7	192.2	100.1
2008	1,700	745	373.0	242.4	133.4
2009	N/A	388	208.0	140.4	125.8

Note: N/A = data not available
Peak flows for 1962, 1963, 1982 to 1984, 1986 to 1995 from the Sacramento County Winding Way gage. Peak flows for 1972 to 1981 and 1985 estimated based on Dry Creek at Vernon gage.

5.2 Updated Dry Creek Peak Flow Frequency Curve. **Table 3** lists the statistics for the peak flow frequency curve, for the Peer Review analysis and the FFA statistics for 60 years of estimated and observed peak flows. The peak flow frequency statistics did not change by much with the addition of 14 years of data. The decision was made not to change the peak flow frequency curve statistics used with the Peer Review adjusted gage measurement record for several reasons. The peak flow record includes many estimated peak flows. Also, the flow frequency curve for the adjusted gage measurement record was developed based on analysis by engineers from several government agencies and engineering firms. Further analysis should be done before making the decision to change the statistics.

5.3 Dry Creek One-Day Flow Frequency Curve. The previously recorded and estimated annual one-day flows for Dry Creek at Vernon Street listed in **Table 6** were plotted on **Plate 4** using the plotting positions estimated from the REGFQ run. Statistics were tested to develop a one-day flow frequency curve that was representative of the plotted one-day data points above the 50% chance exceedence on **Plate 4**. Guidance for the upper end of the frequency curve came from the "Excel spreadsheet" with the one-day flows associated with the 2-, 1-, 0.5-, and 0.2% flood hydrographs for Dry Creek at Vernon Street. These "Excel spreadsheet" one-day flows for Vernon Street are listed in **Table 5.** While the Peer Review peak flow frequency curve has a positive skew, the volume frequency curves developed for the current analysis have zero or negative skews, more typical of flow frequency curves for the region. A zero skew is used for the one-day flow frequency curve. The mean and standard deviation selected for the straight line curve produce a one-day flow frequency curve that fits very well to the observed and estimated one-day flows plotted on **Plate 4** as well as to the "Excel spreadsheet" one-day flows listed in **Table 5.** The final statistics selected for the one-day flow frequency curve are listed on **Plate 4**.

5.4 Dry Creek Five- and Ten-Day Flow Frequency Curves. As discussed in Section 7 below, the synthetic 8-flood series hydrographs for Dry Creek at NEMDC were developed as part of the AR CF GRR. The preliminary 8-flood series hydrographs for Dry Creek at NEMDC were flood runoff from 10-day storms using methodology in the Sacramento City/County Drainage Manual, **Reference 8**. Development of these hydrographs is discussed in the Natomas General Reevaluation Report Hydrology

Appendix, **Reference 9**. The 10-day flood hydrographs were later reshaped into a main 5-day wave preceded by a smaller 5-day wave, as discussed in the AR CF GRR Synthetic Hydrology Technical Documentation Appendix (**Reference 1**)**.** The flood hydrographs were reshaped to conform to the valley-wide flood hydrographs developed for the Sacramento and San Joaquin River Basins Comprehensive Study (**Reference 10**). While the flood hydrograph shapes changed, the 5- and 10-day flood volumes for Dry Creek at NEMDC did not. **Tables 13** and **17** in **Reference 1** list the 5- and 10-day volumes, respectively, of the synthetic 8-flood series hydrographs for Dry Creek at NEMDC**. Table 8** below lists these flood volumes in acre feet. Flood volumes listed in other tables in this report are in average day cfs.

Computer modeling was used to develop a flood reproduction of the New Year January 1997 (NY ’97), 29 December 1996 to 3 January 1997) storm and flood event for Dry and Arcade creeks as part of the AR CF GRR Synthetic Hydrology Technical Documentation (**Reference 1**). The reshaped 8-flood series 10-day flood hydrographs for Dry Creek, with the main 5-day wave and smaller 5-day wave, are based on the shape of the NY ’97 5-day flood reproduction hydrographs for Dry Creek. The computer model for the NY ’97 flood reproduction computed a flood hydrograph for each Dry Creek subbasin and index point. **Figure 1** displays the NY ’97 flood hydrograph computed for Dry Creek at Vernon Street. The 5-day volume for the NY ’97 flood hydrograph for Dry Creek at Vernon Street is 12,459 ac-ft, and the corresponding 5-day flood hydrograph for Dry Creek down at NEMDC is 17,387 ac-ft.

Each of the 8-flood series 5-day volumes for Dry Creek at Vernon Street is computed by multiplying the 8-flood series 5-day flood volume for Dry Creek at NEMDC in **Table 8** by the ratio of the NY ’97 5-day flood volume at Vernon Street to the NY ’97 5-day flood volume at NEMDC. For example, the 50% 5-day flood volume for Dry Creek at Vernon Street is computed by multiplying the 50% flood 5-day volume at NEMDC (9,250 ac-ft in **Table 8**) by the ratio 0.717 (12,460 ac-ft divided by 17,400 ac-ft). The 50% 5-day flood volume for Dry Creek at Vernon Street is about 6,628 ac-ft or 668 average cfs. Each of the 8-flood series 5-day volumes was computed the same way.

The 8-flood series 10-day volumes for Dry Creek at Vernon Street are computed by multiplying the 8-flood series 10-day flood volume for Dry Creek at NEMDC in **Table 8** by the same ratio as above. For example, the 50% 10-day flood volume for Dry Creek at Vernon Street is computed by multiplying the 50% 10-day flood volume at NEMDC (11,000 ac-ft in **Table 8**) by the ratio 0.717. The 50% 10-day flood volume for Dry Creek at Vernon Street is about 7,882 ac-ft or 397 average cfs. Each of the 8-flood series 10-day volumes was computed the same way.

Table 8

Five- and Ten-Day Flood Volumes for Synthetic 8-Flood Series

	50%	20%	10%	4%	2%	1%	0.50%	0.20%
8-Flood Series Five-Day Volumes (ac-ft)								
Dry Cr. at NEMDC	9,250	15,450	19,800	26,600	31,000	35,600	39,800	47,200
Arcade Cr. at NEMDC	3,400	5,310	6,650	8,430	9,710	11,050	12,300	14,260
8-Flood Series Ten-Day Volumes (ac-ft)								
	50%	20%	10%	4%	2%	1%	0.50%	0.20%
Dry Cr. at NEMDC	11,000	18,300	23,600	32,700	38,200	43,900	49,100	58,700
Arcade Cr. at NEMDC	4,220	6,570	8,190	10,300	11,900	13,600	15,100	17,600

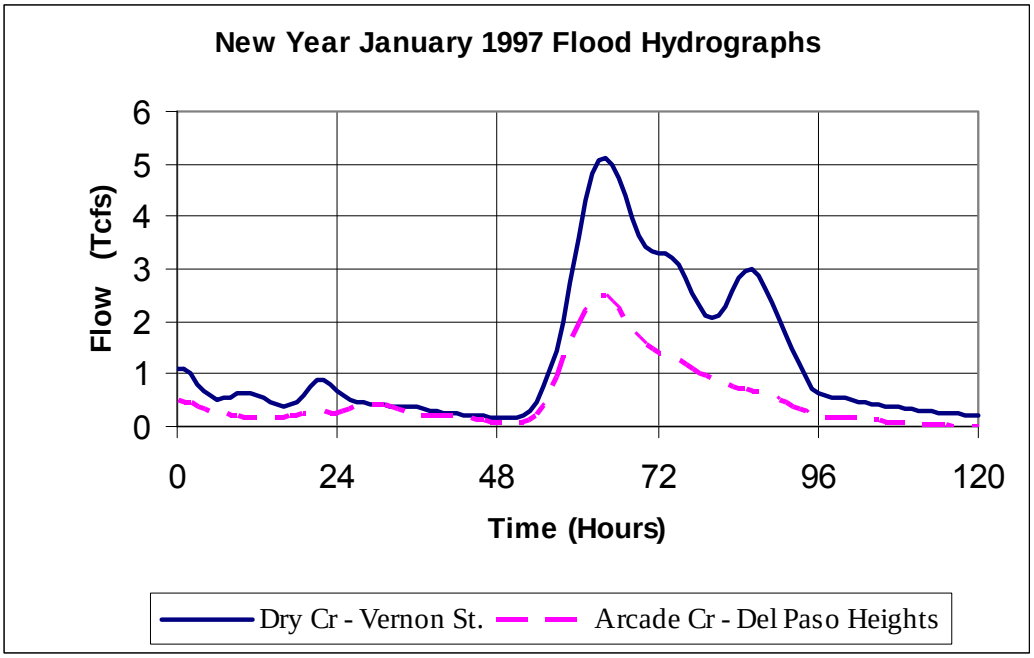

Figure 1. New Year January 1997 Flood Hydrographs Modeled for Dry Creek at Vernon Street and Arcade Creek at Del Paso Heights Gage

The synthetic 8-flood series hydrographs for Dry Creek at Vernon Street, Roseville, were rebalanced to produce higher peak flows. The 8-flood series 5- and 10-day hydrograph volumes remain unchanged. The 8-flood series 5- and 10-day flood volumes, computed as described in the above paragraphs, were plotted as average flows in cfs on **Plate 4**, the flow frequency curves for Dry Creek at Vernon Street. Statistics were tested to develop flow frequency curves that passed smoothly through these flood volumes. The final statistics and flow frequency curves for the 5- and 10-day flood volumes are displayed on **Plate 4**. There are only ten years (2000 – 2009) of observed annual 5- and 10-day flows for the Vernon Street gage. This time period is insufficient to

plot the observed flows on **Plate 4**. The ten annual data points for 5- and 10-day flows, as distributed by the REGFQ program, do not match the 5- and 10-day flow frequency curves and are not shown on **Plate 4**.

5.5 Dry Creek Three-Day Flow Frequency Curve. There are only ten years of recorded data for Dry Creek at Vernon Street for which annual 3-day flows could be computed. This is not a long enough record on which to base a flow frequency curve. The statistics for the 3-day flow frequency curve needed to be somewhere in-between the statistics for the 1-day and the 5-day flow frequency curves, in order for develop reasonable 3-day flood volumes that would not be too difficult to balance as part of the 5-day flood waves for the 8-flood synthetic series at Vernon Street. A preliminary set of statistics for the 3-day flow frequency curve was selected such that the mean peak flow, standard deviation, and skew were between those for the 1-day and 5-day statistics. During the process of balancing the 8-flood series hydrographs, the 3-day volumes needed to be changed by minor amounts to create realistically shaped hydrographs. The 3-day flow frequency statistics on **Plate 4** are those used for the 3-day volumes of the final balanced hydrographs. By coincidence, the plotting positions from the REGFQ program for the ten annual 3-day flows fit along the 3-day frequency curve pretty well and are included on **Plate 4**.

6. ARCADE CREEK AT WINDING WAY/DEL PASO HEIGHTS FLOW FREQUENCY ANALYSIS

6.1 Regional Frequency Computation for Arcade Creek. The annual peak flows for 47 years of record for Arcade Creek at Winding Way/Del Paso Heights are plotted on **Plate 5**, the rainflood frequency curves for Arcade Creek. While more annual duration data are available for Arcade Creek than for Dry Creek, 19 years of duration data are missing for the years that the USGS gage at Del Paso Heights was not in operation. The REGFQ program (**Reference 7**) was also used to develop reasonable estimates of the annual 1-, 3-, 5-, and 10-day flows for the missing years. The annual flows listed in **Table 7** for Arcade Creek were used as input to the Regional Frequency Computation program. **Plate 5** shows the median plotting positions for the annual duration data listed in **Table 7**. Estimates for duration data for the missing years are indicated as gaps between the recorded data points.

6.2 Updated Arcade Creek Peak Flow Frequency Curve. **Table 4** lists the statistics for the Arcade Creek peak flow frequency curve, for the Peer Review analysis and the FFA statistics for 47 years of peak flows. Most of the peak flows were recorded at the Del Paso Heights gage, some were recorded at the Sacramento County gage at Winding Way, and a few were estimated. Updating the peak flow record with 13 more years of data at the Del Paso Heights gage did not make much difference in the frequency curve. It was decided to use the Peer Review statistics, from the FFA analysis for 34 years of record. The statistics are based on the hydrologic data set from 1962 to 1995, rather than updated statistics based on data from 1950 - 2009. The reasoning to use the 1996 analysis are as follows: a) the curve did not change significantly; and b) multiple agencies had worked together to analyze the data and results for the Peer Review Study which gave it importance.

6.3 Arcade Creek 1-Day Flow Frequency Curve. An FFA analysis could not be performed for the one-day flow duration with 19 years missing from the record. The FFA analysis for the Arcade Creek peak flow record showed that 1976 was a low outlier. The REGFQ program was used for the Arcade Creek peak and 1-day flow data with low outlier 1976 removed. The adjusted frequency statistics for the one-day duration matched the plotted data points and were used for the one-day flow frequency curve. The flow frequency statistics, one-day flow frequency curve, and recorded one-day flows for Arcade Creek at the Del Paso Heights gage are shown on **Plate 5**.

6.4 Arcade Creek Five- and Ten-Day Flow Frequency Curves. The frequency curves for the 5- and 10-day volumes for Arcade Creek at Winding Way/Del Paso Heights gage were developed in the same manner as the 5- and 10-day frequency curves for Dry Creek at Vernon Street, Roseville. **Table 8** lists the synthetic 8-flood series 5- and 10-day flood volumes for Arcade Creek at NEMDC, which were developed for the Natomas GRR Hydrology Appendix, **Reference 9**. These flood volumes are still used for the present analysis.

The computer model for the NEMDC tributaries was used to develop a flood reproduction of the NY '97 flood hydrograph for Arcade Creek as well as for Dry Creek (in **Reference 1**). The computer model developed a flood hydrograph for each Arcade Creek subbasin and index point. **Figure 1** displays the NY '97 flood hydrograph computer for Arcade Creek at the Del Paso Heights gage location. The 5-day volume for the NY '97 flood hydrograph for Arcade Creek at the Del Paso Heights gage is 5,300 ac-ft, and the corresponding 5-day flood hydrograph for Arcade Creek down at NEMDC is 6,098 ac-ft.

Each of the 8-flood series 5-day volumes for Arcade Creek at Del Paso Heights gage is computed by multiplying the 8-flood series 5-day flood volume for Arcade Creek at NEMDC in **Table 8** by the ratio of the NY '97 5-dayflood volume at Del Paso Heights gage to the NY '97 5-day flood volume at NEMDC. For example, the 50% 5-day flood volume for Arcade Creek at Del Paso Heights gage is computed by multiplying the 50% 5-day volume at NEMDC (3,400 ac-ft in **Table 8**) by the ratio 0.869 (5,300 ac-ft divided by 6,098 ac-ft). The 50% 5-day flood volume for Arcade Creek at Del Paso Heights gage is about 5,300 ac-ft or 300 average cfs. Each of the 8-flood series 5-day volumes was computed the same way.

The 8-flood series 10-day volumes for Arcade Creek at Del Paso Heights gage are computed by multiplying the 8-flood series 10-day flood volume for Arcade Creek at NEMDC in **Table 8** by the same ratio as above. For example, the 50% 10-day flood volume for Arcade Creek at Del Paso Heights gage is computed by multiplying the 50% 10-day flood volume at NEMDC (4,220 ac-ft in **Table 8**) by the ratio 0.869. The 50% 10-day flood volume for Arcade Creek at Del Paso Heights gage is about 3,667 ac-ft or 185 average cfs. Each of the 8-flood series 10-day volumes was computed the same way.

The synthetic 8-flood series hydrographs for the Del Paso Heights gage location were rebalanced to produce higher peak flows, but the 5- and 10-day hydrograph volumes

were not changed in the process. The 8-flood series 5- and 10-day flood volumes, computed as described in the above paragraphs, were plotted as average flows in cfs on **Plate 5,** the flow frequency curves for Arcade Creek at Winding Way/Del Paso Heights. Statistics were tested to develop flow frequency curves that passed smoothly through these flood volumes. The final statistics, 5- and 10-day flow frequency curves, and recorded 5- and 10-day flows for Arcade Creek at the Del Paso Heights gage are shown on **Plate 5.**

The annual 5-day duration data observed for Arcade Creek fit along the 5-day flow frequency curve on **Plate 5**. The observed annual 10-day volumes for Arcade Creek at Del Paso Heights gage are slightly higher than the 10-day flow frequency curve. The 10-day volumes for the synthetic 8-flood series hydrographs were based on rainfall-runoff modeling of a series of 10-day storms for the NEMDC tributaries, not on analysis of flow frequency data for Arcade Creek. The 10-day storms were based on criteria in the Sacramento City/County Drainage Manual, Volume 2, Hydrology Standards (**Reference 8**). The development of the 10-day storms and runoff hydrograph volumes was presented in the Natomas General Reevaluation Report Hydrology Appendix (**Reference 9**).

6.5 Arcade Creek Three-Day Flow Frequency Curves. The recorded annual 3-day volumes for Arcade Creek at Del Paso Heights gage were plotted on **Plate 5** using the plotting positions output from the REGFQ program. The statistics for the flow frequency curve needed to be somewhere in-between the statistics for the 1-day and the 5-day flow frequency curves, in order to develop reasonable 3-day flood volumes that would not be too difficult to balance as part of the 5-day flood waves for the 8-flood synthetic series at the Del Paso Heights gage. A preliminary set of statistics for the 3-day flow frequency curve was selected such that the mean peak flow, standard deviation, and skew were between those for the 1-day and 5-day statistics and were representative of the plotted annual data points. During the process of balancing the 8-flood series hydrographs, the 3-day volumes needed to be changed by minor amounts to create realistically shaped hydrographs. The 3-day flow frequency statistics on **Plate 5** are those used for the 3-day volumes of the final balanced hydrographs.

7. BALANCED HYDROGRAPH DEVELOPMENT FOR DRY AND ARCADE CREEKS

This section discusses development of the balanced hydrographs to the flow frequency curves displayed on **Plates 4 and 5** for the synthetic 8-flood series at Dry Creek at Vernon Street and at Arcade Creek at the Del Paso Heights gage. For consistency with the Comprehensive Study, the computed New Year January 1997 flood hydrographs for Dry Creek at Vernon Street and Arcade Creek at Del Paso Heights gage were used as the pattern hydrographs for the synthetic 8-Flood Series.

7.1 Peak Flows. The balanced flood hydrographs include the peak flows listed below in **Tables 9 and 10**. The peak flows for Dry Creek (**Table 9**) are the same as the Adjusted Gage Measurement peak flows on **Table 1** and the same as those on the flow

frequency curve defined by the Adjusted Gage Measurement flow frequency statistics on **Table 3**. The peak flows for Arcade Creek (**Table 10**) are the same as the Peer Review FFA Program Results on **Table 2** and those on the flow frequency curve defined by the Peer Review FFA Statistics on **Table 4**. Hydrographs and peak flows for the downstream tributaries and local subbasins on Dry and Arcade creeks were not changed from those previously provided to Hydraulic Design Section.

Table 9

Peak and Volume Tabulation for Synthetic 8-Flood Series

Balanced Hydrographs for Dry Creek at Vernon Street (Roseville)

8-Flood Event	Peak (cfs)	24-Hour (avg cfs)	3-Day (avg cfs)	5-Day (avg cfs)	10-Day (avg cfs)
50%	2,010	1,360	843	665	407
20%	3,900	2,500	1,420	1,080	659
10%	5,640	3,500	1,880	1,400	854
4%	8,500	4,900	2,560	1,860	1,130
2%	11,200	6,340	3,110	2,220	1,350
1%	14,400	7,390	3,720	2,590	1,560
0.50%	18,300	8,620	4,340	2,970	1,790
0.20%	24,500	11,300	5,260	3,530	2,120

Table 10

Peak and Volume Tabulation for Synthetic 8-Flood Series

Balanced Hydrographs for Arcade Creek at Del Paso Heights Gage

8-Flood Event	Peak (cfs)	24-Hour (avg cfs)	3-Day (avg cfs)	5-Day (avg cfs)	10-Day (avg cfs)
50%	1,540	945	425	304	187
20%	2,420	1,460	677	491	302
10%	3,010	1,790	842	613	377
4%	3,730	2,200	1,050	771	474
2%	4,260	2,490	1,200	884	544
1%	4,770	2,780	1,350	995	613
0.50%	5,260	3,050	1,500	1,110	685
0.20%	5,900	3,410	1,680	1,250	769

7.2 Balancing to 1-, 3-, and 5-Day Durations. A spreadsheet was developed to balance the synthetic flood hydrographs to the 1-, 3-, and 5-day durations from the flow frequency curves, **Plates 4 and 5**. The synthetic hydrographs were balanced using the New Year 1997 flood hydrographs on **Figure 1**, for Dry Creek at Vernon Street and Arcade Creek at Del Paso Heights gage. A different flood hydrograph pattern was used for Dry Creek at Vernon Street for the 1-, 0.5-, and 0.2% floods; it is discussed in **Section 7.3** below.

a. 24-Hour Flow. The 1-day flow frequency curve is for the annual maximum 1-day volume, measured at the gage from midnight to midnight. The maximum 24-hour flow for the same event is almost always higher than the 1-day flow, because the maximum 24-hour flow does not normally occur exactly between midnight one day and midnight the next. 24-hour volumes were used to balance the hydrographs to prevent the peak flow from appearing too peaked with respect to the one-day volume. For the balanced hydrographs, the ratio used for 24-hour flow to maximum 1-day flow is less than 1.15. Historically, the ratio of 24-hour flow to 1-day flow is not known for Dry and Arcade creeks, because only 1-day flows were available for most flood events. The 24-hour flows used to balance the synthetic 8-flood series hydrographs are listed on **Tables 9 and 10**.

b. Three Day Flow. In the process of balancing the hydrographs at the upstream gaging stations to the 3-day volumes, the 3-day volumes were slightly modified from those volumes represented by the 3-day flow frequency curves. Except for the 50% flood hydrograph for Dry Creek at Vernon Street, the 3-day volumes listed in **Tables 9 and 10** are within 2% of the 3-day volumes for the flow frequency curves for Dry and Arcade creeks.

c. Five Day Flow. In the process of balancing the hydrographs at the Dry Creek at Vernon Street to the 5-day volumes, the 5-day volumes were slightly modified from those volumes represented by the 5-day flow frequency curves. The 5-day volumes listed in **Table 9** are between 0- and 3% of the flow frequency curve volumes. The 5-day volumes listed in **Table 10** for Arcade Creek at Del Paso Heights are the same as those represented by the 5-day flow frequency curves.

7.3 Dry Creek at Vernon Street Pattern for 1-, 0.5-, and 0.2% Event Floods. The New Year January 1997 flood hydrograph modeled for Dry Creek at Vernon Street, shown on **Figure 1** in Section 5.4 and **Figure 2** below, has a double peak. Not only is the double-peak pattern more difficult to balance, especially for the 1-, 0.5-, and 0.2% flood events, but the New Year January 1997 flood was only about a 12% chance event for Vernon Street. A flood hydrograph pattern needed to be developed that would be easier to balance for the rarer floods yet still be representative of the Dry Creek watershed.

Figure 2 shows how the composite flood hydrograph pattern was developed based on the NY ’97 flood hydrograph as well as the observed or computed flood hydrographs for the two largest floods at Vernon Street. **Figure 2** shows the NY ’97 flood hydrograph for Dry Creek at Vernon Street as well as the flood hydrographs for the February 1986 and January 1995 events. The peak flows for the three hydrographs were

lined up to coincide. Using portions of the three existing flood hydrographs, the composite flood hydrograph was developed to have a reasonable shape for a single peak and recession. The composite flood hydrograph pattern displayed below balanced very well to the 1-, 0.5-, and 0.2% flood volumes.

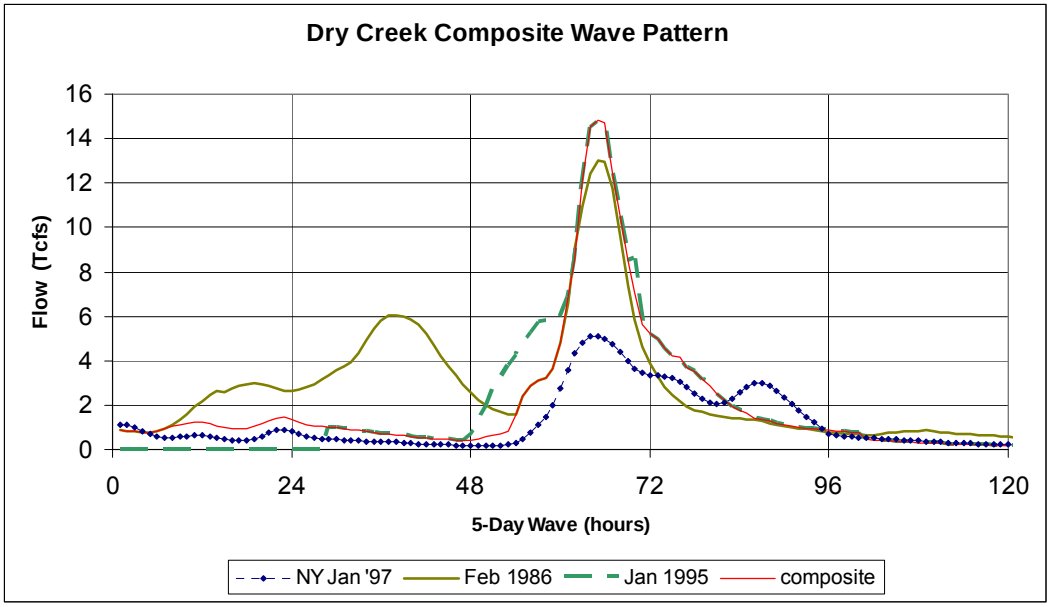

Figure 2. Development of Composite 5-Day Wave Pattern Hydrograph for Dry Creek at Vernon Street, for the 1-, 0.5-, and 0.2% Balanced Flood Hydrographs

7.4 Ten- and Thirty-Day Flood Hydrographs. For the Comprehensive Study, the basic pattern of all synthetic flood hydrographs was a 30-day hourly time series consisting of 6 waves, each 5 days in duration. The highest wave volume was distributed into the fourth, or main, wave. The second highest volume preceded the main wave, so the two highest waves are in the middle ten days of the 30-day hydrograph. The volume of the fourth, or main, wave for each n-flood hydrograph at NEMDC is that listed for the 5-day volume in **Table 8**. For the hydrographs at upstream index points Dry Creek at Vernon Street and Arcade Creek at Del Paso Heights gage, the 5-day main wave volumes are those listed in **Tables 9 and 10**, based on the flow frequency curves on **Plates 4 and 5**. The 5-day wave hydrographs are patterned after the modeled New Year 1997 floods, except for the Dry Creek 1-, 0.5-, and 0.2% floods. Those floods use the composite pattern shown on **Figure 2**. The volume for the second highest wave for each n-flood hydrograph is the difference between the 5-day volume and corresponding 10-day volume in **Tables 9 and 10**.

Flows on the NEMDC tributaries can be high during and immediately after a rainstorm. Without additional rainfall, the flows drop to base flow or to urban runoff levels. The NEMDC tributary flows for the four smaller waves, waves 1 and 2, 5 and 6, would be so minor that zero runoff is assumed for the 30-day hydrographs, except for the middle 10 days (Waves 3 and 4). **Figure 3** displays the 6-wave 30-day pattern balanced

hydrographs for the 1% floods for Dry Creek at Vernon Street and Arcade Creek at Del Paso Heights gage.

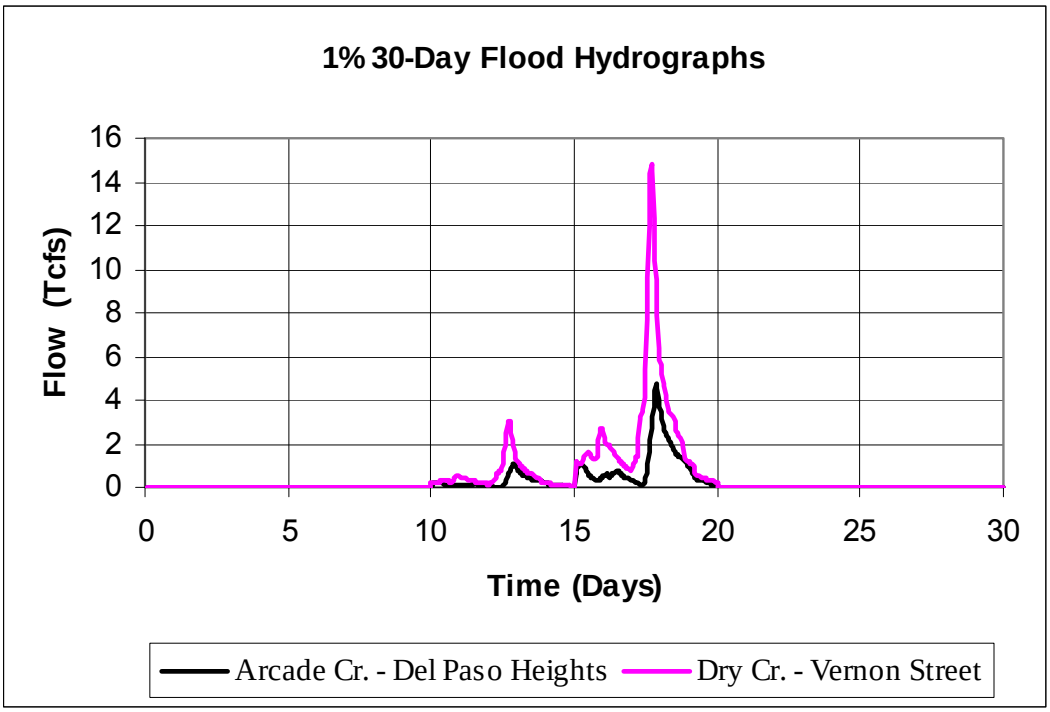

Figure 3. Synthetic 1% Flood 30-Day Wave Hydrographs for Dry Creek at Vernon Street and Arcade Creek at Del Paso Heights Gage

7.5 Routing Balanced Flood Hydrographs to NEMDC. The HEC-1 model was used to route the balanced 30-day synthetic flood hydrographs for Dry Creek at Vernon Street and Arcade Creek downstream to the NEMDC index points, combined with the local flow hydrographs along the way. The 8-flood volumes for Dry and Arcade creeks at NEMDC closely match the 5- and 10-day volumes listed on **Table 8**. The peaks and flood volumes for the flood hydrographs for Dry and Arcade creeks at NEMDC are listed on **Tables 11 and 12** below.

Table 11

Peak and Volume Tabulation for Synthetic 8-Flood Series

Dry Creek at NEMDC from Upstream Balanced Hydrographs

8-Flood Event	Peak (cfs)	24-Hour (avg cfs)	3-Day (avg cfs)	5-Day (avg cfs)	10-Day (avg cfs)
50%	2,170	1,840	1,170	949	543
20%	3,980	3,330	1,990	1,520	887
10%	5,330	4,520	2,620	1,960	1,150
4%	7,280	6,240	3,560	2,580	1,540
2%	8,900	7,670	4,290	3,060	1,830
1%	11,500	9,230	5,050	3,530	2,110
0.50%	14,000	10,700	5,820	4,010	2,410
0.20%	18,800	13,500	7,020	4,760	2,860

Table 12

Peak and Volume Tabulation for Synthetic 8-Flood Series

Arcade Creek at NEMDC from Upstream Balanced Hydrographs

8-Flood Event	Peak (cfs)	24-Hour (avg cfs)	3-Day (avg cfs)	5-Day (avg cfs)	10-Day (avg cfs)
50%	1,810	938	477	321	213
20%	2,380	1550	777	525	341
10%	2,930	1900	982	662	426
4%	3,600	2350	1230	837	535
2%	4,100	2690	1410	964	614
1%	4,620	3010	1580	1090	692
0.50%	4,970	3320	1750	1220	772
0.20%	5,570	3740	1970	1380	872

7.6 Peak Flow Attenuation. The balanced flood hydrographs with higher peaks at the upstream gaging stations on Dry and Arcade creeks do generate higher peak flows downstream at their confluences with NEMDC. With the routing process and addition of local flows, peak flows for the 50- and 20% flood events may increase in magnitude down at NEMDC. For the 10% and rarer floods, peak flows on Arcade Creek may attenuate somewhat as they travel down to NEMDC. In the modeling process, the peak flows for Dry Creek at Vernon Street for the 10% and rarer events appear to attenuate

more in proportion to their magnitude. In the HEC-1 model, the 0.2% flood peak for Arcade Creek at NEMDC is 94% of the peak flow at the Paso Heights gage (5,570 cfs compared with 5,900 cfs upstream), while the Dry Creek peak flow at NEMDC is 77% of the peak flow at Vernon Street (18,800 cfs compared with 24,500 cfs upstream).

For the prior hydrology analysis of the NEMDC tributaries (**Reference 1**), peak flows for Arcade Creek at the "near Del Paso Heights" gage increased slightly downstream at NEMDC. Peak flows for Dry Creek at Vernon Street were attenuated downstream at NEMDC, but by no more than 8%, not by greater than 20%. All of the subbasin hydrographs for Dry and Arcade creeks were ratios of the computed HEC-1 subbasin flows for the modeled NY '97 historical flood. The hydrographs for Dry Creek at Vernon Street and Arcade Creek at Del Paso Heights gage were not balanced, nor were the peak flows adjusted to match existing flow frequency curves.

8. RESULTS

The Dry and Arcade creeks 30-day hydrographs for the synthetic 8-Flood Series were provided to Hydraulic Design Section. The hydrographs for the Dry Creek/Vernon Street and Arcade Creek/Del Paso Heights index points have higher peaks but the same volumes as the 8-flood series hydrographs documented in **Reference 1**. These hydrographs will be used in a hydraulic stage frequency analysis for NEMDC. They will also be used for additional hydraulic routing to upstream index points on Dry and Arcade creeks.

The synthetic 8-flood series hydrographs provided to Hydraulic Design Section are for the locations listed in **Table 13**. These locations are also shown on **Plates 2 and 3** for Dry and Arcade creeks.

Table 13

List of Locations for Balanced Synthetic 8-Flood Series Hydrographs
Provided to Hydraulic Design Section

Subbasin #	Subbasin or Index Pt. Location	D.A. (sq mi)
Dry Creek:		
511140	Dry Cr. At Sacramento-Placer County Line	88.58
512320	Sierra Cr. At Mouth	3.00
512110	Dry Cr. Local at Q Street	5.74
591010	Robla Cr. At Mouth	5.70
591011	Magpie Div. above Robla Cr.	8.90
510930	Dry Cr. Local at Rio Linda Blvd.	2.59
590620	Dry Cr. Local at NEMDC	1.97
590620	Dry Cr. Total Flow at NEMDC	116.48
Arcade Creek:		
HC15	Arcade Cr nr Del Paso Heights Gage	31.83
40	Del Paso Park Subbasin	1.91
50	North Town & Country Subbas	1.81
60	Interior Drainage above Pump 103	1.51
64	Water from Pump 103	1.51
70	Interior Drainage above Pump 159	1.22
72	Water from Pump 159	1.22
80	Interior Drainage above Pump 158	0.78
82	Water from Pump 158	0.78
90	Interior Drainage above Pump 154	1.08
92	Water from Pump 154	1.08
92C	Arcade Cr. Total Flow at NEMDC	40.14

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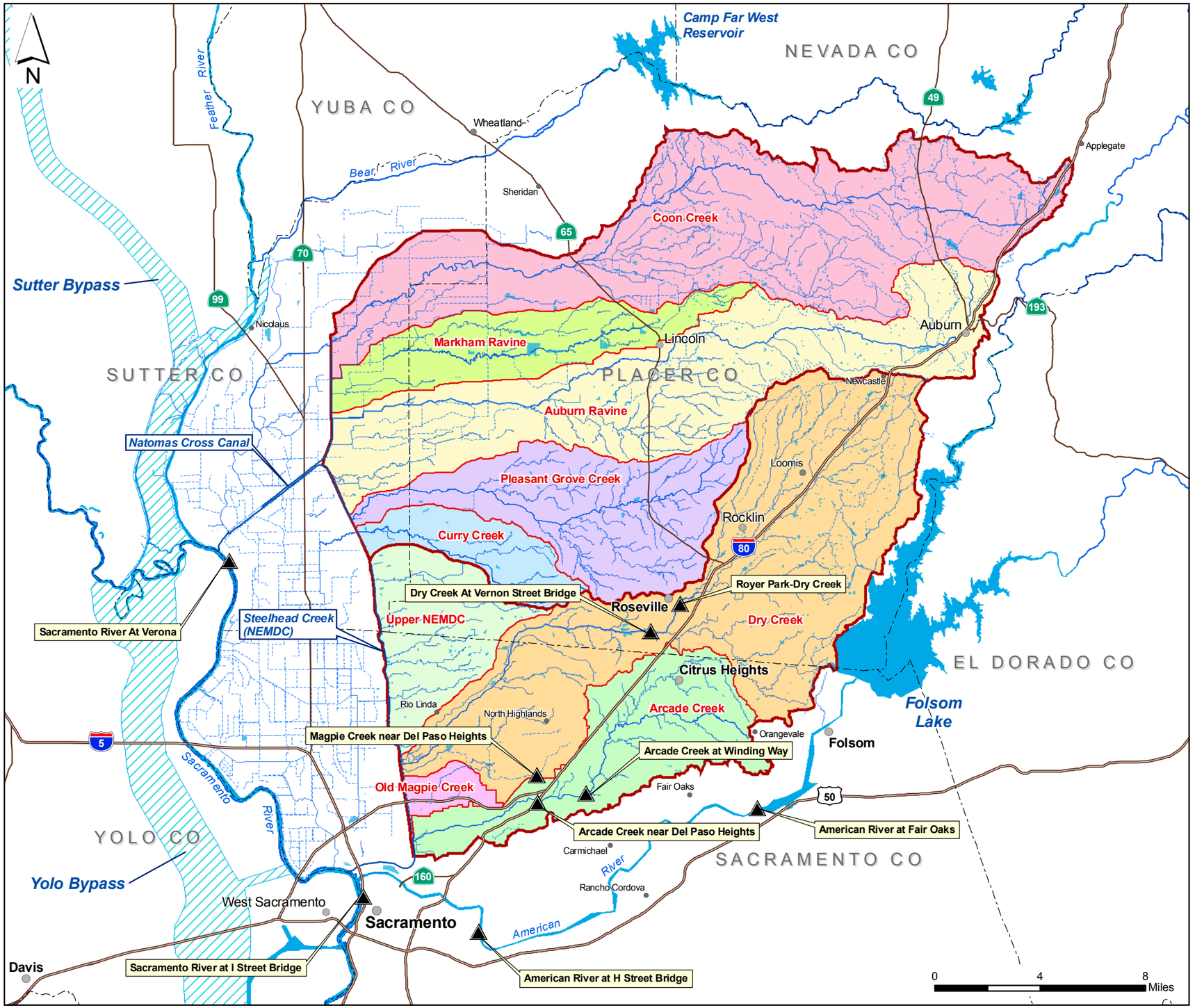
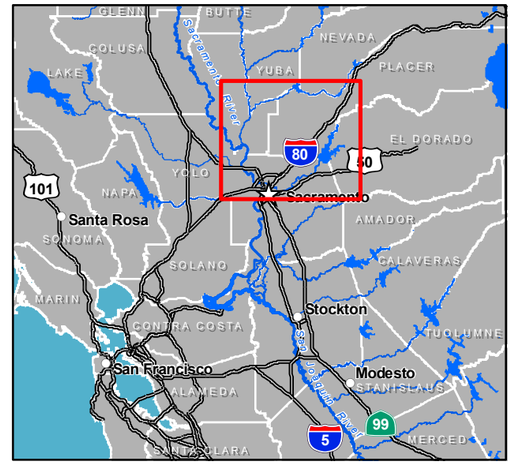


Prepared by J.S.M



Legend

- Stream Gage
- Watershed
- Sub-Watershed
- Lake or Major River
- River or Stream
- Canal or Ditch
- Freeway
- Highway
- County Boundary
- City or Town

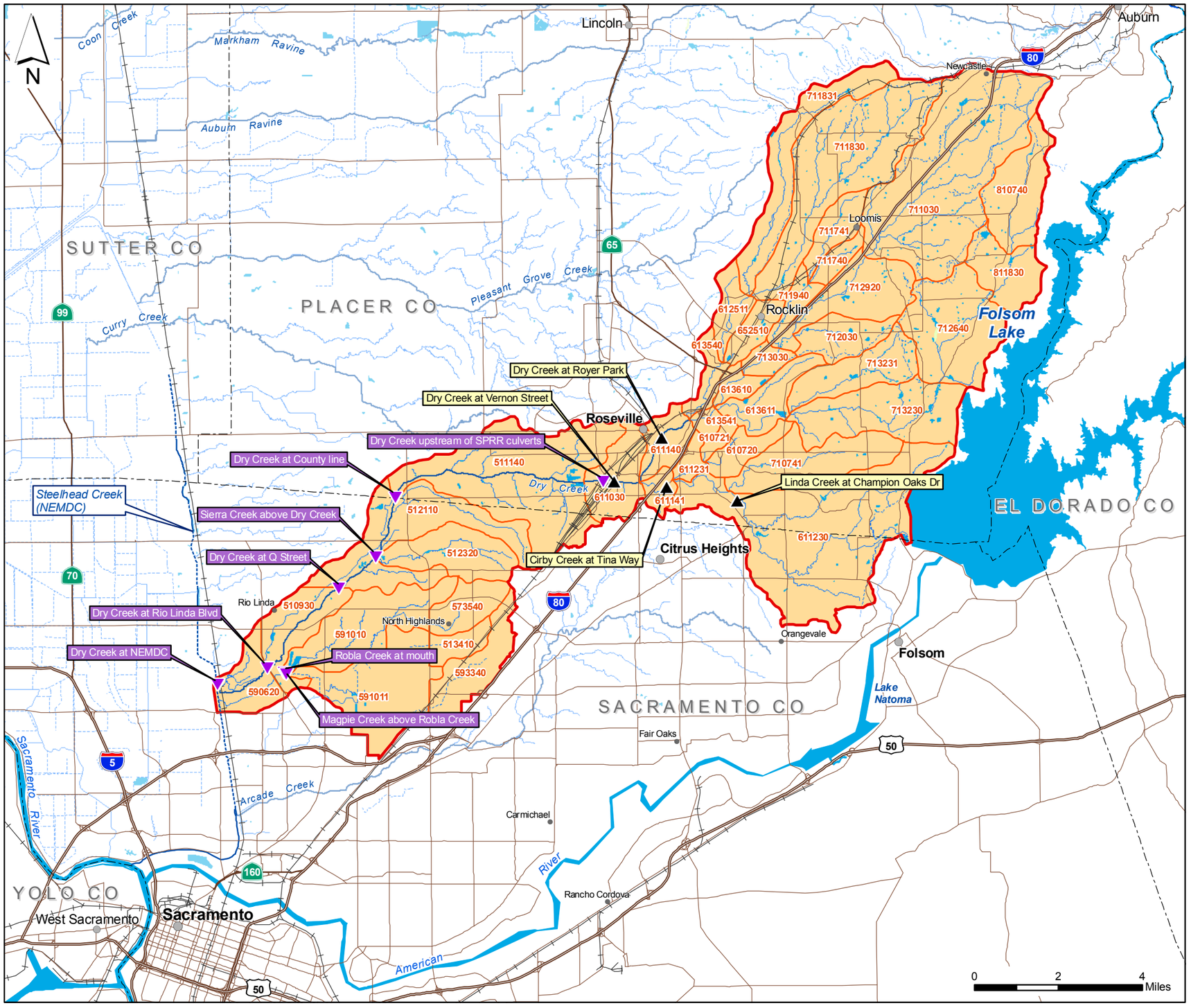
American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

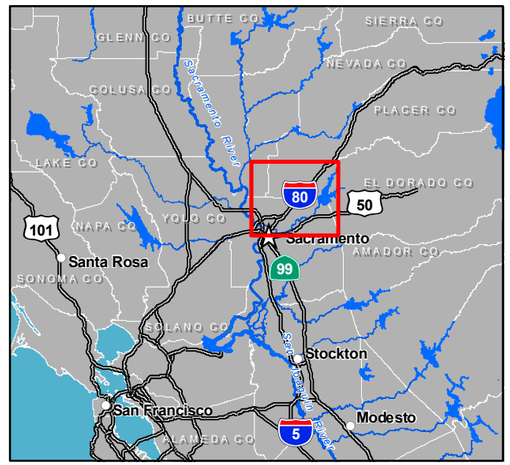
GENERAL MAP

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

NOV 2009

PLATE 1





Legend

- Stream Gage
- Model Index Point
- Watershed
- Subbasin
- Waterbody
- River or Stream
- Canal or Ditch
- Freeway
- Highway
- Major Street or Road
- Railroad
- County Boundary
- City or Town

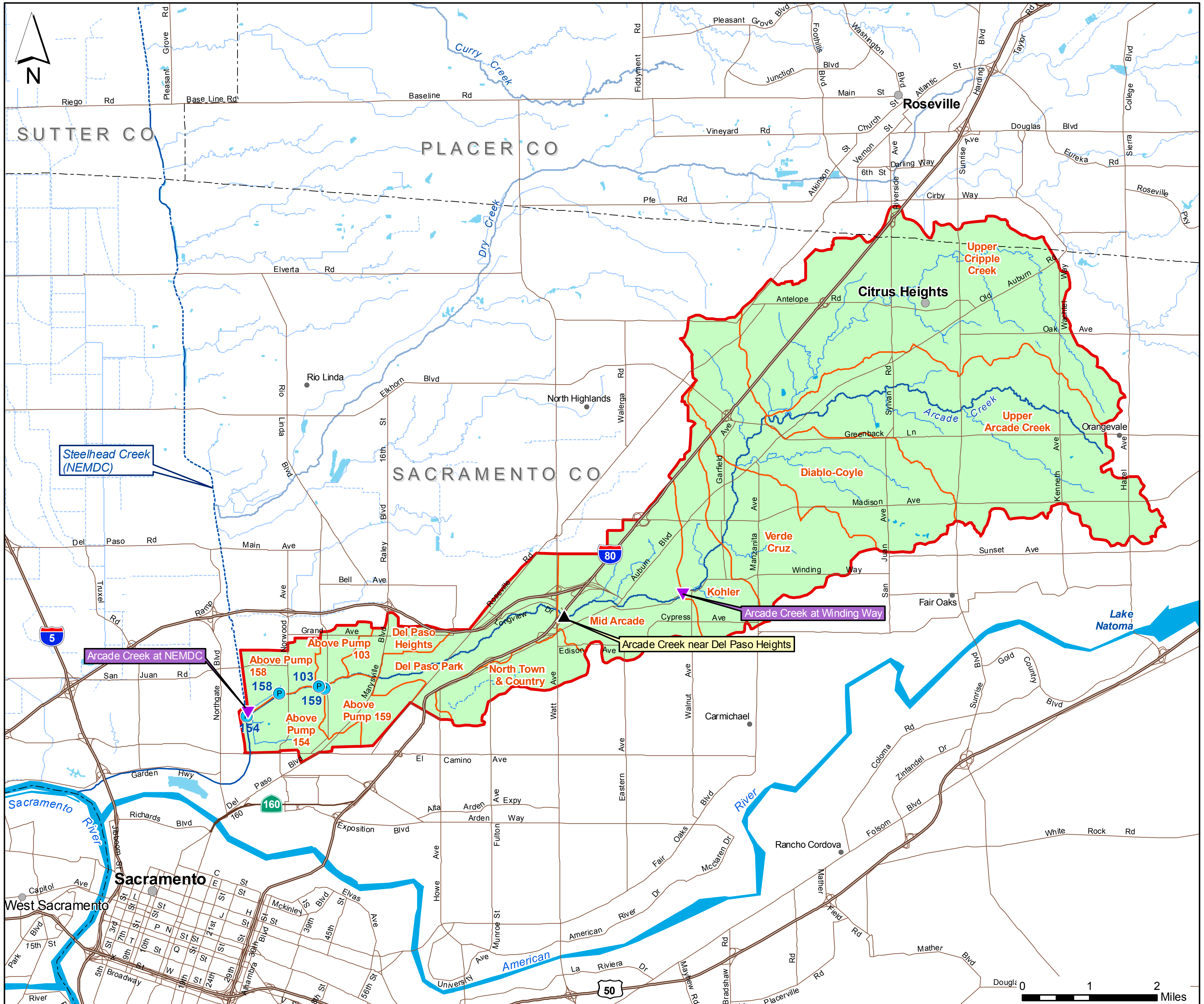
American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

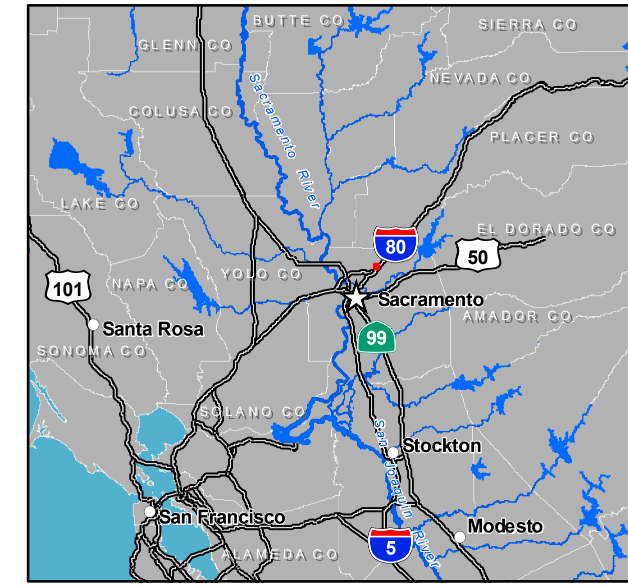
DRY CREEK WATERSHED

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

NOV 2009

PLATE 2





Legend

- Stream Gage
- Model Index Point
- Pump Station
- Watershed
- Subbasin
- Waterbody
- River or Stream
- Canal or Ditch
- Freeway
- Highway
- Major Road
- County Boundary
- City or Town

Prepared by J.S.M

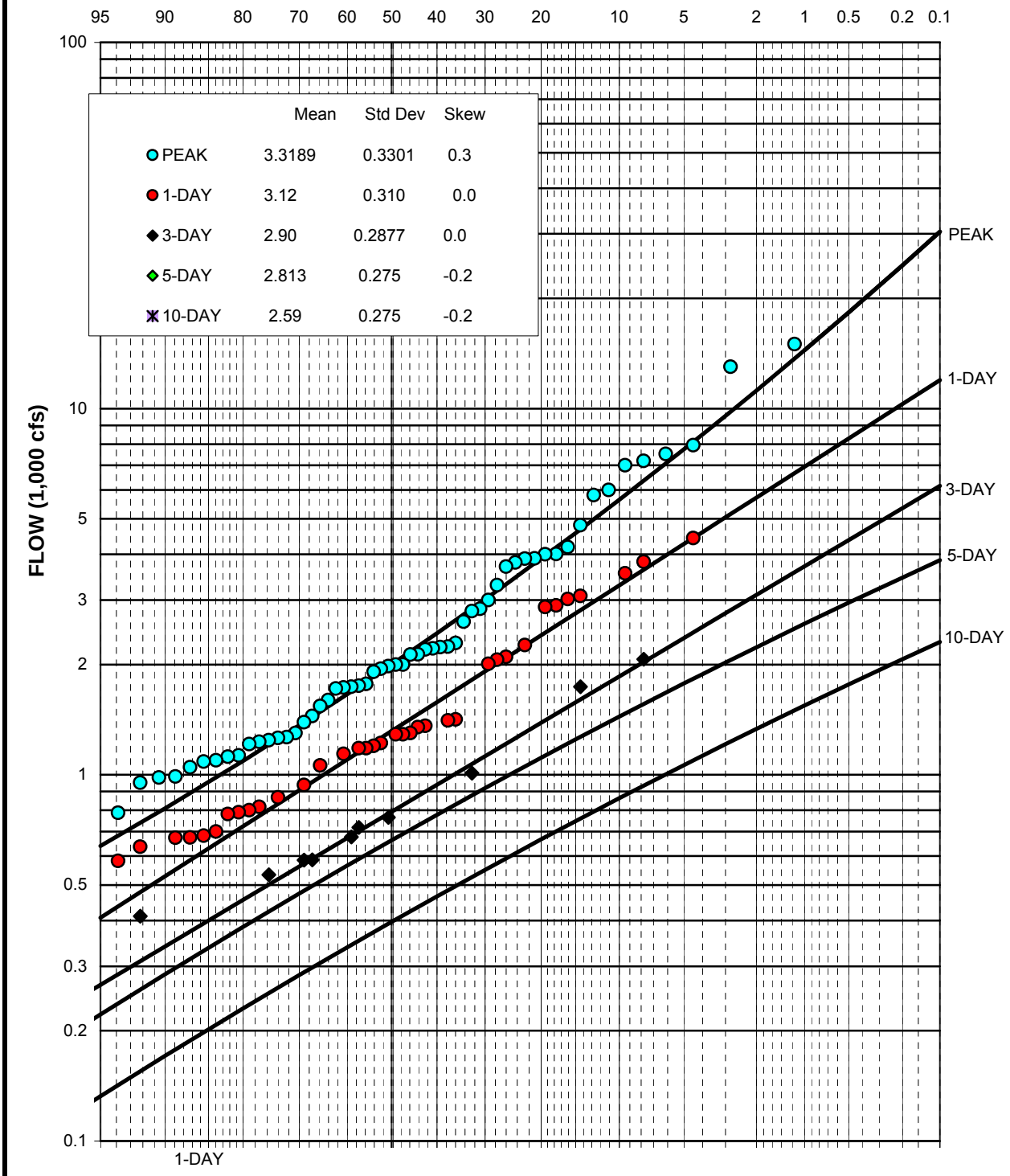
American River Common Features GRR
Placer, Sacramento, Sutter Counties, California

ARCADE CREEK WATERSHED

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

NOV 2009

PLATE 3



NOTES:

1. Drainage area 78.20 sq. mi.
2. Median plotting positions, 60 years record.
3. Peak and 1-day plotting positions for WY 1950 to 2009, observed and estimated flows.
4. 1977 identified as low outlier peak.

Developed by LLW and prepared by JLB

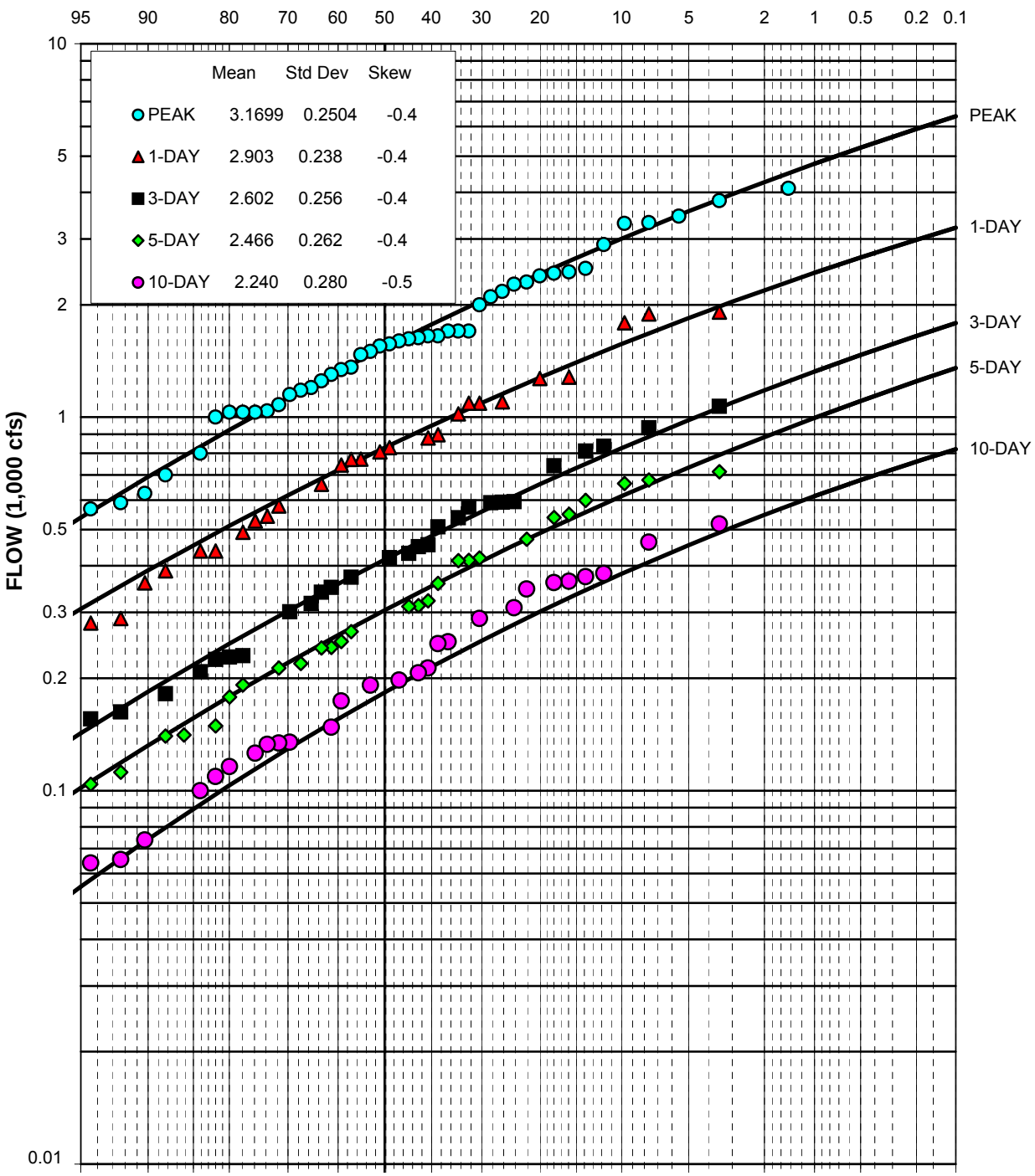
AMERICAN RVR COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CA

RAINFLOOD FREQUENCY CURVES
DRY CREEK AT VERNON ST., ROSEVILLE
USGS STATION 11447293
WATER YEARS 1950 TO 2009

U.S. ARMY CORPS OF ENGINEERS
WATER CONSERVATION DISTRICT

NOV 2009

PLATE 4



NOTES:

1. Drainage area 31.5 sq. mi.
2. Median plotting positions, 48 yrs record.
3. Period of record WY 1964-1978, 1996-2009 for 1-day to 10-day flows.
4. FFA peak flow record for 1962 to 2008.
5. 1976 identified as low outlier peak.

Developed by LLW and prepared by JLB

AMERICAN RIVER COMMON FEATURES GRR
PLACER, SACRAMENTO, SUTTER COUNTIES, CA

RAINFLOOD FREQUENCY CURVES
ARCADE CREEK NR DEL PASO HEIGHTS
USGS STATION 11447360
WATER YEARS 1962-2009

U.S. ARMY CORPS OF ENGINEERS
WATER CONSERVATION DISTRICT

NOV 2009

PLATE 5

WATER MANAGEMENT SECTION
CERTIFICATION FOR AGENCY TECHNICAL REVIEW

American River Common Features Project General Reevaluation Report
Placer, Sacramento, Sutter Counties, California
Synthetic Hydrology Technical Documentation, Sacramento District
September 2008, Revised January 2009

GENERAL FINDINGS

Compliance with clearly established policy, principles, and procedures, utilizing clearly justified and valid assumptions, has been verified for the subject project. This includes assumptions; methods, procedures and materials used in the analyses; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets the customers' needs consistent with law and existing Corps criteria and policy.

I certify that an agency technical review of the project indicated above has been completed and all technical issues have been identified and resolved. I recommend certification that the quality control process has been completed.

In accordance with CESPD R 11 10-1-8, South Pacific Division Quality Management Plan, May 2000, this letter certifies that the without-project hydrology is appropriate as the basis for use in the hydraulic analysis for the American River Common Features Project General Reevaluation.

Laurine L. White — 26 Jan 2009
Laurine L. White
Hydrologist, SPK
Date

James Chieh — 1-26-2009
James Chieh
Independent Technical Reviewer
Date

John M High IV — 1-26-2009
John M. High
Chief, Water Management Section, SPK
Date

HYDROLOGY SECTION
CERTIFICATION FOR AGENCY TECHNICAL REVIEW

American River Common Features Project General Reevaluation Report
Appendix B, Dry and Arcade Creeks Flow Frequency Curves
And Synthetic 8-Flood Series Hydrographs
Upstream of Steelhead Creek, Sacramento District
November 2009, Revised January 2010

GENERAL FINDINGS

Compliance with clearly established policy, principles, and procedures, utilizing clearly justified and valid assumptions, has been verified for the subject project. This includes assumptions; methods, procedures and materials used in the analyses; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets the customers' needs consistent with law and existing Corps criteria and policy.

I certify that an agency technical review of the project indicated above has been completed and all technical issues have been identified and resolved. I recommend certification that the quality control process has been completed.

In accordance with CESPD R 11 10-1-8, South Pacific Division Quality Management Plan, May 2000, this letter certifies that the without-project hydrology is appropriate as the basis for use in the hydraulic analysis for the American River Common Features Project General Reevaluation.

Laurine L. White — 19 January 2010
Laurine L. White
Hydrologist, SPK
Date

James Chieh — 20 January 2010
James Chieh
Independent Technical Reviewer
Date

John M. High — 19 JANUARY 2010
John M. High
Chief, Hydrology Section, SPK
Date

HYDROLOGY SECTION

CERTIFICATION FOR AGENCY TECHNICAL REVIEW

West Sacramento General Reevaluation Report
Yolo County, California
Hydrologic Study

GENERAL FINDINGS

Compliance with clearly established policy, principles, and procedures, utilizing clearly justified and valid assumptions, has been verified for the subject project. This includes assumptions, methods, procedures and materials used in the analyses; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets the customers' needs consistent with law and existing U.S. Army Corps of Engineers criteria and policy.

In accordance with CESPD R 1110-1-8, South Pacific Division Quality Management Plan, May 2000, this letter certifies that the without-project hydrology is appropriate as the basis for use in the hydraulic analysis for the West Sacramento General Reevaluation.

This quality control certification includes the 50% through 0.2% chance flood hydrographs on the Sacramento River and Yolo Bypass in the vicinity of West Sacramento, which is based on the Comprehensive Study Latitude of Sacramento flood centering. The concurrent American River flows in this centering include existing conditions operations for Folsom Dam (SAFCA diagram) with a 145,000 cfs maximum objective release and a future condition Joint Federal Project (JFP) with a maximum objective release of 160,000 cfs. Development of a new Water Control Diagram is in progress that may change the future condition flows, although the maximum objective release is not expected to change.

I certify that an independent technical review of the project indicated above has been completed and that all technical issues have been identified and resolved. I recommend certification that the quality control process has been completed.

John M. High, Section Chief
Hydrology Section, SPK

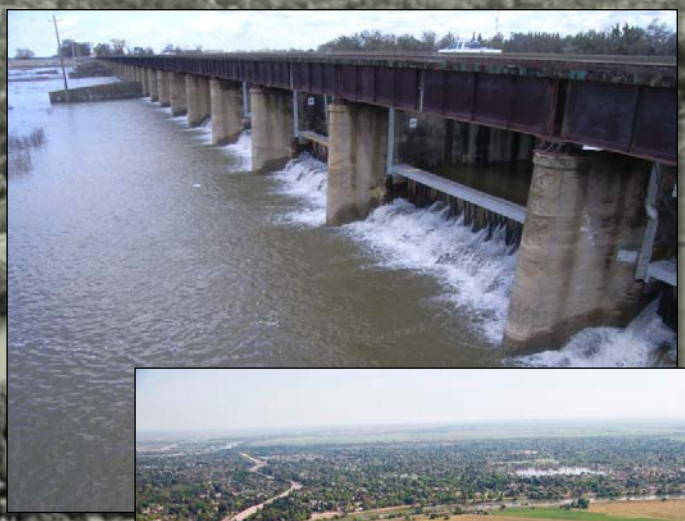
10/19/2010
Date

Gregory A. Kukas, Branch Chief
Hydrology & Hydraulics Branch, SPK

10/19/2010
Date

American River Watershed

Common Features
General Reevaluation Report



Attachment B
Hydraulic Report

December 2015

Sacramento Area Flood Control Agency

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:
Sacramento Weir during operation
Sacramento River facing south near the Pocket and Little Pocket neighborhoods
High flows on the American River at the Highway 160 overcrossing
Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Attachment B
Hydraulic Report

U.S. Army Corps of Engineers
Sacramento District

December 2015

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AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

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Technical Memorandums Supporting this Executive Summary Report

Memorandums are referred to in the text by the numbers shown below but are not included in this report. Copies are available on request.

1. Sacramento Basin HEC-RAS Phase I Model Development
2. Sacramento Basin HEC-RAS Phase II Model Development
3. Sutter Basin HEC-RAS Model Conversion
4. Datum Conversion of Hydraulic Models to NAVD88 Values
5. Downstream Boundary Conditions
6. Gages
7. Hydrologic Inputs (DSS files)
8. High-Water Marks
9. Hydraulic Uncertainty
10. FLO-2D Floodplain Mapping Documentation
11. Levee Breach Sensitivity
12. Climate Change Memo
13. Systems Risk and Uncertainty
14. Interior Drainage
15. Upstream Alternative Analysis
16. Calibration
17. TSP Comparison
18. Historic Upstream Levee Failure

1 STUDY DESCRIPTION

1.1 Introduction

This Hydraulic Report summarizes a collection of technical memorandums documenting the hydraulic analysis performed to support the ARCF GRR and has been prepared to meet the intention of the new USACE SMART Planning process – Specific, Measurable, Attainable, Risk-informed and Timely. A complete list of the memorandums cited in this document follows the Table of Contents and are also located in the References section. To support streamlined documentation as part of SMART Planning, the memorandums are referenced but not included with this report. They can be provided on request.

Several significant factors justify a reevaluation of the American River Common Features Project at this time:

1. Since the last authorization of the American River Common Features Project, the scope and cost of levee improvements for the Natomas Basin have increased.
2. New hydraulic modeling and geotechnical studies suggest potential issues with the Sacramento River east levee downstream of the American River. Specifically, the levees have shown evidence of through-seepage and underseepage that could lead to a failure. Such a failure could cause major flooding in the city of Sacramento.
3. There are also additional erosion issues on the American River that will need to be addressed to ensure that the American River can pass 160,000 cubic feet per second (cfs) with some degree of certainty.

Based on these factors, the city of Sacramento may continue to have a high risk of flooding, even with the completion of all authorized improvements in the Natomas Basin, along the Lower American River, and at Folsom Dam.

Previous study efforts of the Natomas Basin under the Natomas GRR were folded into a more broadly scoped American River Common Features General Reevaluation Report. That report considered all the aforementioned issues from a system approach in order to reduce the flood risk in the entire city of Sacramento.

1.2 Location

The project area reflects the area for which alternatives were formulated to meet the planning objectives. The study area is a broader area where the benefits (or impacts) of the alternatives was evaluated. The project area is divided into three basins – Natomas, American River North, and American River South – and has an upstream boundary at Verona and a downstream boundary at Freeport on the Sacramento River (see Plate 4 for the location of these basins). It also includes the leveed portions of the American River, the Natomas Cross Canal, the Natomas East Main Drain Canal (NEMDC), the Pleasant Grove Creek Canal, Magpie Creek, and the leveed portions of Dry and Arcade creeks. The study area for the ARCF GRR includes the above project area and extends beyond it both upstream and downstream. See Plates 1 and 2 for a watershed and a general topographic map, respectively.

Flood control channels and other features in the Sacramento area are part of a much larger flood control system known as the Sacramento River Flood Control Project (SRFCP). The SRFCP in the

Sacramento Valley consists of a series of levees and bypasses, placed to protect urban and agricultural areas and take advantage of several natural overflow basins. See Plate 3 for a graphic depiction of the system layout. The SRFCP system includes levees along the Sacramento River south of Ord Ferry; levees along the lower portion of the Feather, Bear, and Yuba Rivers; and levees along the American River. The system includes the Sutter, and Yolo bypass channels. These bypass channels run parallel to the Sacramento River and receive excess flows from the Sacramento, Feather, and American rivers via overflow channels and constructed weirs. During floods, the flood control system is one continuous waterway.

1.3 Topographic Data

Existing topography and bathymetry were used for most of the study's hydraulic modeling efforts. There were several areas with updates, including the Natomas east side tributaries area for the HEC-RAS model where new surveyed cross sections were developed.

The topography for the HEC-RAS model was previously collected for the Sacramento River Bank Protection Project and the Sacramento San Joaquin Comprehensive Study (Comp Study) UNET model. More detailed descriptions of the hydrographic and topographic surveys completed are in documentation provided by Ayres Associates in support of the Comprehensive Study (References 31, 32).

The geospatial survey data used in the development of the FLO-2D models were obtained from both Sacramento County and the United States Geological Survey (USGS). The Sacramento County information included LiDAR data for the urban area of the county and is dated 2004. The USGS information included publicly available 30-meter USGS Digital Elevation Models (DEMs) which were obtained from http://www.GISdatadepot.com.

All topographic data references the North American Vertical Datum of 1988 (NAVD88) and the North American Datum of 1983 (NAD83), projected in California State Plane Zone 2. The units are in feet. Several of the topographic datasets were created in different vertical datums and significant effort has been made to convert the topographic datasets and hydraulic models into the current standard vertical datum, NAVD88. See both the Technical Memorandum (USACE May2013c) on model datum conversion and the reference on the Comprehensive Study topography conversion (HJW Geospatial, 2010).

1.4 Study Approach

The three basins that are the focus of this GRR – American River North, American River South and Natomas (described in more detail in Chapter 3) are susceptible to flooding from both the American River and Sacramento River. Within the study area, the American and Sacramento rivers were divided into more than 25 river reaches according to the geotechnical similarity of their levees. The number was reduced to five representative reaches that would adequately describe the flood risk within the study area during the plan formulation process.

HEC-RAS (1-dimensional channel model) and FLO-2D (2-dimensional gridded model) hydraulic models were used to produce necessary outputs for the economic evaluation of the future without-project conditions and alternatives. The ARCF GRR used the same basic models that were developed and refined for the existing conditions (F3, March 2009) analyses and the Natomas Post Authorization Change Document (NPAC, 2010). HEC-RAS was used to model the main flood control channels of the

system to determine the water surface profiles assuming no levee failure. The model was also used to simulate levee failure scenarios and simulate flood hydrographs into the floodplain areas. This HEC-RAS model includes the major river reaches within the lower portion of the Sacramento River Watershed. This was done to capture upstream and downstream influences to the project area as well as to eventually determine the potential project impacts to areas outside the project area.

Flood hydrographs generated in HEC-RAS from a levee break were input into FLO-2D for delineation of the floodplain in each basin. In order to generate flood damages for economic evaluations, floodplains were delineated for the 50% (1/2), 10% (1/10), 4% (1/25), 2% (1/50), 1% (1/100), 0.5% (1/200-Yr) and 0.2% (1/500) annual chance exceedance events. The analysis was limited to flooding within the basin from levee breaches and does not include localized flooding from rainfall-runoff and smaller streams and drainages.

Floodplain delineations presented in this study are based on a single levee break within a levee reach. The levee break location was determined by the most significant geotechnical concerns along that reach and by any overriding hydraulic concerns, such as low levee elevations or locations where a large amount of water could travel through the levee break and out into the floodplain. The resultant flood depths from FLO-2D and the stage-discharge-frequency curves derived from HEC-RAS outputs were used to perform the risk analysis for the without-project condition and the alternatives.

This report presents a very specific and detailed analysis of the with- and without-project conditions for the general Sacramento metropolitan area. Based on an evaluation of study risks, some analyses typically found in a hydraulic appendix have been reduced to a sensitivity analysis, have not been done, or have been postponed to a later date and will likely be completed during design. These efforts are summarized below:

Efforts analyzed using sensitivity:

- Climate change
- Sea level rise
- Interior flooding

Efforts not expected to be completed at this time or in design:

- FEMA accreditation/certification
- Safe overtopping locations and evacuation plans
- Boat wave erosion

Efforts recommended for design or during refinement of selected plan:

- Sedimentation engineering, fluvial geomorphology
- Channel stability, channel stabilization, bridge scour
- Bank projection, vegetation analysis (tree scour)
- Operation and maintenance

The key assumptions for each analysis are listed in Table 1-1.

Table 1-1. ARCF Hydraulic Analyses and Key Assumptions	
ARCF Hydraulic Deliverables	Key Assumptions
Future without-project condition analysis (HEC-RAS, Flo-2D)	The project area is adequately represented by index points at 5 key locations, reduced from over 25.
Evaluation of final alternatives for evaluation (HEC-RAS)	For alternative analysis, large cost measures screened out qualitatively. Many features reduced and combined into final array of alternatives.
With-project floodplain analysis (Flo-2D)	Used without-project floodplains and adjusted frequency of floodplain based on peak stage and volume.
Potential Hydraulic impacts (HEC-RAS)	The baseline for potential hydraulic impacts at Folsom is the future without project condition with the Folsom features(JFP Spillway, Dam Raise) in place.
Residual risk (HEC-RAS, Flo-2D)	Overtopping of American River upstream of leveed reach and Sankey Gap will not be modified by a future project.
Interior drainage	Existing FEMA interior floodplains used in place of full interior drainage analysis.
Systems risk and uncertainty	HEC methodology used based on Reference 5.
Climate change	Sutter methodology used, sensitivity analysis only.
Sea level rise	Used Information from recent study in the Delta and existing sensitivity analysis.
Coincident flow frequency	Based on direction from Hydrology Section Chief, using the n-year event for coincident flows on the Eastside Tributaries and the American River until design, then refinement likely needed.
Superiority	No analysis was performed. Instead, ETL 1110-2-299 was used with bypasses serving as the overtopping locations along with using congressional legislation assumptions specifically for the American River.
Erosion (including riverine/bank, wind-wave, and channel stability)	Limited analysis conducted, coordinating with ongoing design efforts that are not yet complete. Erosion repair for the American River is identical to all alternatives.
Vegetation variance	Vegetation Variance Deferred to PED, Hydraulic efforts will be part of erosion scoping, likely a HEC-18 analysis for tree scour.

1.5 Basis of Design

The following is a partial list of USACE guidance used in the hydraulic analysis:

ER 1110-2-1150	Engineering and Design for Civil Works Projects
EC 1110-2-281	Requirements of River Hydraulics Studies
ER 1110-2-8153	Sedimentation Investigations
ER 1110-2-1405	Hydraulic Design for Local Flood Protection Projects
EC 1165-2-201	Ecosystem Restoration in the Civil Works Program
EM 1110-2-1416	River Hydraulics
EM 1110-2-1619	Risk-Based Analysis for Flood Damage Reduction Studies
EM 1110-2-4000	Sediment Investigations of Rivers and Reservoirs
EM 1110-2-1205	Environmental Engineering for Local Flood Control Channels
EM 1110-2-1601	Hydraulic Design of Flood Control Channels
ERDC/CHL TR-01-28	Hydraulic Design of Stream Restoration Projects
ETL 1110-2-299	Design of Overtopping of Levee
EC 1110-2-6067	USACE Levee Certification Guidance

2 PROJECT DESCRIPTION

2.1 Project Area Limits

The project limits for the floodplain north of the American River cover approximately 124 square miles of Sacramento County (see Plate 5). The American River North basin includes the area north of the American River and east of the Natomas East Main Drain Canal (NEMDC). It is separated from the Natomas Basin by the NEMDC. The American River North Basin is bounded on two sides by levees and high ground on the remainder as follows:

- Southern boundary: American River levees from Hazel Avenue to the NEMDC
- Western boundary: NEMDC levees
- Northern boundary: High ground and Elverta Road
- Eastern boundary: High ground

The American River South basin includes the area south of the American River and east of the Sacramento River (see Plate 6). For this effort, it does not include the Morrison Creek Stream Group. The study limits for the floodplain south of the American River cover approximately 254 square miles of Sacramento County and are defined as follows:

- Southern boundary: Morrison Creek Stream Group levees
- Western boundary: Sacramento River levees
- Northern boundary: American River levees from Hazel Avenue to confluence with Sacramento River
- Eastern boundary: High ground

The Natomas Basin is almost completely enclosed by levees and has significant interior drainage works (see Plate 7). The Natomas basin includes the reach of the Sacramento River from the Natomas Cross

Canal to the American River, the Pleasant Grove Creek Canal (PGCC), and the NEMDC. The Natomas basin is bounded as follows:

- Southern boundary: American River levees from the NEMDC to the confluence of the American and Sacramento Rivers
- Western boundary: Sacramento River levees from the Natomas Cross Canal to the confluence of the American and Sacramento Rivers
- Northern boundary: Cross Canal levees
- Eastern boundary: The NEMDC levees to the southern two-thirds of the eastern boundary and levees for a drainage canal connecting to the Cross Canal for the northern one-third of the eastern boundary

There is one location that is not leveed in the Natomas Basin, where the NEMDC and the drainage canal on the eastern boundary meet. This opening is less than a quarter mile in length near Sankey Road, and is commonly referred to as the Sankey Gap.

2.2 Future Without-Project Condition

The Sacramento River system configuration as it generally exists now (between years 2006 and 2014) was used for the future without-project condition with the exception of changes on the American River.

The ARCF GRR study assumes that the work identified in the Natomas PACR Chief's Report has been completed.

This study also assumes that all previously authorized constructed and unconstructed work on the American River, the new spillway being constructed at Folsom Dam, and the future planned raise of Folsom Dam. The Folsom Dam and Spillway were assumed to be operated as described in Appendix B2: American River Hydrology and Folsom Dam Reservoir Operations of the Hydrology Appendix.

As part of the March 2009 Existing Conditions Conference (F3), multiple scenarios were proposed and analyzed for the without-project and future without-project conditions for the American River. Much of the Sacramento River system was expected to be the same under the future without-project condition with the exception of the following:

- Changing operations at Folsom Dam because of the Joint Federal Project Spillway (JFP),
- Levee repairs as described in the "Natomas Post Authorization Change Report"
- Levee repairs as described in the "Authorized American River WRDA 96/99 Sites"

The Project Delivery Team (PDT) decided to analyze conditions needed to justify only the current work proposed by the ARCF GRR document. This decision considered the significant effort already expended and additional effort still needed to answer the question of incrementally justifying projects on the American River. Based on this information as well as profile comparisons, it was determined that it is not necessary to consider the multiple without-project conditions as previously studied.

For the ARCF GRR document, only a single without-project condition was analyzed. This condition was known as the NA3 condition in the CF GRR F3 documentation. Because previous nomenclature used was confusing, a new naming system was developed. The NA3 condition is now known as the Authorized Common Features + Joint Federal Plan + Dam Mini-Raise (ACF + JFP + Dam Mini-Raise). This

plan includes all previously authorized constructed and unconstructed work on the American River, the new spillway being constructed at Folsom Dam, and the future planned raise of Folsom Dam.

All this is considered to be part of the without-project condition. Any work beyond the without-project condition, proposed under the ARCF, is considered part of the with-project condition.

3 CHANNEL HYDRAULICS

3.1 Background

This chapter documents the HEC-RAS model development and calibration for the Sacramento River Basin river system in support of the ARCF GRR. HEC-RAS is a 1-D hydraulic model that can be run in steady or unsteady mode. The model for the Sacramento River Basin was generated from a combination of several previous modeling efforts, many of which modeled a portion of the Sacramento Basin. Previous modeling was supplemented with new modeling for some reaches.

A basin-wide UNET model was previously developed for the Sacramento Basin as part of the Sacramento and San Joaquin River Basins Comprehensive Study (Comp Study. As part of the F3, the entire model was converted from UNET to HEC-RAS, with the exception of the Butte Basin and the Sacramento River north of Colusa. All modeling is currently being done using HEC-RAS. Handoffs from the UNET model in the form of flow hydrographs were used as upstream boundary conditions for the HEC-RAS model. Details regarding development of the HEC-RAS model are contained in the Sacramento Basin HEC-RAS Phase I Development Technical Memorandum (USACE May 2013i).

Modeling of the study area was done in different phases in order to avoid delays to the major milestones of the ARCF GRR schedule. Phase 1(USACE May 2013i) of the model development was completed previously and supported the Natomas Post Authorization Change Document (Natomas PAC) in 2010 (the Natomas PAC is a portion of the overall ARCF GRR study). Phase 1 documents the generation of the main geometry files with pertinent features, including representation of major flood control levees in the system. During this phase of model development, the model was calibrated to the 1997 flood event. The model developed under Phase 1 was used to run *n*-year synthetic events, [50% (1/2), 10% (1/10), 4% (1/25), 2% (1/50), 1% (1/100), 0.5% (1/200-Yr) and 0.2% (1/500)] for without-project conditions to determine economic damages and to screen alternatives for the Natomas PAC study. This model was based on the NGVD1929 vertical datum.

For Phase 2 of model development, the model was converted to the NAVD1988 vertical datum (USACE, May 2013c). Additional reaches were added to the model, in particular the Natomas east side tributaries (WEST July 2010). Though the model does cover a large portion of the lower Sacramento watershed, its main purpose is not to provide detailed hydraulics for all reaches in the system, but rather to support the ARCF GRR, which is for flood damage reduction efforts in and around Sacramento. Other Corps studies within the Sacramento Basin system, in particular the Sutter County Feasibility Study and the West Sacramento GRR studies, also use the same “base” Phase 2 model, but include refinements pertinent to their particular study reaches. More information on Phase 2 development can be found in the Draft Sacramento Basin HEC-RAS Phase II Development Technical Memorandum (USACE, May2013j).

3.2 Hydrology

Inflow hydrographs to the hydraulic models presented in this report are described in the hydrology report. Hydraulic model simulations were performed for flood frequencies ranging from 50% (1/2) through the 1.2% (1/500) ACE events. The hydrology report includes minor updates were made to the hydrology used in the Natomas Post Authorization Change Report. This includes greater detail and refinement of the tributary streams on the east side of the Natomas Basin and an update on timing of the American River outflows. For a revised map showing locations of boundary conditions, see Plate 57.

3.3 Model Calibration

The model was calibrated to flood events that occurred in 1997 and 2006. The Calibration Technical Memorandum (USACE, May 2013a) includes additional information on the calibration efforts. The 1986, 1997, and 2006 flood events were considered for model validation. The 1986 flood could not be used for validation, however, because it lacked a complete set of data. The 1997 event was selected for calibration because a significant amount of calibration data was collected for the 1997 event. However, this event was complicated by the challenges of accurately representing breach flow through two levee failures. The 2006 event was initially selected for model validation for two reasons: (1) there were no levee failures, even though it produced high stages within the Sacramento Flood Control System, and (2) results of the 2006 event, when compared to high-water mark data and gage data gathered at that time, could be used to test the results of the 1997 calibration. The 2006 was used first to validate the hydraulic model results and then it was also used as a second calibration because there were refinements mostly in terms of weir coefficients. This second calibration effort removes the independence of the model validation and there is not an additional flood event with enough hydrologic information to continue the model validation. However, the 2006 event has been reasonably reproduced and demonstrates the model's ability to reproduce results from multiple events.

Insomuch that calibration was done to both the 1997 and 2006 flood events, two separate model geometries had to be created to account for geometric changes that occurred between 1997 and 2006 that could impact the hydraulics. The first geometry represents the state of the system leading up to the 1997 flood event. The second geometry represents the state of the system leading up to the 2006 flood event. The 2006 geometry is different because it includes the following physical features that were constructed after the 1997 flood event:

1) *Pump Station at the Natomas East Main Drain Canal (NEMDC) / Dry Creek Confluence*
2) *Setback levee at Shanghai Bend on the Feather River*
3) *Setback levee on the Bear River as it meets the Feather River*

Model result hydrographs were compared to gage records and peak stage data, where available, for the 1997 and 2006 flood events. The HEC-RAS model parameters for Manning's *n*, weir coefficients, and levee breaches were then adjusted as needed in an iterative procedure to modify the model results to more closely match the calibration data. The final modeled water surface profiles matched highwater marks, hydrograph peak stages and flows, and hydrograph shapes at numerous gages throughout the system reasonably well.

3.4 Water Surface Profiles

The HEC-RAS model was used to develop water surface profiles for all reaches surrounding the three basins. A suite of seven *n*-year frequency profiles [50% (1/2), 10% (1/10), 4% (1/25), 2% (1/50), 1% (1/100), 0.5% (1/200-Yr) and 0.2% (1/500)] is shown in Plates 12–24 for the future without-project condition (FWOP). The FWOP will serve as the baseline for alternative comparison. This suite of model runs included raising the levees along the project reaches high enough to contain all of the flow up to and including the 0.2% (1/500) ACE event through that reach. This approach supported an economic analysis of levee raises at multiple heights above the existing top of levee. The baseline to determine if a levee needs to be raised was set at the median 0.5% (1/200) Annual Chance Exceedance (ACE) plus 3 feet. This assumption is based on both the local sponsor's Urban Levee Design Criteria (DWR 2012) and the intent of the Folsom JFP to control releases up to 160,000 CFS which is currently estimated to be a 0.5% (1/200) ACE event.

This top of levee design of 3 feet above the median 0.5% (1/200) ACE was used on all reaches except the American River where there was already a design water surface profile from the WRDA 1996/1999 Design efforts. The American River top of levee was set at 3 feet above the design flow of 160,000 cfs (currently a median 0.5% (1/200) ACE) at a single index point but this would need to be evaluated in PED for the entire reach for levees on both sides.

There are two unique features on the water surface profiles on Plates 12-24. First, on the NEMDC right bank levee (Plate 19), there is a pump station at RM 6.3 that also acts as a barrier to rising American River backwater flowing up the channel. This is shown by a lower water surface profile upstream of the NEMDC Pump station than on the downstream side. Secondly, during large flood events, water from the American River flows upstream on the Sacramento River to the Sacramento Weir, where it discharges into the Sacramento Bypass (which connects to the Yolo Bypass). This creates a flat or increasing water surface profile downstream of the Sacramento Weir, which can be seen in the profile plates noted above.

3.5 Levee Breach Assumptions

Levee breach model results are needed for input into the 2D floodplain routing model (FLO-2D) to delineate the corresponding floodplains. Several key levee breach assumptions are listed below:

- A levee breach width of 500 feet was used consistently in the models that support the ARCF GRR. Historical precedent shows that 1,000 feet (which the Corps has used on other studies in the Sacramento Basin) is an achievable breach width, but it is on the high end of all known widths. The 500-foot width was chosen as a more reasonable or average value.

- For each model run with a levee break, the trigger elevation for a levee break was set to 0.5 feet below the max water surface of the simulated event at the failure location.

- If the maximum water surface did not reach the toe of levee, it was assumed that the levee did not fail and a breach simulation was not performed.

- The time for the breach to develop was set at 1 hour.

Several of these assumptions were evaluated with a sensitivity analysis and confirmed to not significantly impact the hydraulic results. The sensitivity analysis is discussed further in section 5.2 and the Levee Breach Sensitivity Technical Memorandum (USACE, May 2013h).

4 ALTERNATIVE DEVELOPMENT

4.1 Evaluation of Measures

A wide range of features were evaluated to reduce flood risk in the project area. There are two main strategies to reduce this risk:

- Reduce the consequences of flooding by moving communities to higher ground out of the floodplain, flood proofing, land use changes, and/or other non-structural alternatives.

- Reduce the probability of inundation of structures. This is generally done in one of two ways:
    - Reduce the amount of flood water getting to and through the project area
    - Fortify and improve the current flood defense system

Reducing the consequences of flooding is addressed in the main feasibility report and the economic appendix. Reducing the probability of inundation is addressed starting here in Chapter 4, with additional information found in Chapters 5-7. Measures to reduce the probability of inundation by strengthening or improving the existing flood risk management system are described below, with additional information found in the engineering appendix and its geotechnical attachment.

From a hydraulic perspective, measures to reduce the probability of inundation generally fall into four categories: levee improvements, upstream transitory storage, diversions, and combinations of these features. Of these features, it was determined that the first increment would be some amount of levee improvement and this is the base for combining additional measures to become the alternatives. Based on preliminary analyses, the other measures did not show significant reductions in stage or flow, had the potential to create hydraulic impacts, or had very large real estate requirements (USACE, May 2013m). Even with some of these additional measures, the stages and flows were not reduced enough to eliminate the need for levee improvements. For purposes of the current study, the following measures were therefore removed from further consideration:

- Upstream transitory storage at various locations
- Wicket gates at several location along the Sacramento River upstream of the American River confluence
- Pocket bypass
- Yolo Bypass widening
- I Street Diversion Structure
- Adjacent levee – seen as a design refinement to use where possible

Below is a list of alternatives developed by combining measures that were carried forward; these are described in greater detail in the following sections (4.2 - 4.3).

- Strengthen levees in place
- Strengthen levees in place with the Sacramento Bypass widening

The alternative including upstream storage on the American River was carried forward for planning purposes and existing information was used for this study.

4.2 Alternative 1: Strengthen Levees in Place

Due to the urban nature and proximity of existing development to the levees within the American River North and South basins, Alternative 1 proposes strengthen-in-place levee remediation. The stated purpose of this alternative is to improve the flood damage reduction system to safely convey flows up to a level that maximizes net benefits including the potential for a levee raise.

Alternative 1 primarily calls for landside strengthening of levees that do not change in-channel geometry or characteristics. These levee fixes involve the construction of levee remediation measures to address concerns such as seepage, slope instability, potential overtopping, erosion, lack of vegetation compliance, and lack of O&M access along the following streams: the American and Sacramento Rivers; the Natomas East Main Drainage Canal (NEMDC); Arcade, Dry, and Robla Creeks; Magpie Creek; the Pleasant Grove Creek Canal (PGCC); and the Natomas Cross Canal (NCC). This alternative combines construction of levee improvement measures while maintaining the present levee alignment in its existing location (aka, strengthen levees in place).

The Natomas Post Authorization Change Report (PACR) proposed levee improvements for the Natomas Basin that consisted of a combination of strengthen in place, adjacent levee, seepage cutoff walls, and seepage berms. The ARCF GRR study assumes that the work identified in the PACR will be completed as stated and proposes that levee raises are all that remain to be evaluated in the Natomas Basin. The levee raise is expected to be constructed within the existing or now expanded levee footprint. There may need to be some additional real estate considerations along the Natomas East Main Drain Canal downstream of the Pump Station (~RM 6.5). The levee would potentially expand on the landside to minimize any hydraulic impacts. See the Engineering Appendix for more information on the footprints of the alternatives.

A crest elevation of the future without-project mean 0.5% (1/200) ACE event plus 3 feet levee profile was compared the current top of levee. Levee raising (except for the Sankey Gap) was identified when the current top of levee fell below this profile. The typical amount of height increases needed is 1 to 2 feet. Plates 31-56 show the water surface elevations for the alternatives, the future without-project condition for both the 10-year and the 200-year events respectively. Plates 9–11 show the locations of levee raising along with erosion protection (Erosion is discussed in Section 8). Table 4-1 shows the extent (length) of levee raising needed per reach.

One reach in the American River North Basin, Magpie Creek, will require more than just strengthen levees in place to reduce the probability of inundation. Additional features for Magpie Creek may include a detention basin, a new reach of levee, and bridge improvements and are called out in Corps' Section 205 Continuing Authorities Program Basis of Design Report (MWH/CH2M Hill, 1999), and refined by the Draft Supplemental Report to the Section 205 Final Detailed Project Report and Environmental Assessment on Magpie Creek (USACE May 2003). These features will be refined during the Preconstruction, Engineering and Design (PED) Phase.

After the analysis was complete and in response to the increasing concerns about USACE projects encouraging development in floodplains (EO 11988), all proposed levee improvements proposed as part

of this report for the Natomas Basin have been removed from all of the final alternatives. See the main report for more information.

4.3 Alternative 2: Alternative 1 plus Sacramento Bypass Widening

Alternative 2 starts with Alternative 1 (strengthen levees in place) as a base and adds the widening of the Sacramento Bypass/Weir. The purpose of this alternative is to redirect more floodwaters from the Sacramento River to the Yolo Bypass and thereby reduce the extent of levee repairs required to meet current design guidance for seepage and stability in the project area. Currently, the Sacramento Weir is 1,920 feet wide with 48 wooden gates that are manually removed when the water surface elevation on the Sacramento River at the I Street gage reaches 30.0 feet NAVD88. If the Sacramento Bypass were widened, it would allow more water to flow into it and, therefore, into the Yolo Bypass. This would lower the water surface elevation on the Sacramento River downstream of the confluence with the American River and subsequently reduce the need for levee raising along the Sacramento River in the Pocket area. Table 4-1 shows the extent (length) of levee raising needed per reach for Alternatives 1 and 2.

The widening of the Sacramento Bypass and Weir was analyzed by expanding the width in increments from 500 feet to 3,000 feet to the north. Each width variation included adding gates (identical to the ones already in place) to the new portion of the weir and widening the bypass to the north. Widening the bypass/weir by 1,500 feet was found to be optimal; however a limited amount of levee raising along the Sacramento River downstream of the confluence is still needed.

For the purposes of this analysis the operation of the expanded Sac Weir was originally set to same condition as the rest of Sac Weir by maintaining a water surface elevation at the I-street Gage on the Sacramento River.

In an attempt to minimize additional flows into the Yolo Bypass for frequent events and in coordination with the sponsor, the new portion of the Sacramento Weir is proposed to be activated based on Folsom Releases. The new portion of Sacramento Weir will only operate when flows from Folsom into the American River exceed 115,000 cfs. This would occur for flood magnitudes between 1% (1/100-Yr) ACE event and a 0.5% (1/200-Yr) ACE.

It is assumed that further more detailed analysis would occur during Preconstruction, Engineering and Design (PED).

Table 4-1:Length of Levee Raising Per Reach (miles)							
River	Basin	Bank	Reach Length (miles)	Alt 1		Alt. 2	
				Length of Raise (mi)	Average Height (ft)	Length of Raise (mi)	Average Height (ft)
American River	ARN	Right	13.8	E	-	E	-
Arcade Creek	ARN	Right	2.1	0.5	0.5	0.5	1.0
Arcade Creek	ARN	Left	2.1	0.52	1.0	2	1.0
Dry/Robla Creek	ARN	Left	2.0	0.4	.5	0.4	0.5
Dry/Robla Creek	ARN	Right	1.5	-	-	-	-
Magpie Creek	ARN	Left	0.3	0.5	3	0.5	3
Natomas East Main Drain Canal	ARN	Left	3.6	-	-	-	-
American River	ARS	Left	11.5	E	-	E	-
Sacramento River	ARS	Left	14.9	8.1	1.0	1.0	1.0
Natomas Cross Canal	NAT	Left	5.0	R	-	R	-
Natomas East Main Drain Canal	NAT	Right	12.4	R	-	R	-
Pleasant Grove Creek Canal	NAT	Left	3.8	R	-	R	-
Sacramento River	NAT	Left	18.2	R	-	R	-
		Totals	91.2	10.0		2.9	

R - Removed per EO11988 considerations

E - American River Levees Height set to slightly different profile, raises assumed not to be necessary.

5 FLOODPLAIN HYDRAULICS AND FLOODPLAIN DELINEATION

5.1 FLO-2D Model Development

Floodplain mapping was delineated using FLO-2D, a 2-dimensional, finite-difference flood routing model that used breach hydrographs generated from HEC-RAS model runs simulating failures at the various reaches within the Natomas, the American River North and American River South areas. An existing calibrated HEC-RAS model of the Sacramento and American River system (described in Chapter 3) was used to develop the needed breach hydrographs at all seven frequencies [50% (1/2), 10% (1/10), 4% (1/25), 2% (1/50), 1% (1/100), 0.5% (1/200-Yr) and 0.2% (1/500)] at each breach location. These breach hydrographs were then used as inflows for the FLO2D model. The FLO-2D Documentation Technical Memorandum (Tetratech, December 2008) provides detailed information on model development. Much of this information was also provided as part of the F3 Hydraulic Technical Documentation. Plate 25 shows the model extents; the resulting floodplains are shown in Plates 26–30.

For Natomas in particular, the basin acts much like a bathtub. As a breach occurs, floodwaters are contained by the surrounding levees and the area fills up (Plate 7). The Natomas Basin is generally not impacted by roadways and other obstructions in modeling large flood events such as a levee breach. Rainfall and interior flooding are also considered insignificant compared to the volume that would be achieved with a levee breach, and therefore were not considered in the development of the with- and without-project floodplains used in the economic analysis.

The project area is represented with two separate FLO-2D models, one for the floodplain north of the American River and one for the floodplain south of the American River. The study area was split into two floodplains primarily because the north and south floodplains have significantly different topographic characteristics. The north floodplain consists of two basins, the Natomas Basin and North Basin, created by surrounding levees and high ground. The south floodplain slopes away from the American River to the south and west, such that breakout flows from the American River flow across and down valley until diverted or confined by the levees along the Sacramento River and other levees. The American River South model and the American River North model (consisting of the North Basin only) were originally developed for the American River Economic Evaluation Report (ERR) study. For the ARCF GRR study, the Natomas Basin has been added to the American River North model.

The following key assumptions were used in the development of the American River North (Including Natomas) and American River South floodplain FLO-2D models:

- **Grid element size: 400 feet.** The goal was to optimize the grid size to ensure reasonable run times while retaining the ability to adequately define floodplain features.

- **Study origin (top left) point: X = 6,670,800 and Y = 1,998,800.** Using a common study origin point allows for different grid systems to be based on the same grid spacing. Models can be merged and enlarged as needed.

- **Grid element elevation based on the FLO-2D Grid Developer System (GDS) interpolation routine with the high and low outlier elevations determined based on the standard deviation difference filtering scheme.** Due to the large amount of point data available from the LiDAR data, the filtering scheme ensures that any low or high outlier points do not unduly influence

the final grid elevation.

- **No streets modeled.** Streets are typically used for modeling interior drainage and are not used for riverine flood delineation, especially given the significant volume of water that would overwhelm the streets in the study area.

- **No rainfall on the floodplain modeled.** No information was available to determine the concurrent rainfall events that would occur for the flood events modeled; therefore, a clear sky was assumed at the time of the levee breakouts.

- **Soundwalls along freeways are not modeled.** Soundwalls are not built to the same structural integrity as an engineered floodwall, and it is assumed that the soundwalls would not hold more than 2 to 3 feet of water at a maximum. In most areas having soundwalls, the road embankments are 2 to 3 feet, eliminating the need to separately model the soundwalls. Only the raised roadway embankment was added a barrier for flow in the FLO2D model.

- **Infiltration was not modeled in the FLO-2D models.** This was due to a number of factors including (1) the short duration of the of the initial breakout flow hydrographs, (2) the urban nature of the primary floodplain with limited potential infiltration area, and (3) the probable saturation of the ground from the storm event and preceding storm events, creating a very low to no initial infiltration potential. While any infiltration that does occur will have a noticeable effect on the final floodplain extent and depth (as accounted for in the dewatering analysis), it would not noticeably affect the maximum extent and floodplain depths, which are the focus of this analysis.

- **Existing interior pump stations and discharge points to the American or Sacramento rivers are assumed to be inoperable.** This is partially based on lessons learned from New Orleans during Hurricane Katrina, including such causes as high stages in the respective rivers, direct and backup power failures, submerged equipment damage, etc. that occur when pump stations are overwhelmed and flooded.

5.2 Levee Breach Hydrograph Sensitivity

Levee breach conditions in the HEC-RAS model are dependent on many parameters. A sensitivity analysis was performed to determine how a breach hydrograph is impacted by selection of levee breach elevation, timing of breach, breach formation duration and breach width. Index point B on the American River South Basin (American RM 4) was used for this analysis, which is documented in the Levee Breach Sensitivity Technical Memorandum (USACE, May 2013h).

The changes in peak river stage, peak river flow and breach hydrograph volume were used to evaluate the sensitivity of the selected breach parameters at both the 4% (1/25) and 0.5% (1/200) ACE. Of the three variables, volume is seen as having the greatest impact for floodplain extents and depths. The same levee breach assumptions described in Section 3.5 were used for each levee break scenario (at each index point for each the seven frequencies.)

General trends were observed and are noted below and addition information can be found in the Levee Breach Sensitivity Technical Memorandum.

- Floodplains are not sensitive to changes in levee breach elevations, but are sensitive to the timing of the hydrograph of the flood event.

- Floodplains are not sensitive to breach formation duration, based testing done for the Sutter County Feasibility Study.

- Floodplains are sensitive to breach width during frequent flood events [4% (1/25)] but not infrequent flood events [0.5% (1/200)]. However, many Sacramento Corps feasibility studies generally use infrequent flood events (such as the 1% (1/100) ACE event) based on historical levee breach information. It is also important to have consistent breach widths (500 ft) for the full suite of frequency flood events, so the same breach width was used for frequent and infrequent flood events.

- Floodplains are sensitive to the timing of the breach, particularly when the levee breaches after the peak flow during a flood event (on the receding limb of the river hydrograph). When the breach occurs at the end of a flood event, a smaller floodplain occurs because the amount of water conveyed into the floodplain decreases. The sensitivity to the breach timing is independent of the flood frequency because much of the volume of water in the flood event has already passed by the levee breach location. Thus, even though this parameter affects the floodplain volume, assuming a breach on the receding limb of the hydrograph results in a smaller floodplain extent, and is not considered the most likely condition. Breach formation was therefore assumed to occur on the rising limb of the hydrograph to reflect the most likely flooding condition in each damage area.

The conclusion from this sensitivity analysis is that, for the purposes of the feasibility study, the assumptions used for the levee breaches are appropriate for use in the economic analysis.

5.3 With-Project Floodplains

For the with-project floodplains, the without-project condition floodplains were used with adjustments made to the frequency of the floodplains.

To approximate each with-project floodplain, the with-project breach hydrographs were compared to the corresponding without-project breach hydrographs. Peak flow and volume were the variables used to compare the two levee breach hydrographs. For each alternative and at each index point, the following comparison was made for each of the seven frequencies:

- If the change between without- and with-project breach hydrograph volumes were within 10%, then the without-project levee breach hydrograph and corresponding floodplain could be substituted for use as the with-project levee breach hydrograph and corresponding floodplain.

- If the change in volume was greater than 10%, then the without-project levee breach hydrograph and corresponding floodplain from the next largest flood event were evaluated based on the same threshold. If that comparison failed, the process was repeated with increasingly large flood events until a substitute event was found that met the threshold. For example, the 10-yr with-project levee breach hydrograph was compared to the 10-yr without-

project levee breach hydrograph at each index point and if the volume differed by greater than 10%, the 10-yr with-project levee breach hydrograph was then compared to the 25-yr without-project levee breach hydrograph. If the volume again differed by greater than 10% for that comparison, the 10-yr with-project levee breach hydrograph was then compared to the 50-yr event and so on until the threshold was met.

Table 5-1 shows the specific changes in Annual Chance Exceedance (ACE) used to adjust the floodplains from the without-project condition to with-project conditions. The shaded areas in the table represent where a without-project floodplain from a different frequency was used for the with-project floodplain for each alternative.

Table 5-1 Alternative Floodplain Key

Future Without Project / Alt. 1: Strengthen in Place								
Basin	**Index Point**	**2-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**200-yr**	**500-yr**
ARN	A	-	-	25-yr	50-yr	100-yr	200-yr	500-yr
ARN	E	-	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
ARS	A	-	-	25-yr	50-yr	100-yr	200-yr	500-yr
ARS	F	2-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
NAT	D	2-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
Alt. 2: Alt. 1 +Sacramento Bypass Widening								
Basin	**Index Point**	**2-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**200-yr**	**500-yr**
ARN	A	-	-	25-yr	50-yr	100-yr	200-yr	500-yr
ARN	E	-	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
ARS	A	-	-	25-Yr	50-Yr	100-Yr	200-Yr	500-Yr
ARS	F	2-yr	10-yr	25-Yr	50-Yr	100-Yr	100-Yr	500-Yr
NAT	D	2-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr

6 RISK ANALYSIS

Inputs were generated for risk analysis from the hydraulic modeling. The Hydrologic Engineering Center's Flood Damage Assessment modeling software (HEC-FDA) is the principal tool used by the Corps to calculate flood damage risks. The HEC-FDA model performs Monte Carlo random sampling of the discharge-frequency, stage-discharge, stage-probability of failure, and damage-stage relationships and their respective uncertainty distributions. The primary outputs of HEC-FDA are expected annual damage (EAD) and project performance statistics. Project performance statistics include the annual exceedance probability (AEP, or the expected annual probability of flooding in any given year), the long-term risk of flooding over a 10-, 25-, or 50-year period, and the conditional non-exceedance probability (CNP) for specific Annual Chance of Exceedance (ACE) events (the probability of passing specific ACE flood event).

Recent guidance has come out that provides a means for more explicitly performing a risk analysis in a system setting such as the Sacramento River (HEC, 2009). Some processes derived from this new guidance were implemented in generating inputs for the HEC-FDA analyses. The guidance was based

upon a demonstration project using the Sacramento River system and an earlier version of the HEC-RAS Common Features model. The work was done by West Consultants, Inc., for the Hydrologic Engineering Center (HEC). Some values derived from the study are therefore directly applicable to this study. A similar assessment was conducted by MBK Engineers and David Ford Consulting Engineers (MBK Engineers, 2009 and David Ford, 2009) for the Sacramento Area Flood Control Agency (SAFCA). Information derived from these reports including FDA models including uncertainty values from HEC and the updates from the follow on applications of the policy by the local sponsor (SAFCA) was considered and used in developing the inputs for the West Sacramento GRR study.

6.1 Index Points

Hydraulic results are available at each cross section in the HEC-RAS model. For economic purposes, a single point is needed to represent each reach and is often referred to as an index point. The levees surrounding Sacramento, already separated by a waterway, are further divided into reaches represented by similar geotechnical conditions, as described in the geotechnical report. Each reach was originally represented by a single index point located at the same position as the geotechnical fragility curve.

Data is generated at representative index points within each reach and are used to estimate project performance statistics under both without-project and with-project conditions. The engineering data is also used in conjunction with economic data to estimate expected damages and benefits. Both sets of results are then used together to describe the flood risk in the study area.

Twenty-five reaches were originally identified based on extensive geotechnical analyses of the levee conditions along each source of flooding within the study area. From these 25 reaches, the project delivery team (PDT) selected five of them, each containing one index point, for which to generate engineering data for use in the economic modeling and the associated without-project damage and with-project benefit analyses. They are also listed in Table 6-1.

Table 6-1. Index Points

Index Point	Basin	Index Point	Project Reach	River Mile
American River North Levee	ARN	A	American River	7.8
Arcade Creek North Levee	ARN	E	Arcade Creek	0.9
American River South Levee	ARS	A	American River	8.9
Sacramento River South	ARS	F	Sacramento River	50.3
Natomas Cross Canal South Levee	NAT	D	Natomas Cross Canal	2.7

The PDT also selected three additional index points -- two located on the right and left banks of the American River and one located on the NEMDC/PGCC (also known as the Sankey Gap) at locations where there are no levees. These index points were not part of the original 25, but were included in order to aid in a more accurate description of residual flood risk in the study area.

The representative index points used in economic analysis were selected based on preliminary estimates of the chance of flooding and consequences of flooding using flood plain extents and depths, levee fragility (geotechnical fragility curves), and estimates of ACE event damages.

In this analysis "representative index points" refers to those locations whereby the without-project condition (damages and performance) of the study area is best characterized. The PDT's intent was to balance rigor with practicality in choosing the number of index points to use in the analysis. Once the number of index points was determined for this GRR – essentially one index point to represent a major source of flooding (per bank side) plus several others to be able to check for residual damages (e.g., outflanking locations on the American River), the PDT then made a preliminary comparison of the chance of flooding and the consequences of flooding – in other words the overall flood risk associated with a levee breach at various locations – in selecting the representative index points. During the course of the study, two of the index points (ARS B and ARS E) that were originally selected were replaced by alternate index points (ARS A and ARS E).

6.2 Stage-Discharge Frequency Curves

Peak stage data for all index points was derived for the 10% (1/10) ACE through the 0.2% (1/500) ACE events in the same manner for both with- and without-project conditions. Results were taken directly from the HEC-RAS model runs. However, the 99.9% (1/1.001) ACE and the 50% (1/2) ACE stage data was derived via a different process using gage data, and is further discussed in the Risk Analysis Technical Memorandum (USACE, May 2013i). The use of flow-frequency and stage-discharge relationships in HEC-FDA is preferable; however, currently HEC-FDA requires an increasing flow value for an increasing stage value (in this case a stage-frequency relationship must be used). For index points ARN A, ARS B, and ARS E, flow-frequency and stage-discharge relationships were generated for the HEC-FDA analysis (see Plate 8 for location of index points). A stage-stage relationship similar to a stage frequency relationship was used for ARN E and NAT D due to backwater effects.

6.3 Uncertainty

6.3.1 Hydraulic Uncertainty

Following guidance in Engineer Manual EM 1110-2-1619, "Risk-Based Analysis for Flood Damage Reduction Studies," the performance and reliability of the project features were assessed with an uncertainty-based analysis. The stage uncertainty parameter in HEC-FDA is used to account for uncertainties in the calculated water surface elevations. These uncertainties can be attributed to accuracy and precision of the topographic data, hydraulic computational assumptions (roughness coefficients and bridge debris loading), sedimentation and operations (gates/pumps) and other potential factors. The total uncertainty from these attributes is a combination of the following factors from EM 1110-2-1619: natural variations, model uncertainty, sedimentation, and operations factors. Table 6-2 has the total stage uncertainty for each index point for the suite of frequencies. See the Risk Analysis Technical Memorandum (USACE, May 2013i).

Table 6-2: Total Stage Uncertainty (One Standard Deviation), Feet						
River		American	Arcade	American	Sacramento	Natomas Cross Canal
Index Point		A	E	A	F	D
RS		7.83	0.95	8.90	50.25	2.71
Basin		ARN	ARN	ARS	ARS	NAT
Percent Annual Chance Exceedance	50%	0.97	0.85	1.00	0.75	0.85
	10%	1.23	0.90	1.29	0.77	0.92
	4%	1.38	0.93	1.45	0.76	1.03
	2%	1.38	0.95	1.45	0.76	1.04
	1%	1.36	0.93	1.43	0.76	0.98
	0.50%	1.53	0.86	1.59	0.75	0.84
	0.20%	0.76	0.75	0.75	0.78	0.75

6.3.2 Hydrologic Uncertainty

For index points along the Sacramento River (ARS E), Natomas Cross Canal (NAT D) and Arcade Creek (ARN E), the flow frequency analysis is based on a graphical method. The period of record (equivalent years of record) for index points NAT D and ARN E is 71 years and period of record for index point ARS E is 73 years. The period of record was chosen based upon the HEC report for the systems risk and uncertainty analysis (HEC, 2009). Results from locations closest to index points were used. Values for Arcade Creek were taken from the SAFCA 408 Request (MBK, June 2009), which is based on EM 1110-2-1619.

The index points along the American River (ARN A & ARS B) are based on analytical flow frequency analysis. The input statistics for FDA analysis are shown in Table 6-2.

Table 6-3: American River at Fair Oaks (1905-2004)
Adopted Unregulated Inflow Statistics

Log Mean	4.581
Log Std Dev	0.43
Log Skew	-0.077
Equivalent Record Length (yrs)	100

6.3.3 Inflow-Outflow Uncertainty

The purpose of the inflow-outflow curves is to translate unregulated flow-frequency curves and uncertainty to the regulated condition. It also provides an additional means of accounting for hydrologic uncertainty within the system, recognizing that flow entered into the upstream ends of the system attenuates. How much it attenuates depends in large part upon the capacity of the river or levee system. Inflows correspond to the analytical and graphical inflow frequency curves in FDA (Reference f). The outflows were taken from standard HEC-RAS output tables at each index point. Inflow-outflow

curves were generated for both with-project and without-project conditions assuming no upstream levee failures. Uncertainty for the inflow-outflow curve was based on work done in the Natomas Post Authorization Change Hydraulics and Hydrology Appendices.

6.4 Flood Damage Modeling

In addition to the no-levee-failure model runs, flood damage assessment was done by simulating the flow of water from a levee failure into each basin. Levee failures were simulated for each reach using seven frequencies (50% (1/2), 10% (1/10), 4% (1/25), 2% (1/50), 1% (1/100), 0.5%(1/200), 0.2%(1/500) ACE) to generate a stage-damage relationship for each reach for the economic analysis. As described in Section 5.2, levee failure runs were made only using the without-project condition. Plates 65 through 69 contain the water surface elevations at the project index points for the full suite of frequencies and the following conditions and alternatives:

- Future without-project condition
- Alternative 1: Strengthen in place
- Alternative 2: Strengthen in place with Sacramento Bypass widening

A summary of the key results are described below:

- For all index points, there are no significant changes in stage or flow between the future without-project condition and the Strengthen Levees in Place Alternative 1.
- As expected, there are reductions in stage and flow on the Sacramento River Reach below the confluence with the American River (at ARS E) when Alternative 2 is compared to the future without-project condition.
- The results for Natomas Index Point D, located on the Natomas Cross Canal, are similar for all conditions.

6.4.1 Upstream Levee Performance

As part of the CF GRR F3 analysis, upstream levee performance was considered in a sensitivity analysis (USACE, 2009e). A single index point at Verona (just downstream of the Natomas Cross Canal and Sacramento River confluence) was tested using historical data. The analysis showed that there was no significant influence on the stage and resulting expected annual damages from upstream levee performance. Based on this information, a decision was made to proceed with analyses assuming no upstream levee failures. All work under the American River Common Features GRR assumes no upstream levee failures.

6.5 Performance Evaluation

Future without-project annual exceedance probability (AEP) was computed on a reach/index point-specific basis using the HEC-FDA model. The HEC-FDA model integrates the hydrologic, hydraulic, geotechnical and economic relationships with uncertainty to create exceedance probability-damage functions with uncertainty.

The annual exceedance probability (AEP) represents the percent chance of a target stage being exceeded in any given year, thereby causing flooding and subsequent significant property damage. The

annual exceedance probability results for each damage area are computed by HEC-FDA based on specific engineering data: frequency-stage curve, equivalent record length, and top-of-bank stage.

The AEP results were used to establish the future without-project expected annual damages (EAD) to determine economic benefits and evaluate performance of the alternatives. Table 6-4 shows the results of the levee performance evaluation for each index point in the project area. The 0.5% assurance values are a linear interpolation of HECFDA results between the 1% and 0.4% Assurance values. The future without project condition is included in Table 6-4 because it is the basis of comparison for the alternatives; this is discussed in greater detail in Section 2.2. More information about the economic benefits and expected annual damages can be found in the economic appendix.

Table 6-4: Performance at each Index Point

	Basin	ARN	ARN	ARS	ARS	NAT
	Index Point	A	E	A	F	D
	River	American	Arcade	American	Sacramento	NCC
	River Station	7.8	0.9	8.9	50.3	2.7
FWOP	Annual Exceedance Probability (AEP)	0.010	0.017	0.011	0.031	0.009
	1/AEP	96	61	93	32	108
	1% Assurance	75%	54%	76%	69%	84%
	0.5% Assurance	47%	29%	45%	55%	58%
	0.2% Assurance	22%	7%	18%	24%	37%
Alt. 1	Annual Exceedance Probability (AEP)	0.006	0.005	0.005	0.007	0.006
	1/AEP	182	200	185	135	159
	1% Assurance	90%	94%	91%	95%	84%
	0.5% Assurance	59%	69%	64%	93%	56%
	0.2% Assurance	24%	23%	31%	89%	27%
Alt. 2	Annual Exceedance Probability (AEP)	0.006	0.004	0.005	0.007	0.006
	1/AEP	172	256	192	147	164
	1% Assurance	89%	95%	91%	95%	85%
	0.5% Assurance	57%	80%	60%	94%	57%
	0.2% Assurance	22%	28%	32%	81%	28%

6.6 Considerations and Assumptions

The results of the risk analysis are affected by technical considerations and assumptions regarding the inputs to HEC-FDA. For example, geotechnical studies developed relationships that characterize the reliability of the levees. Perhaps the most significant assumption is the levee failure methodology, which can significantly influence simulated breach hydrographs. These assumptions are described in Section 3.5 and were also evaluated in a sensitivity analysis in the Levee Breach Sensitivity Technical Memorandum (USACE May 2013h). The methodology chosen provides a conservative and consistent simulation of the potential flooding extent for system-wide hydraulic and economic evaluations. It does not necessarily represent conditions during an actual flood event, when flood fighting and other emergency actions are likely to take place.

6.7 FEMA Certification/Accreditation

The Engineering Circular 1110-2-6067 serves as guidance for USACE to provide the necessary Risk and Uncertainty (R&U) rationale to certify/accredit levees for FEMA. FEMA certification was not determined at this time. The local sponsor has an interest in having the strengthened levees meet the minimum requirements needed for FEMA accreditation. By traditional FEMA methodology (Title 44 CFR Section 65.10), it is likely that the local sponsor could achieve FEMA Certification in all three basins using this proposed project, recent projects (Natomas PAC) and the locals' ongoing efforts under the Natomas Levee Improvement Program (NLIP). If the sponsor conducted the certification, they would have to meet the requirements of Title 44 CFR Section 65.10. If USACE performed the certification, they would have to meet additional requirements described in EC 1110-2-6067. At a minimum during design, the locally preferred plan will have a top of levee profile that would be set to meet the minimum height requirements as defined in Title 44 CFR Section 65.10

The Engineering Circular 1110-2-6067 serves as guidance for USACE to provide the necessary Risk and Uncertainty (R&U) rationale to certify/accredit levees for FEMA. FEMA certification was not determined at this time. The local sponsor has an interest in having the strengthened levees meet the minimum requirements needed for FEMA accreditation. By traditional FEMA methodology (Title 44 CFR Section 65.10), it is likely that the local sponsor could achieve FEMA Certification in all three basins using this proposed project, recent projects (Natomas PAC) and the locals' ongoing efforts under the Natomas Levee Improvement Program (NLIP). If determined to be needed, this additional analysis will most likely be conducted during refinement of the selected alternatives (including a possible locally preferred plan) or during the design phase. If the sponsor conducted the certification, they would have to meet the requirements of Title 44 CFR Section 65.10. If USACE performed the certification, they would have to meet additional requirements described in EC 1110-2-6067. At a minimum this would be likely be completed by ensuring that there is 3 three feet of freeboard above the 1% (1/100) ACE for all the levees in the project area.

6.8 Urban Levee Design Criteria (ULDC)

Urban Levee Design Criteria (ULDC) is a state standard established by the CA Dept of Water Resources where from a hydraulic perspective; urban levees are required to have at least 3' feet of free board above the mean 200-Yr event or a combination of freeboard (2-3) and assurance (90%-95%) to contain the mean 200-Yr event.

The State has established a standard for urban flood protection in California which applies to cities with populations greater than 10,000 inhabitants. This standard requires levees to withstand flows with a top elevation equal to the mean 200-year water surface profile, plus three feet of freeboard, plus an allowance for wave run-up, plus one foot to account for climate change. USACE does not identify a target level of risk reduction but rather identifies the plan which reasonably maximizes net benefits. The analysis to identify the plan which maximizes net benefits was done with an awareness of the State's goal for urban flood protection for the purpose of informing the State of where the individual plans fall with regards to the State's standards. Neither of the final alternatives is currently able to contain a 1/200 ACE event with 90% assurance. The levee improvements along the Sacramento River will increase the assurance to a level close to 90% but the assurance for the levees along the American River will remain lower than the ULOP criteria for the 1/200 ACE. However, the locally preferred plan will meet the minimum height requirements as described in the ULDC. It will be contingent upon the local community to prove to the State that the aggregate flood risk management projects meet the State's standard.

6.9 Systems Risk and Uncertainty

Each of the final alternatives included setting the top of levee profile at the 0.5% (1/200) ACE plus 3 feet (except for Sankey Gap), and a systems risk analysis was conducted to determine if there are hydraulic impacts from this levee raising. A process for evaluating system-wide hydraulic impacts of proposed modifications to the levees of the Sacramento River Flood Control Project (SRFCP) has been developed by the Hydrologic Engineering Center (HEC) and further information can be found in their "Documentation and Demonstration of a Process for Risk Analysis of Proposed Modifications to the SRFCP Levees" report. The process utilized risk analysis methods that followed USACE policy as outlined in ER 1105-2-101. The Systems Risk Technical Memorandum (USACE, May 2013l) further details the application of this ER and HEC guidance to this study. The system wide risk analysis method defined by HEC was considered applicable to the ARCF GRR study.

A key assumption of the system-wide risk analysis is that risk of a levee failure is associated with overtopping only. Levee fragility curves are not used in this analysis and levees are assumed to convey water to the top of levee throughout the system. This assumption is based on USACE Letter on Guidance on System Risk for modifications to Corps of Engineer Projects (USACE, July 2008).

The purpose of this evaluation was to determine if potential system-wide impacts can be identified based on the increase in annual exceedance probability (AEP) or a decrease in conditional non-exceedance probability (CNP, also referred to as 'assurance') within the FDA model. Using the model HEC created for the Sacramento River Flood Control Project (SRFCP) levees, new plans were created for each of the four scenarios. The following four scenarios were analyzed:

- Future without-project baseline condition
- Alternative 1: Strengthen in place
- Alternative 2: Strengthen in place with Sacramento Bypass widening

Potential impacts are identified when an increase in the AEP and a reduction in CNP occur at locations throughout the system when compared to the hydraulic baseline condition. The median AEP is computed directly from the inflow discharge-exceedance probability, the inflow-outflow and stage-discharge relationships that are defined at each index location. The expected AEP incorporates

uncertainty in these relationships. Typically, an increase in water surface elevation without a change in the levee height will result in an increase in AEP and a reduction in CNP, which indicates an increase in the level of risk.

The following changes in AEP and CNP were identified based on comparison of the two alternatives and the two baseline conditions:

- There was no significant change in median overtopping AEP
- There was no significant change in expected overtopping AEP (rounded at three significant figures)
- There are small changes in the overtopping CNP/assurance, mostly in the thousandths place.

6.10 Potential Hydraulic Impacts to the Yolo Bypass

The proposed project features main purpose is to reduce flood risk in the project area. Hydraulic Impacts outside of the project area as result of these features being implemented have to be disclosed and possibly accounted or mitigated for in this study. With the widening of the Sacramento Bypass, there was added attention to how this widening would impact the Yolo Bypass.

From the executive summary HEC's PR-71 document:
"The potential impacts defined from deterministic analysis results are changes in water surface elevation and freeboard that are defined in units of length such as feet. Due to the common use of length units in everyday affairs, the significance of differences expressed in units of length are generally well understood. In contrast, the potential impacts defined from risk analysis results are changes in probabilities. In general, the significance of differences in probabilities, particularly small differences in probabilities, are difficult to conceptualize. Consequently, a need exists for development of guidance or criteria to define the significance of risk analysis results."

For purposes of this analysis, the definition of a potential hydraulic impact was defined as a change in water surface elevation. With the advent of risk and uncertainty, guidance is lacking on what constitutes a significant impact though changes in stage on the order of 0.1 feet to 1.0 feet are often used as a threshold.

The hydraulic baseline is the future without-project condition where most of systems exist as it is today and includes the recent and in-construction Folsom improvements (including the JFP) in place.

For with-project conditions, the peak releases from Folsom Dam for the 1% (1/100) ACE and 0.5% (1/200) ACE events are 115,000 cfs and 160,000 cfs. This amount of flow continues on down the American River to the Sacramento River. Flow conditions splits for the 10% (1/10) ACE, 1% (1/100) ACE, and 0.5% (1/200) ACE events are depicted on the Sacramento-American River Confluence Plates 70-72.

With the widening of the Sacramento Weir and Bypass and for when flows exceed 115,000 cfs on the American River, some of the American River flow that would have gone downstream on the Sacramento River is instead drawn upstream to the widened Sacramento weir.
To determine if there are potential hydraulic impacts in the Yolo Bypass, stages the future without-project condition were compared with the stages from Alternatives 1 and 2. The additional water that

would flow through the weir and into the Sacramento Bypass could raise water surface elevations in the Yolo Bypass up to 0.11 feet for the 0.5% (1/200) ACE and 0.8 feet for 0.2% (1/500) ACE event. This increase is considered less than significant because it would not change land uses, require additional levee remediation, and is not expected to significantly increase flood risk. For a 0.2% (1/500) ACE event, many areas are subject to inundation from overtopping or other levee failure mode. Tables 6-6 and 6-7 contain water surface elevations at Yolo Bypass stream gages upstream and downstream of the Sacramento Bypass. It is assumed that further more detailed analysis would occur during Preconstruction, Engineering and Design (PED) to further reduce any increase in water surface elevation.

Given the geographic connection of the current ARCF project and several ongoing American River projects (JFP Spillway, Natomas PAC, WRDA 96/99 Sites), there was a rationale to evaluate the individual projects together as a single project to evaluate hydraulic effects or impacts. Many of the projects are tied to the larger single American River Watershed Investigation study that occurred in the early 1990s. After significant discussion, this idea of separating the hydraulic baseline from the economic baseline was abandoned.

Table 6-5. Water Surface Elevation Summary for the Yolo Bypass at the Woodland Gage (RM 50.9).

Water Surface Elevation Summary				
Yolo Bypass at the Woodland Gage(RM 50.9)				
Frequency	FWOP	Alt. 1 Strengthen in Place	Alt. 2 Sac Bypass	FWOP - Alt. 2
	NAVD88	NAVD88	NAVD88	NAVD88
2-Yr	26.6	26.6	26.6	0.00
10-Yr	30.2	30.2	30.2	0.00
25-Yr	32.9	32.9	32.9	0.00
50-Yr	33.7	33.7	33.7	0.00
100-Yr	34.7	34.7	34.7	0.00
200-Yr	36.6	36.6	36.7	0.05
500-Yr	37.3	37.3	38.0	0.77

Table 6-6. Water Surface Elevation Summary for the Yolo Bypass at the Lisbon Gage (RM 35.7).

Water Surface Elevation Summary				
Yolo Bypass at the Lisbon Gage (RM 35.7)				
Frequency	FWOP	Alt. 1 Strengthen in Place	Alt. 2 Sac Bypass	FWOP - Alt. 2
	NAVD88	NAVD88	NAVD88	NAVD88
2-Yr	19.7	19.7	19.7	0.00
10-Yr	24.5	24.5	24.5	0.00
25-Yr	27.0	27.0	27.0	0.00
50-Yr	27.7	27.7	27.7	0.00
100-Yr	28.6	28.6	28.6	0.00
200-Yr	29.6	29.6	29.7	0.11
500-Yr	30.7	30.7	30.7	-0.02

7 RESIDUAL RISK

Several methods and types of analysis are used to describe the hydraulic impacts and residual risk of the proposed alternatives. They are described below.

7.1 Residual Risk

Residual risk is the risk of being inundated after the selected alternative has been implemented which can include residual risk associated with the project features, residual risk from physical conditions not related to project features, and residual risk from an event exceeding the design of the system. Residual flood risk after completion of the selected plan would vary throughout the study area. The levees in the project area have not been designed for overtopping with the exception of the Sankey Gap in Natomas.

The residual risk associated with project features is captured by the with-project fragility curves and floodplains, and is covered in Chapters 4 through 6 of this report. The residual risk floodplains were developed using HEC-RAS and FLO-2D, and provided to the Economics Section to be included as part of the overall net benefit calculation. Additional information on Risk can also be found on the Economic Appendix.

The residual risk from both project features and physical conditions not related to project features are reflected in the residual floodplains for each of the three basins (Plates 62-64). The residual risk for each basin is described below.

The three primary sources of residual flood risk for the Natomas Basin would be:

-Overtopping Flows from the Sankey Gap.

-Infrequent large flood events [greater than 0.5% (1/200) ACE] that overtop the project levees.
-Unforcasted geotechnical failure of the project levees [mostly for events greater 1% (1/100) ACE]

In the Natomas basin, the Sankey Gap is located in the northeastern corner of the basin between the Pleasant Grove Creek Canal and the Natomas East Main Drain Canal (see Plate 7). The Sankey Gap is a hardened overtopping weir built to handle flow from ponded water that flows into the basin. During a flood event on the Sacramento River, water will pond on the northeastern exterior edge of the Natomas Basin and then back up small creeks along the Pleasant Grove Creek Canal and eventually flow through this hardened weir. The height of the ponded water at the Sankey Gap is tied directly to stages in the Sacramento River, and flow through the Sankey Gap was observed in the 1986 and 1997 flood events. Plate 62 show the 0.2% (1/500) ACE residual floodplain based on overtopping from the Sankey Gap. There are no plans to change the operation of this feature to reduce the residual risk.

An overtopping flood event would likely be preceded by flood warning and river guidance issued by the National Weather Service (NWS) and California Nevada River Forecast Center (CNRFC) five days in advance. A more accurate warning would likely be made 24 to 36 hours in advance. Overtopping Risk could come from any of the levees along the Sacramento River, American River, Natomas East Main Drain Canal (NEMDC), Natomas Cross Canal (NCC), and Please Grove Creek Canal. The likely first overtopping locations would be along the Sankey Gap and parts of the NEMDC where the volume of water is significantly less than in the American or Sacramento Rivers.

The Natomas Basin Levees does have some superiority built into them by way of the Fremont Weir and the Sutter-Yolo Bypass. Much of the water(approx. 75%) coming down the Sacramento River Flood Control Project goes over the Fremont Weir just upstream of the Natomas Basin. Given that the Sacramento River and Natomas Cross Canal were both strengthened (as part of Natomas PACR and SAFCA Natomas 408) raised (SAFCA's 408), it is very likely the other parts of the system would begin to overtop before these levees. The American River water is limited by both flows out of Folsom and channel capacity as described more in the next section on the other two basins in the project (ARN and ARS). However, any failure of the levee system surrounding Natomas will continue to have consequences given the large population and deep floodplains with depths greater than 20 feet for breaks along the Sacramento River, American River and the lower portions of the NEMDC. The extents of the floodplains for the unforcasted geotechnical failure would be similar to the without project floodplains found on Plates 30.

The two primary sources of residual flood risk for the American River North and American River South Basins would be:

-Infrequent large flood events [greater than 0.5% (1/200) ACE] that overtop and outflank the channel upstream from the leveed system.
-Unforcasted geotechnical failure of the project levees [mostly for events greater 1% (1/100) ACE] mostly driven by a risk of erosion failure due to high velocities in the American River.

An overtopping flood event would likely be preceded by flood warning and river guidance issued by the National Weather Service (NWS) and California Nevada River Forecast Center (CNRFC) five days in advance. A more accurate warning would likely be made 24 to 36 hours in advance. Plates 63–64 only contain the 0.2% (1/500) ACE residual floodplains for the two basins as it is assumed that the channel will be able to hold up to a 0.5% (1/200) ACE coming out of Folsom after completion of the Joint Federal Project Auxiliary Spillway and levee improvements along the American River. This assumption is based

on the auxiliary spillway's ability to control flows out of Folsom up to the 0.5% (1/200) ACE. The extents of the floodplains for the unforcasted geotechnical failure would be similar to the without project floodplains found on Plates 26 and 28.

The American River Levees have superiority built in by this channel outflanking as there is a maximum amount of water that continues down the channel with the excess flow leaving the system in a somewhat calmer manner than a levee break.

In the American River South Basin, the Sacramento River has strengthened levees and superiority is built in by the use of the Sacramento Weir and Bypass that divert high flows away from the Sacramento and out into the Yolo Bypass. The use of weirs to help with superiority follows ETL 110-2-299. Alternative 2 enhances this feature by widening the Sacramento Weir and Bypass allowing more water to be diverted away from Sacramento.

According to ETL 1110-2-299, "Overtopping of Flood Control Levees and Floodwalls," two design types can be used to control initial overtopping. The first is the use of different levee heights relative to the design water surface from reach to reach to force overtopping in a desired location. The second design uses notches, openings, or weirs in the structure. The inverts for these features are at or above a design water surface elevation but below the neighboring top of levee. Examples are railroad or road crossings of levees and rock weirs.

For the areas described above, the residual risk associated with project features, and physical conditions not related to project features is assumed to be the same for the final array of alternatives. The levee improvements and possible Sacramento Bypass widening do not significantly change the hydraulic conditions on the American River upstream of the leveed section or the northern part of the Natomas basin.

7.2 Climate Change – Hydrology

A sensitivity analysis was conducted to assess the impact of climate change for the American River Common Features GRR. Studies have shown that increasing temperatures associated with climate change are causing a shift in the runoff patterns of Pacific slope watersheds with a large snowmelt component. The runoff shifts for those watersheds include increased runoff in winter, less snowmelt in summer, and earlier runoff in the spring (USACE, 2011b).

The methodology for the climate change sensitivity analysis of runoff peaks and volumes was developed by the Sutter Basin Pilot Study, and this method was applied to the American River Common Features Study. The Sutter team made further refinements to this method, but because the refinements yielded results similar to the first attempt, the ARCF PDT continued to use the results of the first method. The approach is summarized below, and more details on the application of this method can be found in the Climate Change Technical Memorandum (USACE, May 2013b).

The present-condition hydrology in the study was assumed to be representative of 2009 conditions. For future-condition hydrology scenarios, results from a University of California, San Diego study on Sierra Nevada runoff (UCSD, 2011) were interpolated and extrapolated to determine the percent difference of the 4% (1/25), 1%(1/100), 0.5%(1/200), 0.2%(1/500) ACE events. The return period was plotted as a function of the percent difference, and a logarithmic curve was fit to the graph. The resultant estimated

climate change differences from the study presented in Table 7-1 were used to translate the frequency of the water flowing into the various reservoirs in the Sacramento River system.

Table 7-1. Climate Change Differences for Northern Sierra Nevada, WY 2049

% Difference in 3-day Unregulated Flow			
Frequency	CNRM CM3	GFDL CM2.1	NCAR PCM1
1/2	12	22	6
1/5	16	23	-4
1/10	21	27	-10
1/20	27	32	-14
1/50	35	40	-19
1/100	35	40	-19
1/200	35	40	-19
1/500	35	40	-19

Global Climate Change Models:

CNRM CM3: French National Centre de Recherches Meteorlogiques Climate Models.

GFDL: Geophysical Fluids Dynamics Laboratory model version 2.1

NCAR PCM 1: National Center for Atmospheric Research Parallel Climate Model

A sensitivity analysis was conducted at two locations in the study to evaluate the effect of climate change on regulated flows: at the American River Fair Oaks gage and at the Sacramento River Verona gage. The analysis was performed by applying the changes shown in Table 7-1 to the unregulated flow-frequency curves at the two locations. Reservoir operations were assumed to remain the same for future conditions, and therefore inflow-outflow relationships would not change. The translation of regulated flows was made graphically with more information on this process found in the Climate Change Technical Memorandum (USACE, May2013b). Tables 7-2 and 7-3 show the future regulated flows and anticipated annual chance of exceedance (ACE) for both index locations.

Table 7-2. Change in Frequency of Flows with Climate Change at American River Fair Oaks

Climate Model		CNRM CM3	GFDL CM2.1	NCAR
Present Regulated Frequency and Flow		Future Regulated Frequency: WY 2049	Future Regulated Frequency: WY 2049	Future Regulated Frequency: WY 2049
ACE	Flow (cfs)	ACE	ACE	ACE
½	26,000	1/2	1/2	1/2
1/10	72,000	1/7	1/7	1/13
1/25	115,000	1/17	1/14	1/39
1/50	115,000	1/25	1/25	1/83
1/100	115,000	1/48	1/40	1/167
1/200	160,000	1/83	1/71	1/385
1/500	224,000	1/200	1/167	1/1000

Table 7-3. Change in Frequency of Flows with Climate Change at Sacramento River Verona

Climate Model:		CNRM CM3	GFDL CM2.1	NCAR
Present Regulated Frequency and Flow		Future Regulated Frequency: WY 2049	Future Regulated Frequency: WY 2049	Future Regulated Frequency: WY 2049
ACE	Flow (cfs)	ACE	ACE	ACE
½	70,000	1/2	1/2	1/2
1/10	93,000	1/6	1/6	1/14
1/25	110,000	1/13	1/13	1/50
1/50	113,000	1/20	1/20	1/111
1/100	120,000	1/33	1/33	1/250
1/200	130,000	1/56	1/56	1/500
1/500	155,000	1/125	1/111	---

Climate change may also have an effect upon the levees, where a levee raise might be needed to maintain a desired levee performance. While the project will be constructed to maintain a design flow rate, this sensitivity analysis estimates a new frequency for overtopping. The levee crest elevation for future conditions was set at a 0.5% (1/200) ACE event stage plus 3 feet. This new top of levee was compared with present levee crest heights. For the American River Fair Oaks, it appears that there is no overtopping concern needed in response to climate change. However, for the Sacramento River Verona gage, it appears that the left levee crest would have a potential overtopping concern and would need to be raised an average of 3 feet and the right levee crest will need to be raised by 3.5 feet to provide the same performance in response to climate change. The current alternatives have an average levee height raise of 1-2 feet, so to maintain the same performance this average height raise would need to be doubled to account for the estimated effects of climate change along the Sacramento River reach.

The analysis described above should be considered a sensitivity analysis, not a rigorous analysis of climate change using snowmelt hydrology models, reservoir operations models, and river routing models. The State of California is developing a state-wide approach to climate change with a system-wide historical

record for unregulated conditions (no reservoirs) along with one regulated condition (with reservoirs). Some of the preliminary data from that state-wide approach was used in this analysis, but the final results are not currently available for use in the ARCF GRR study.

7.3 Sea Level Rise

A second aspect of climate change is sea level rise. Rising sea levels have been observed at locations around the world, and the rate is expected to continue at the current level or increase in the future (IPCC, 2007). Increases in sea level can have a variety of impacts on coastal areas, including flooding, changing ecosystems, and declining water quality. Local subsidence can also cause a greater apparent sea level rise. To analyze potential effects on the Sacramento River system from these changes, several sea level rise scenarios were developed for 50 and 100 years. A subsidence rate was also applied to the low and high 100-year sea level rise scenarios.

Three sea level rise scenarios were developed based on the information contained in EC 1165-2-211, Water Resources Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs (USACE, 2009). Following the method described in EC 1165-2-212, values for low, intermediate, and high sea level rise rates were developed for 50 and 100 years. The information describing the application of EC 1165-2-211 came from an existing report developed for USACE for work on the Sacramento-San Joaquin Delta (Dynamic Solutions, 2011) and a summary of that information is provided below.

7.3.1 Low Sea Level Rise-

Following guidance outlined in EC 1165-2-211, the low sea level rise scenario was developed using historically measured data at the San Francisco tide gage. EC 1165-2-211 suggests using a tide gage with a minimum of 40 year period of record. The San Francisco tide gage period of record begins in 1897, which is more than sufficient to see long term patterns. Figure 7-1 shows the sea level trend at San Francisco with the seasonal cycle removed.

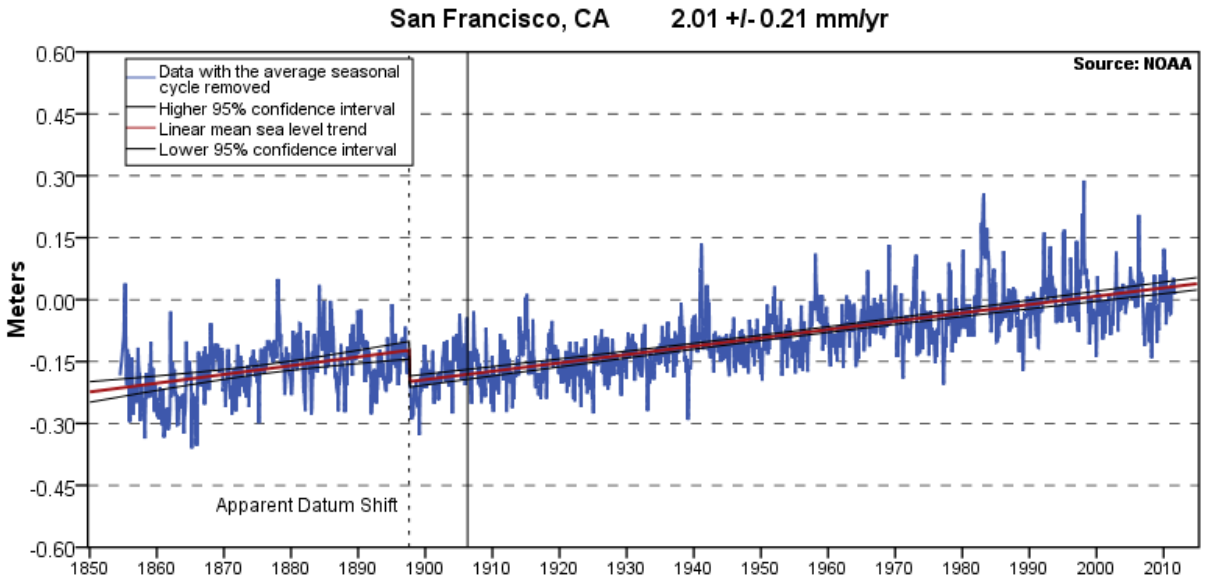

Figure 7-1. Sea Level Trend at San Francisco (NOAA, 2009)

The red line shows the mean sea level trend of 0.08 in/yr (2.01 mm/yr), and the black lines are the 95 percent confidence intervals. The solid vertical line is the 1906 earthquake, while the dashed vertical line is an apparent datum shift. Based on the historical data observed at San Francisco and following the guidance in EC-1165-2-211 of using the historical trend, a sea level rise of 0.08 in/yr (2.01 mm/yr) was chosen for the low case. This sea level rise value resulted in a 50-year increase of 0.33 ft (0.10 m) and a 100-year increase of 0.66 ft (0.20 m) at this location.

7.3.2 Intermediate Sea Level Rise

The intermediate sea level rise case was calculated using the modified NRC Curve I, as described in EC 1165-2-211. The equation used was

$$E(t_2) - E(t_1) = 0.07(t_2 - t_1) + b({t_2}^2 - {t_1}^2)$$

where t_2 is the time between the projected time and 1986, t_1 is the time between current time and 1986, and b is a constant value of 7.74E-5 (2.36E-5 for metric) for the medium sea level rise. To estimate the sea level rise in 2061, 50 years from 2011, values of 75 and 25 were used for t_2 and t_1, respectively. For the 100 year scenario, values of 125 and 25 were used for t_2 and t_1, respectively.

Using the above equation, sea level rise values of 0.66 ft (0.20 m) and 1.71 ft (0.52 m) was calculated for the 50 and 100 year scenarios, respectively.

7.3.3 High Sea Level Rise

The high sea level rise case was calculated using the modified NRC Curve III as described in EC 1165-2-211. The equation is the same as given above, with a b of 3.30E-4 (1.005E-4 for metric). Again, for the 50 year scenario, 75 and 25 were used for t_2 and t_1, respectively, and for the 100 year scenario, 125 and 25 were used for t_2 and t_1, respectively.

Using the above values, a sea level rise of 1.94 ft (0.59) m was calculated for 50 years, and 5.51 ft (1.7 m) for 100 years.

7.3.4 Summary of Sea Level Rise Values

The sea level rise values calculated above were checked against other sources to determine their validity. Table 7-4 presents a summary of the calculated sea level rise values, and Table 7-5 presents a sample of the range of sea level rise values described in the literature.

Table 7-4. Summary of Calculated Sea Level Rise Values at San Francisco Gage 94114290

Sea Level Rise Scenario	50-Year Rise (ft)	100-Year Rise (ft)
Low	0.33	0.66
Intermediate	0.66	1.71
High	1.94	5.51

Table 7-5. Sea Level Rise Values Seen in Literature

Source	100-Year Sea Level Rise Range (ft)
California Climate Change Center – Projecting Future Sea Level Rise (CCCC, 2006)	0.43–2.92
International Panel on Climate Change – Synthesis Report (IPCC, 2007)	0.59–1.94
Delta Risk Management Strategy (DRMS) – Climate Change (DRMS, 2008)	0.66–4.59

As shown in the above tables, the 100-year range calculated from EC 1165-2-211 of 0.66 – 5.51 ft (0.2–1.7 m) compares well with the ranges presented in the literature.

The low sea level rise rate was verified with observed data at the San Francisco station. For 2001, the arithmetic mean of the hourly water surface elevations was 9.02 ft (2.75 m) NAVD88. After applying the 0.08 in/yr (2.01 mm/yr) sea level rise, an average of 9.02 ft (2.77 m) was predicted. This matched well with the observed average in 2010 of 9.09 ft (2.78 m).

7.3.5 Sensitivity of Hydraulic Model Results

The estimates in sea level rise described previously were used in a sensitivity analysis to evaluate the impacts of sea level rise on the water surface profiles in the American River Common Features project area. More information can be found in the Downstream Boundary Sensitivity Analysis Memorandum for File (USACE, January 2010b). The analysis focused on the downstream boundary conditions. The sensitivity of the downstream boundaries for the American River Common Features project was tested by varying downstream stage hydrographs at three locations to reflect increases in stage due to sea level rise. Water surface profiles from the original model and the sensitivity runs (with shifted downstream boundary stage hydrographs) were compared along the American River reach and Sacramento River reach.

The effects of shifting the downstream hydrograph to account for changes in stage due to sea level rise resulted in no changes on the Sacramento at Verona and minimal changes on the Sacramento at Freeport. The largest difference in stage was two-tenths of a foot for the10% (1/10) ACE event on the Sacramento River at Verona, and the average difference in stage was one-hundredth of a foot or less for the 1% (1/100) ACE event along the Sacramento River. There were also minimal variations in surface water elevations in the Yolo Bypass, indicating no significant change in the routing of the flood event through the combined waterways of the Sacramento River and the Yolo Bypass. These minimal changes in water surface elevations within the project area indicate that the project water surface profiles are dominated by riverine conditions and are not sensitive to reasonably estimated future sea level rise conditions.

7.4 Interior Drainage

An analysis was done to examine the interior drainage of the smaller, non-leveed streams in the three project basins (USACE November 2012). Measures to reduce the risk for flooding from these small streams are not being considered for alternatives, but the risk of flooding is being accounted for in the economic analysis. The results (flood depths and water surface elevations for the 10% (1/10), 4% (1/25), 1% (1/100), and 0.2% (1/500) ACE events will be used to estimate residual damages in the floodplain

when doing the larger-scale risk estimation for the ARCF study. Plate 58 shows the project area for the interior drainage study.

Existing FEMA Digital Flood Insurance Rate Maps (DFIRMs) and associated flood insurance studies (FIS) were used to represent the interior flooding within the three basins. This analysis is general and approximate in nature and the level of detail is deemed appropriate in light of applying SMART Planning to this study. More information on the interior drainage analysis and process performed can be found in Interior Drainage Technical Memorandum (USACE November 2012).

Flood depths were determined for each recurrence interval by rasterizing the topographic data, the DFIRM shape files (30-foot grid cells), and the FIS data points in GIS and determining the difference between the two. The floodplains were created by interpolating the resultant rasterized flood depths. Plates 59-61 show the floodplains for the three areas.

The results indicate that the Interior drainage floodplains are significantly smaller than a floodplain from a levee break. The modifications to existing interior drainage facilities have been limited to bringing the facilities in compliance with Corps criteria for penetrations through levees (upgrading discharge lines, pumps, etc. to raise the drainage over the top of levee). An assessment of the capacity of existing facilities to address the residual flooding from interior runoff will be accomplished during the design phase or by the local maintaining agencies as part of their FEMA certification requirements.

7.5 Life Safety

Life safety information was taken from the USACE Levee Screening Tool (LST) for use in this study. The Levee Screening Tool supports the levee screening process by facilitating a preliminary assessment of the general condition and associated risks of levees in support of the USACE Levee Safety Program. (RMC, 2011)

The LST determines a screening risk index that considers routine inspection results and ratings coupled with a review and evaluation of historical performance data, as-built drawings, economic and life loss consequences, historic and current hydraulic and hydrology data, and other data. This helps determine the potential for failure and the consequences of failure. The culmination of the LST process is a screening risk index and risk classification that can be weighed against other screened levee segments in the portfolio.

Life safety can be evaluated using the consequence portion of the Levee Screening Tool (LST). Readily available data and information are used along with limited analysis to assess the potential consequences related to two different flooding scenarios: overtopping of a levee segment (with or without breach) and breach prior to overtopping of a levee segment. Consequence estimates focus on loss of life, but also include population at risk, number of structures, and direct monetary damage estimates to structures. The following is a description of the consequence results:

- **Population at Risk (Day/Night)**. These values represent the computed total number of people that would get wet if they did not evacuate when a levee breach occurred and inundated the entire leveed area up to the maximum profile elevation of the levee segment being screened.

- **Exposure Weighted Life Loss Estimates**. Computed "average" life loss estimates for each scenario that represent the loss of life caused by breach of the levee based on the movement of people in and out of the leveed area throughout the day.

The life safety and life loss estimates can be found in Table 7-6. This information comes from a series of Levee Screen Tool Presentations by the Sacramento District on the three basins or systems. (USACE, 2011), (USACE, 2012a), (USACE 2012b)

Table 7-6. Life Safety and Life Loss Information
From USACE's Levee Screening Tool

American River North	
Population at Risk (Day)	58,558
Population at Risk (Night)	51,380
Loss of Life (Day)	170
Loss of Life (Night)	156

Natomas	
Population at Risk (Day)	76,973
Population at Risk (Night)	65,696
Loss of Life (Day)	669
Loss of Life (Night)	553

American River North, Small Streams	
Population at Risk (Day)	15,457
Population at Risk (Night)	23,816
Loss of Life (Day)	77
Loss of Life (Night)	131

American River South	
Population at Risk (Day)	350,000
Population at Risk (Night)	439,491
Loss of Life (Day)	503
Loss of Life (Night)	978

8 EROSION

8.1 Overview and Assumptions

Erosion is the removal of sediment, rocks, cobble, vegetation and general deterioration of a bank or a levee due to the power of water, often measured by shear stress and velocity. The probability of erosion eroding a levee resulting in failure can present a significant flood risk. There have been many studies on erosion, sediment transport, and channel stability and in the study area, with most of the focus on the American River.

The primary concern about erosion related flood risk in the project area is on the American River and secondary concern is on the Sacramento River. While there may be erosion occurring on the smaller tributaries in the project area, it is assumed that any repairs would be incorporated into current designs with limited added costs, would not involve large quantities of rock, and would not have specific designs called out.

The plan for erosion management features is ongoing; more analysis is expected to provide greater insight. Erosion repairs are expected to be part of all three alternatives and refinement efforts will continue beyond the Tentatively Selected Plan (TSP) milestone. Existing erosion conditions in the project area are presented briefly in the following section. A separate multidisciplinary Erosion Protection Report was developed for this study that contains addition information.

8.2 Existing Bank Erosion Conditions

Below is a brief description of the existing bank erosion condition for each of the reaches in the project area. This section is based on existing annual erosion survey reports from the Sacramento River Bank Protection Project that covers the entire Sacramento River Flood Control System. (USACE 2012a) See Plate 3.

Sacramento River – Middle Reach, Colusa to Sacramento (RM 79 to RM 61). The middle reach of the Sacramento River has the levees close to the river and multiple diversion structures to move flow into the bypass system. The Sacramento River was split at the confluence with the American River for the purposes of this discussion because the conditions of the river change at this location. The middle reach was intentionally designed with the levees close to the banks to help move some of the bed load and debris that remained from the days of hydraulic mining. In addition, USACE was responsible for keeping the river navigable up to the city of Colusa. As a result of this design, much of the reach is protected with rock, especially the outsides of bends. The majority of the rock in this reach is cobbles placed prior to the 1960s and some areas with more recent quarry stone. The cobble sites are reaching the end of their design life. Figure 8-2 shows a typical view of the middle reach of the Sacramento River.

Figure 8-1. Typical View of the Middle Reach of the Sacramento River

Sacramento River – Delta Section (RM 61 to RM 45). The Delta reach of the Sacramento River has levees placed directly adjacent to the main channel and is tidally influenced. The location of the channel has been relatively stable for the past 150 years. A large percentage of this reach has already been armored with riprap. This area has heavy wave action from recreational boats and wind, and the banks are heavily used by the public. Many of the levees are constructed of dredged soils from the bottom of the channel. Figure 8-3 shows a typical view of the Delta section of the Sacramento River. The causes of erosion in this reach are boat wake, wind-wave, mass failure, fluvial processes, and public use.

Figure 8-2. Typical View of the Delta Section of the Sacramento River

American River. The American River reach is located downstream of Folsom Dam, is therefore generally sediment-starved, and has been eroding and transporting the fine materials from the channel bed. Once the fines have been removed and the bed is armored, the channel is expected to move laterally and erode the banks. The right bank levee is set back from the channel for the lower 5 miles. Boat wake is not a concern as there is a no wake zone for the entire river. The main causes of erosion are fluvial, tree undercutting, and public use. This river is generally well maintained and has had many bank repairs in the recent years. Figure 8-4 shows a typical view of the American River.

Figure 8-3. Typical View of the American River

Natomas East Main Drainage Canal, Arcade Creek, and Dry Creek. Arcade Creek and Dry Creek (formerly known as Linda Creek, and now more commonly referred to as Big Dry Creek) drain water from the Rio Linda, Roseville, Antelope, Citrus Heights, and Carmichael areas. Arcade Creek has the levees relatively close to the channel; however, the small amount of floodplain maintains a healthy riparian habitat. Dry Creek has a large floodplain but relatively little riparian habitat, as the floodplains appear to be used for cattle grazing. Figure 8-5 shows a typical view of Dry Creek. The Natomas East Main Drainage Canal (NEMDC) directs the flow from Arcade and Dry creeks and sends it south to the American River. NEMDC is a man-made channel that runs north-south and protects the east side of Natomas.

Erosion is not considered to be a significant problem on these smaller tributaries or on the Natomas Cross Canal, Pleasant Grove Canal, or Coon Creek Interceptor (described below). Any work needed to address erosion will be part of the levee design effort and were accounted for in the cost contingency and is not expected to add any cost or change the hydraulics of these reaches.

Figure 8-4. Typical View of Dry (Linda) Creek

Natomas Cross Canal, Pleasant Grove Canal, and Coon Creek Interceptor. Pleasant Grove Canal and Coon Creek Interceptor collect water from the east foothills and communities of Lincoln and Pleasant Grove. These flows are then directed into the Natomas Cross Canal, which moves the water down to the Sacramento River. Pleasant Grove Canal and Coon Creek only have levees on the east side. The levees are steep with some grass and shrub vegetation. The Natomas Cross Canal is man-made and the levee on the south side was recently rebuilt. The south levee is mowed and grazed by sheep in the summer while the north levee has tall grasses with shrubs/trees on the lower bank. Figure 8-6 shows a typical view of the Natomas Cross Canal.

Figure 8-5. Typical View of the Natomas Cross Canal

8.3 Existing Sediment Transport

A sedimentation analysis was not completed for this study. However, a sediment study of the Sacramento River from Colusa to Freeport is near completion under the Sacramento River Bank Protection Project (NHC, 2012). The main objective of this sediment study was to investigate sediment transport processes and geomorphic trends along the lower Sacramento River and its major tributaries and distributaries. A HEC-6T sediment transport model was developed for the study reaches of the Sacramento, Feather, and American Rivers to estimate degradational or aggradational trends over the next 50 and 100 years.

For the entire study reach of the Sacramento River (RM 79-46), the average bed elevation decreases by 0.02 ft for the 50-year simulation period and decreases by 0.10 ft for the 100-year simulation period. Despite a few significant (on the order of feet) localized vertical adjustments in the channel geometry (mostly associated with infilling of deep pools and scour of elevated riffles), the study reach of the Sacramento River appears to be generally stable, with a slight degradational trend.

On the lower American River, the long-term simulation results indicate that most of the 22-mile long study reach is actively degrading. Upstream sediment supply on the American River is interrupted by Folsom and Nimbus Dams, which results in “sediment-hungry” waters and channel degradation below the dams. Simulated long-term changes in the American River bed profile range from 9-16 ft of degradation to about 3-4 ft of aggradation. Degradation is simulated upstream of RM 12 and downstream of RM 11, while aggradation is simulated in a short reach between RMs 12-11. For the entire study reach of the American River, the average bed degradation is 4.8 ft and 5.8 ft for the 50- and 100-year simulations, respectively.

It should be noted that the channel of the American River is highly irregular at many locations (especially in braided reaches upstream of RM 8). These irregular reaches may not be adequately represented in the 1-d HEC-6T model. Therefore, results obtained for the irregular reaches may be subject to modeling errors and should be treated with caution. In general, however, the degradational trend predicted by

the model agrees with stage-discharge records showing ongoing channel degradation of the American River channel.

8.4 Existing American River Channel Stability

Specific to the American River, multiple analyses have been completed and many are still underway to better understand the overall channel stability. These efforts are ongoing and are expected to be incorporated into the design of the tentatively selected plan.

Recognizing that significant efforts have been completed and that current studies are not yet finished, the hydraulic characteristics of the American River channel under with-project conditions were evaluated using existing information. The 2004 Ayres Report, "Lower American River – Erosion Susceptibility Analysis for Infrequent Flood Events" for the American River provided 2-D hydraulic model results of velocity, shear stress and water depth for flows of 115,000 cfs, 130,000 cfs, 145,000 cfs, and 160,000 cfs. The report and model results were provided to the Civil Design and Geotechnical Sections; additional information on erosion designs can be found in their respective appendices.

The conclusions from the Ayres 2004 report provide further evidence for the need of erosion protection measures to reduce the flood risk on both sides of the American River and are described below:

> *Based upon our modeling efforts, field review and overall experience with the Lower American River system, we offer the following conclusions:*
>
> 1. *Geomorphic principles, the thalweg profile, and the field review all agree that the river system is degradational under present operating conditions.*
>
> 2. *The Lower American River is starved of sediments by Folsom and Nimbus dams. Bedrock has been reached in the channel bottom as far downstream as Guy West Bridge, and this bedrock is slowing further degradation. With the river starved for sediments and without significant bed slope reduction, it will now tend to erode laterally to satisfy the need for sediment.*
>
> 3. *The hydraulic modeling shows areas of riverbank and levees where allowable velocities for vegetative cover and soil materials are exceeded. These sites need to be evaluated in more detail to determine if a levee failure is likely to occur.*
>
> 4. *The field review verified that erosion of the riverbank is occurring (RM 9.0R) even at low flow conditions of 7,000 cfs, which was the peak flow from the 2003 runoff season. Erosion on the American River is continually occurring. This condition is leaving the channel banks scarred and susceptible to further erosion, especially during a high flow event. In addition, this condition is further reducing the amount of berm separating the main channel from the levee. The loss of underlying vegetation is leaving bare soil, which is susceptible to erosion at a lower velocity.*

8.5 Existing Wind-wave

Wind-wave analysis was done to evaluate the risk of failure due to wind-wave erosion for about 85 miles of the American River Common Features levees in Sacramento and Sutter Counties for coincident 0.5% (1/200) ACE event water levels and extreme wind events (NHC, 2010). The study approach and methods

followed Engineering Circular 1110-2-6067 and other technical publications related to wind-wave analysis. Wind-wave characteristics were calculated from the highest observed winds on record at stations in the Sacramento area. Frequency analysis of the annual maxima at the stations, by direction, suggested that the maximum 1-hour gusts had about a 2% (1/50) ACE event. No studies were performed to determine the coincident probability of the (1/200) ACE event water level and the maximum wind occurring simultaneously.

Each site was assigned a risk level based on the highest risk assigned for either levee face erosion or overtopping for any wind direction at a given site. The risk at each study site was than generalized to nearby sites, which were expected to experience similar wave heights and which had similar geometry and protection. Overall, 46 miles of levee were determined to be at high risk of failure due to wind-wave erosion during coincident extreme wind and water levels, 25 miles were determined to be of moderate risk, and 14 miles were assumed to be low risk. High risk sites are likely to require repair for the levee to be a certifiable flood defense structure. Sections of levee with moderate risk are not expected to require repair and any damage at these locations during a large flood should likely be mitigated with flood fighting. Low risk sites do not require repair and likely will not require any flood fighting for wind-wave erosion.

It should be noted that the possibility of levee breach due to wind-wave action is small compared to other issues currently being considered, such as underseepage and stability, and that conservative assumptions were made in regards to the need for erosion protection due to wind-wave action on the PGCC and the upper NEMDC.

8.6 Existing Boat Wave Erosion

Boat wave erosion has not been accounted for in this analysis because the impact of boat wave erosion in the project area is unlikely to be significant. Only smaller recreational boats operate in the Sacramento and lower American Rivers, and the other project reaches do not have enough consistent depth or width of channel to sustain boat traffic. Any repairs needed from boat waves is assumed to be addressed as part of standard operation and maintenance of the levees.

8.7 Existing Vegetation Analysis (Tree Scour)

The preliminary designs for erosion protection include leaving some of the vegetation in place, an option made possible by a waiver process included in ETL 1110-2-571. A pier scour analysis to represent tree scour (likely using HEC-18) is included in the application for waiver. This effort is considered part of the erosion analysis, and is expected to be done as part of the refinement during PED.

8.8 With-Project Erosion Features

With the levees set back on the American River, there are some additional options available to address erosion. A launchable rock trench at the levee toe is considered a viable measure, along with protecting the bank with a rock layer. All launchable rock trenches would be constructed outside of the natural river channel and designed to deploy once erosion has removed the bank material covering it.

In a flood event where the bank erodes back to the levee, the launchable rock would already be in place to protect the levee slope and nearby bank, halting the erosion. The rock trench can be covered with

dirt and vegetation so that the entire fix is not visible. A key assumption for the rock trench is that it would not change the hydraulics, because the design would not affect the cross sectional area of the channel. See the geotechnical report for information on the details of this erosion repair measure.

The preliminary locations where bank protection (as opposed to rock trench protection) was proposed suggested a concern about channel capacity. An initial hydraulic model run was made with a revised geometry reflecting the obstruction estimated for the bank protection. This model run showed stage increases approximating 1 foot for the 0.5% (1/200) ACE event (currently set to be 160,000 cfs). Given the significant increase in stage, the option of replacing the bank protection upstream of the narrowest part of the American River (near Guy West Bridge, approximately RM 6.5) with rock trench measures was evaluated with another hydraulic model run. The results indicated that this limited erosion fix option caused very little change in stage for the 0.5% (1/200) ACE event.

Based on this analysis, the rock trench measure is proposed for areas upstream of the Guy West Bridge (approx. RM 6.5) with bank protection or a rock trench downstream of this point. Further refinement in PED will likely be necessary to verify this measure.

8.9 Bridge Scour

There are over 15 bridges crossing the channel on multiple reaches in the project area. Bridges along the Sacramento and American rivers will likely need an analysis during design to account for bridge scour protection. This effort is considered part of the erosion analysis and is expected to be done as part of the refinement during PED.

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LEGEND

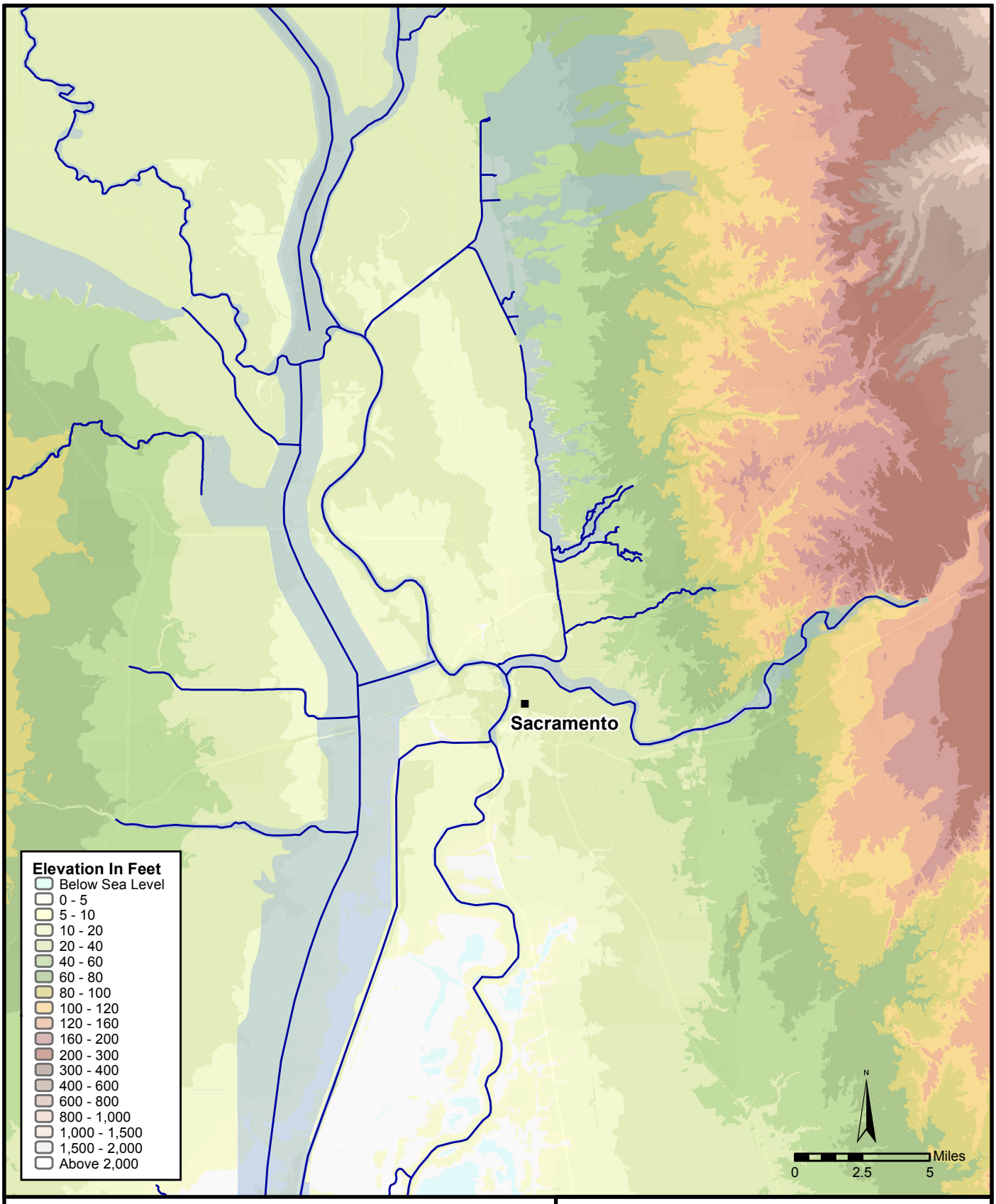
- Rivers
- Sacramento Watershed
- Lakes and Reservoirs
- Designated Floodways

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

SACRAMENTO RIVER WATERSHED

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013



LEGEND

Rivers

Floodways

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

GENERAL TOPOGRAPHIC MAP

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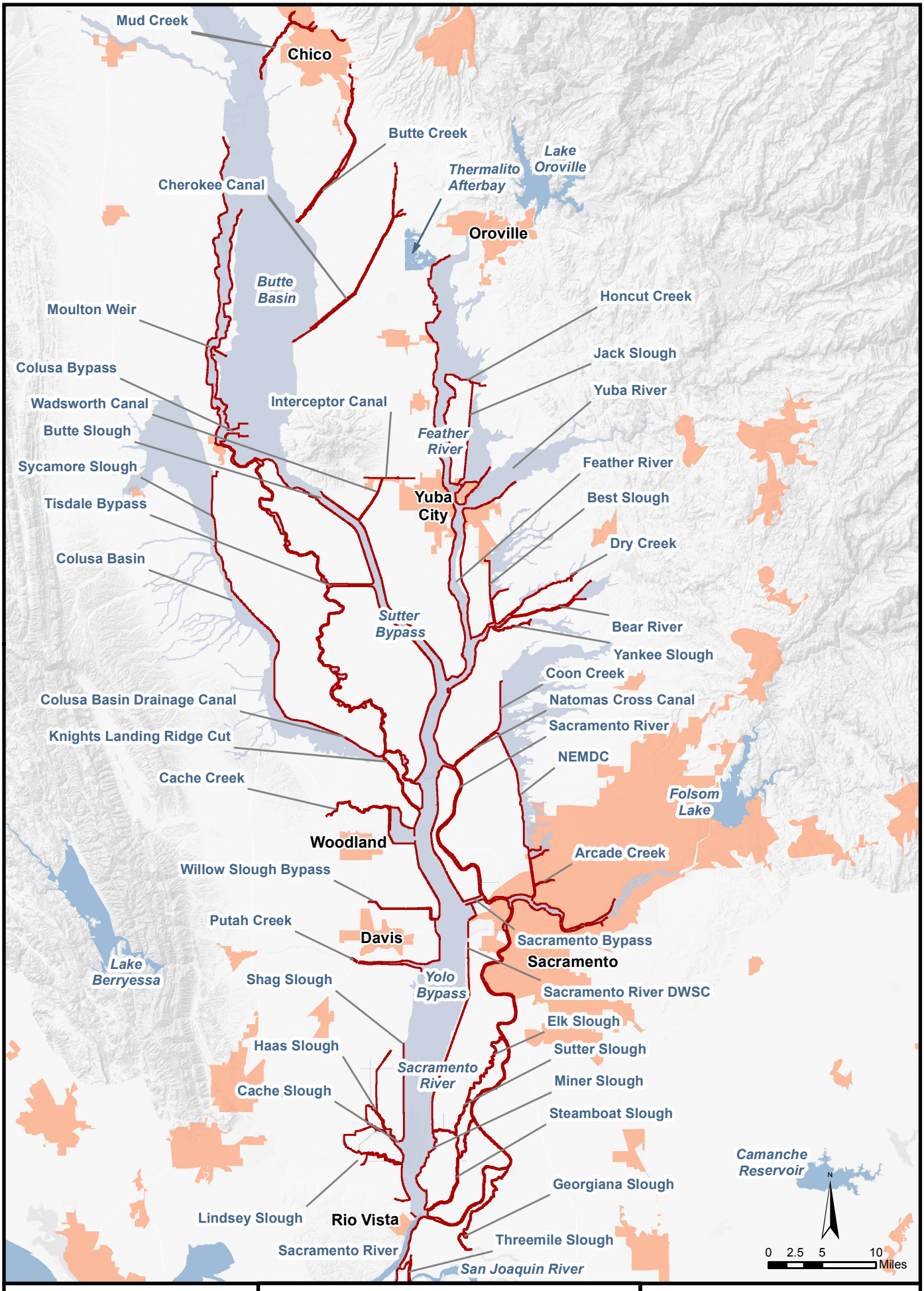
SACRAMENTO DISTRICT

Feb 2013

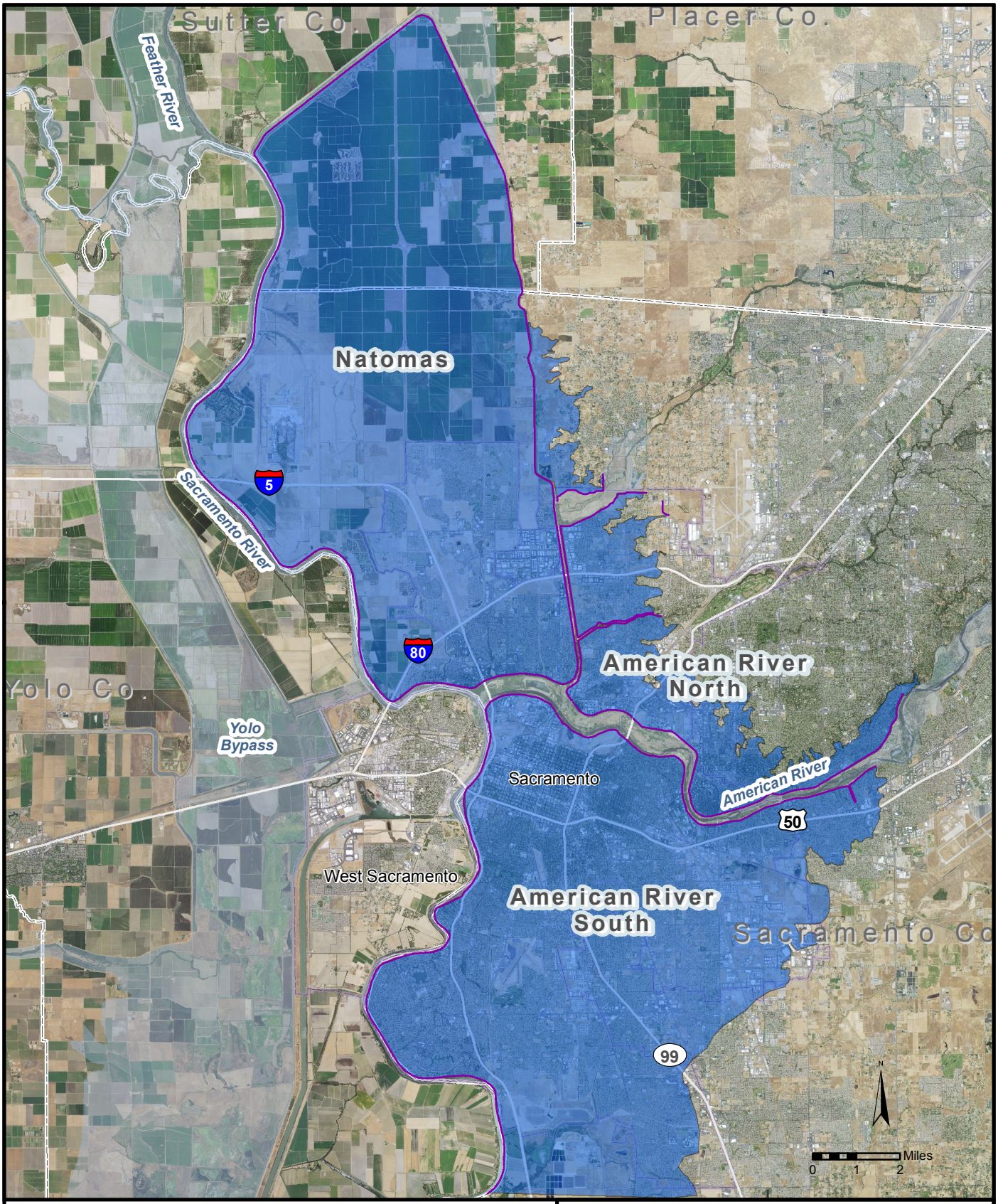
Plate 2



AMERICAN RIVER COMMON FEATURES GRR SACRAMENTO, CALIFORNIA	**Sacramento River Flood Control System**	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT

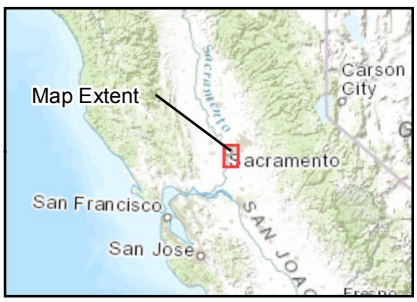
Feb 2013

Plate 3



LEGEND

- ARCF Levees
- ARCF Project Area
- Floodways
- Cities
- County Lines



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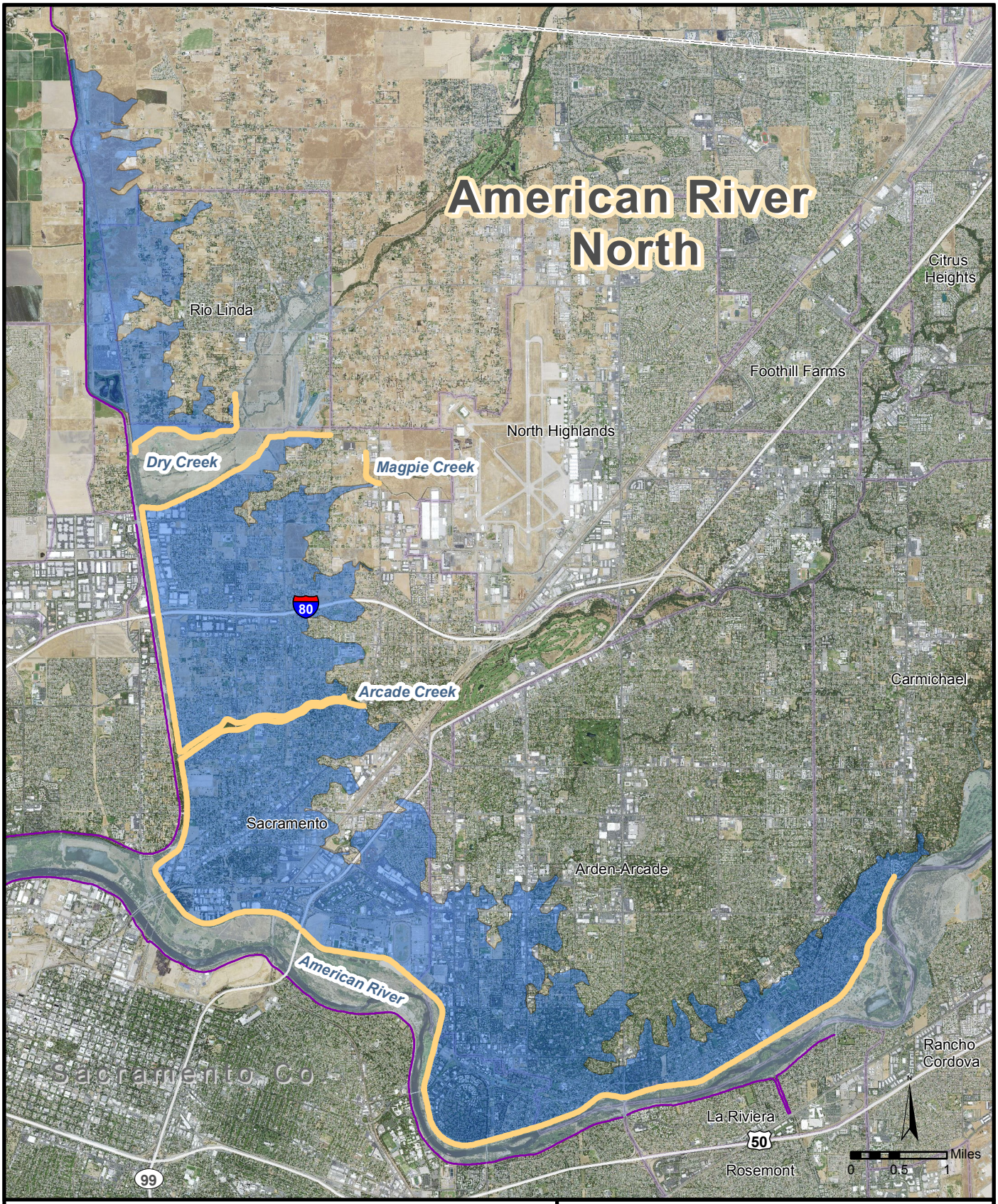
SACRAMENTO, CALIFORNIA

PROJECT AREA MAP

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Sept 2015



LEGEND

- ARN Project Area
- ARN Levees
- ARCF Levees
- Floodways
- County Lines
- Cities

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER NORTH PROJECT AREA

U.S. ARMY CORPS OF ENGINEERS
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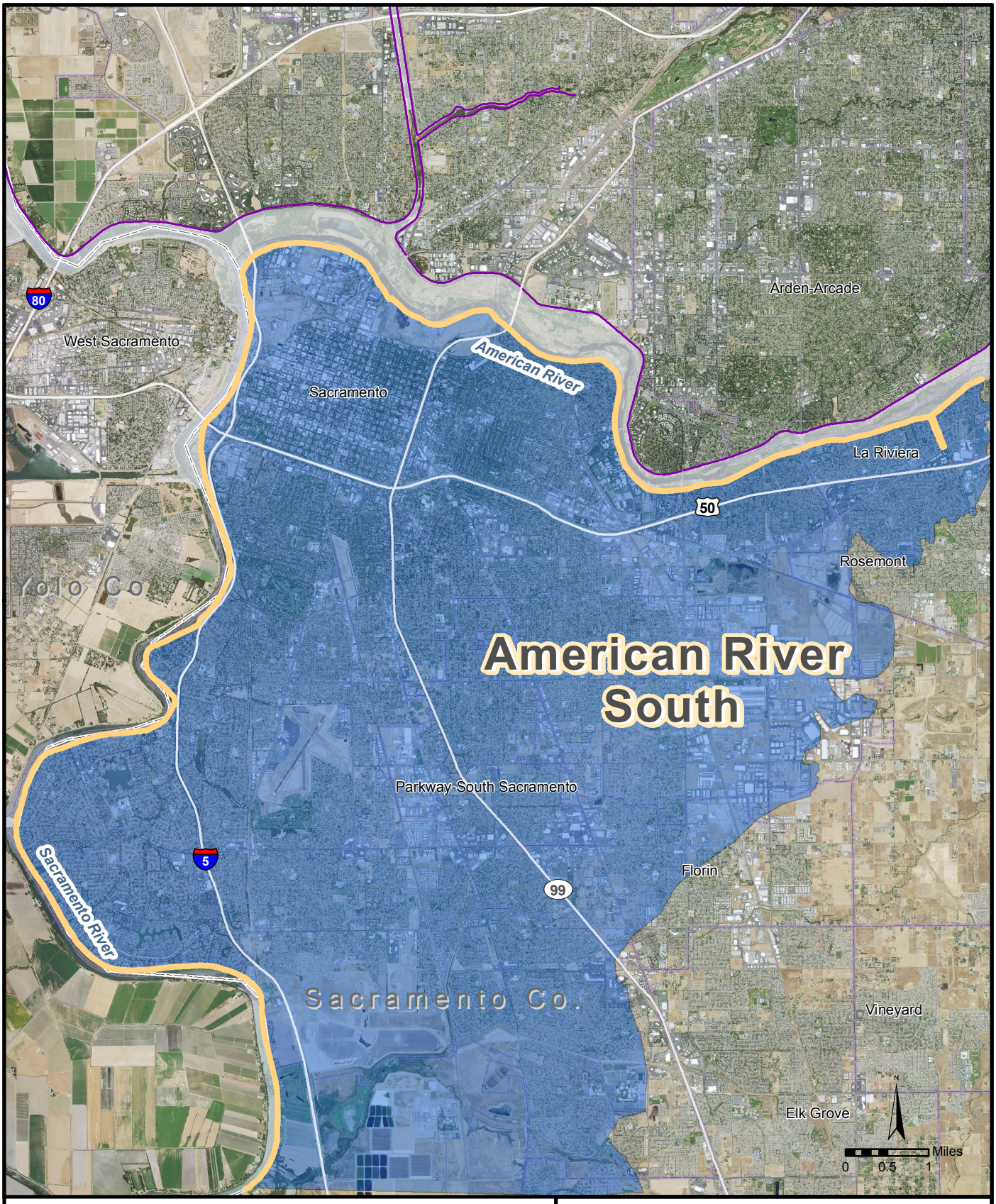
Sept 2015



LEGEND

- ARCF Levees
- ARS Levees
- County Lines
- Cities

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER SOUTH PROJECT AREA

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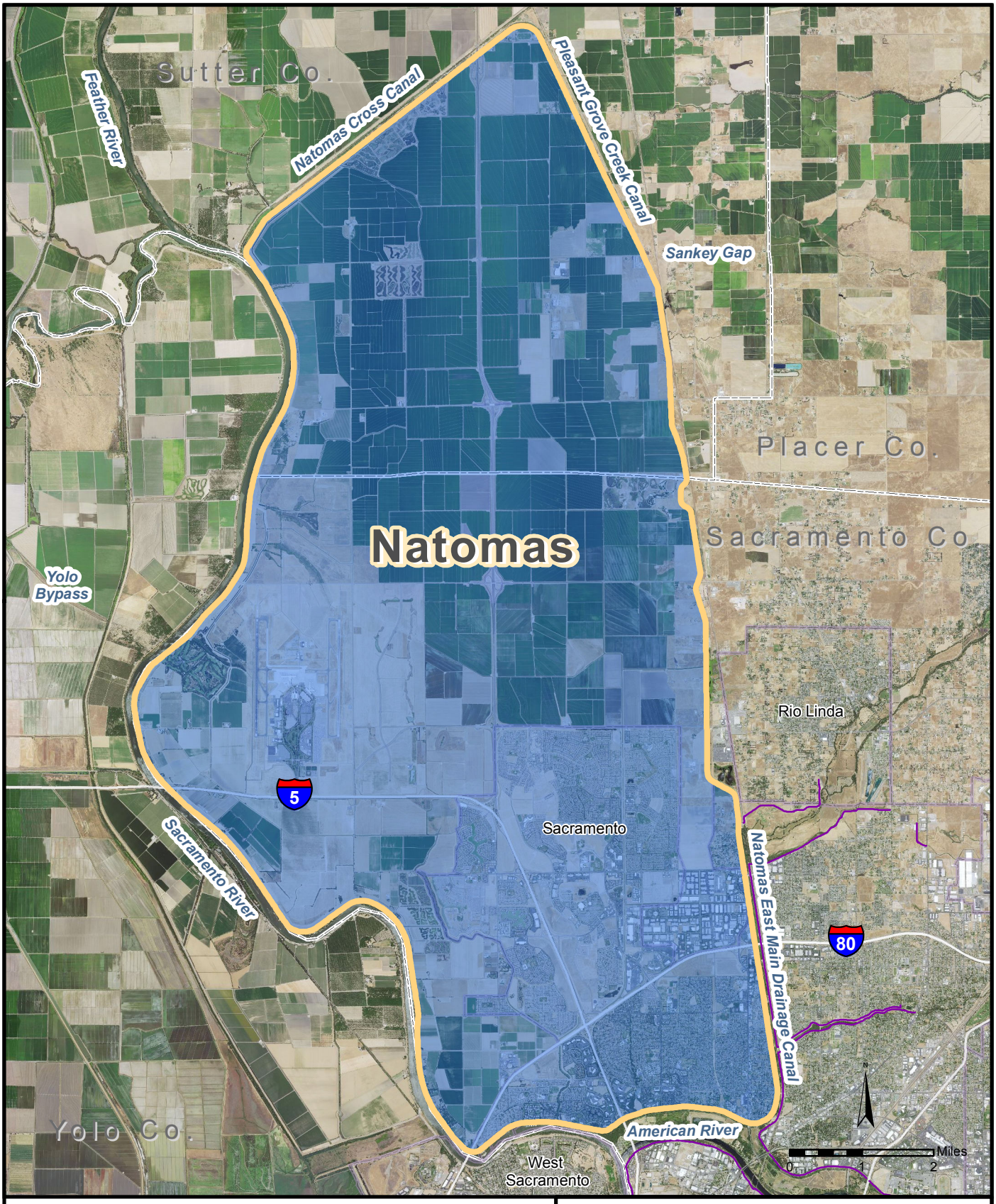
SACRAMENTO DISTRICT

Sept 2015

Plate 6



LEGEND

- ARCF Levees
- Natomas Levees
- Cities
- County Lines

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

NATOMAS BASIN PROJECT AREA

U.S. ARMY CORPS OF ENGINEERS
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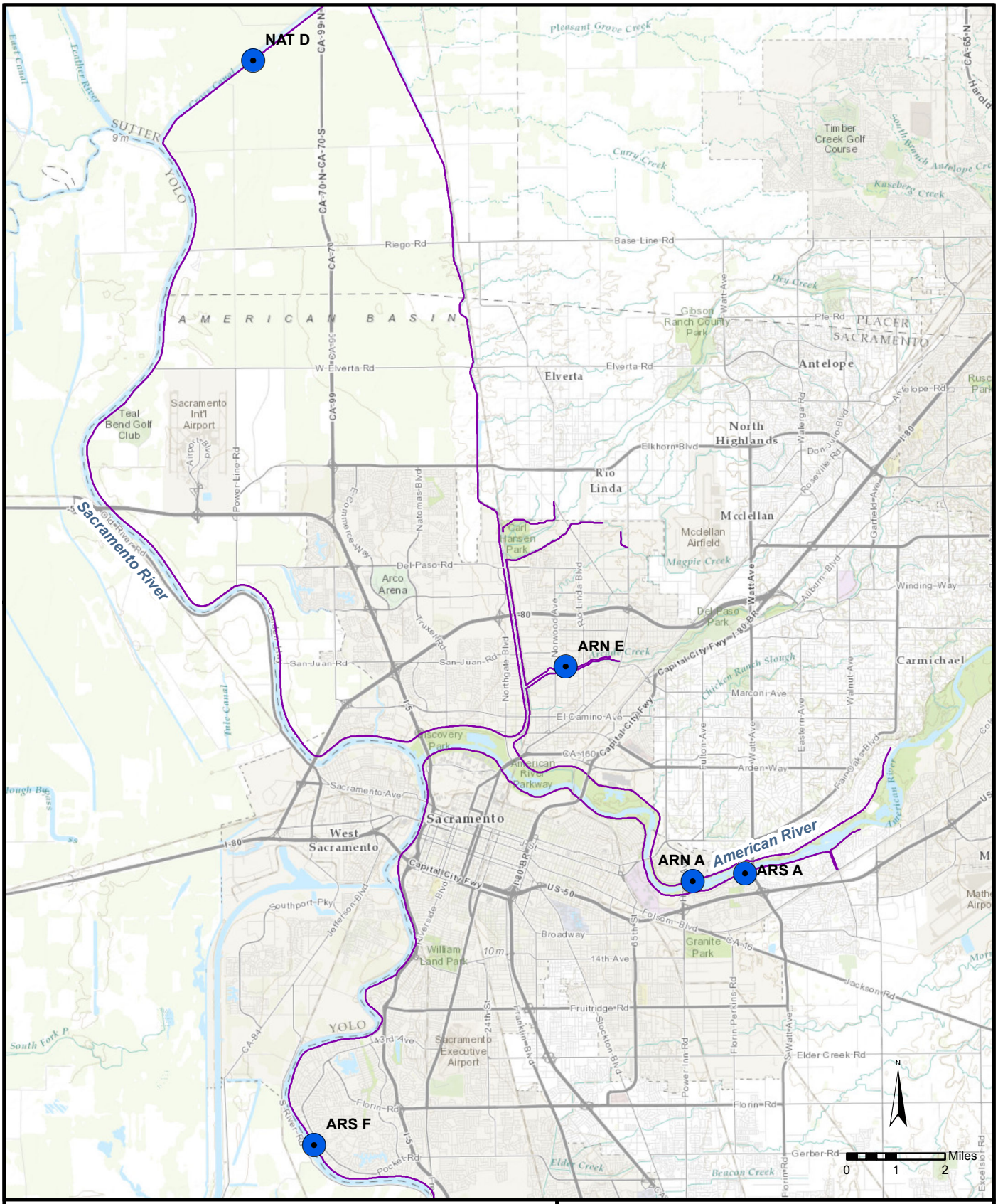
Sept 2015



LEGEND

- ARCF Index Points
- ARCF Levees

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

INDEX POINT LOCATION MAP

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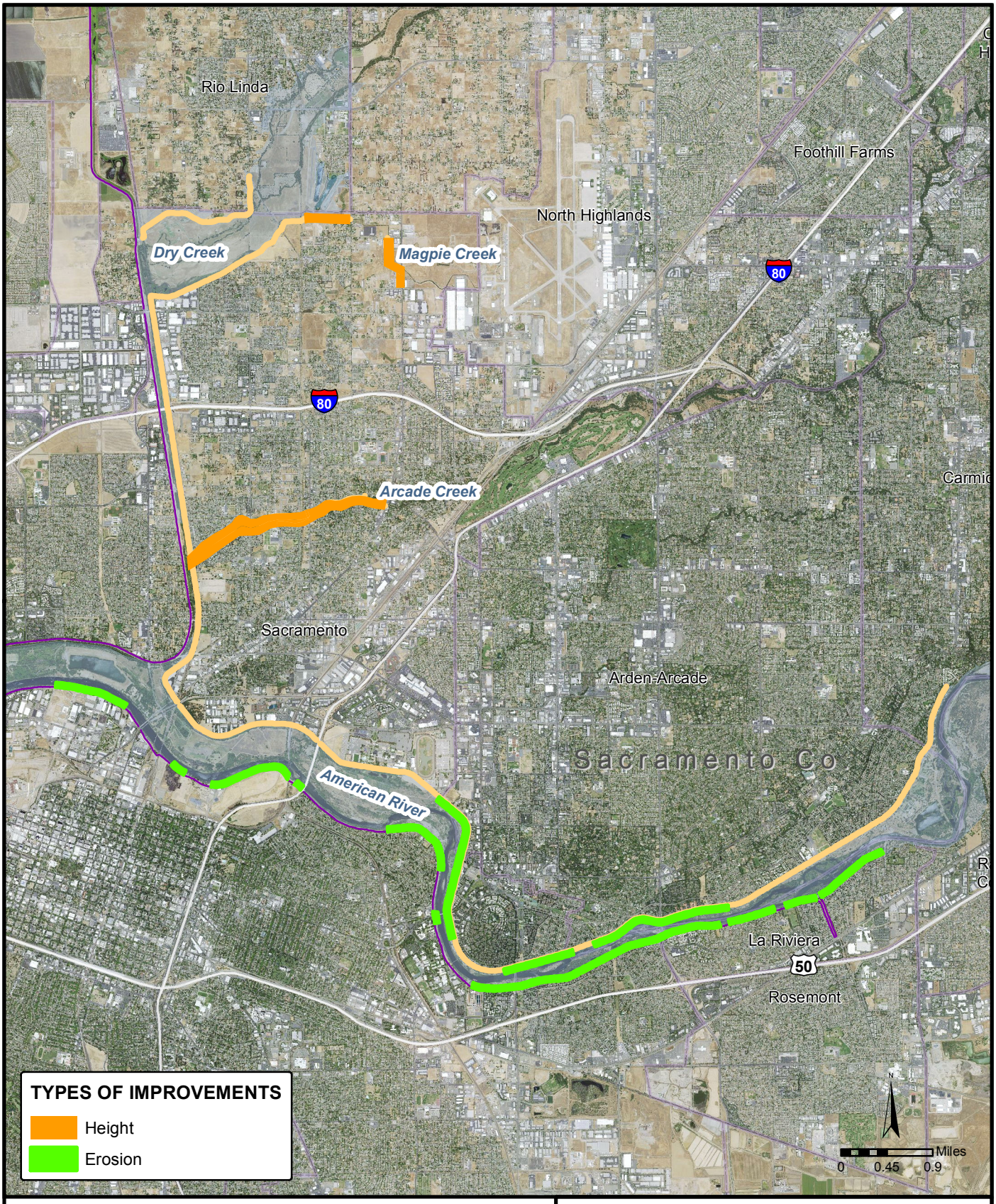
SACRAMENTO DISTRICT

Sept 2015



LEGEND

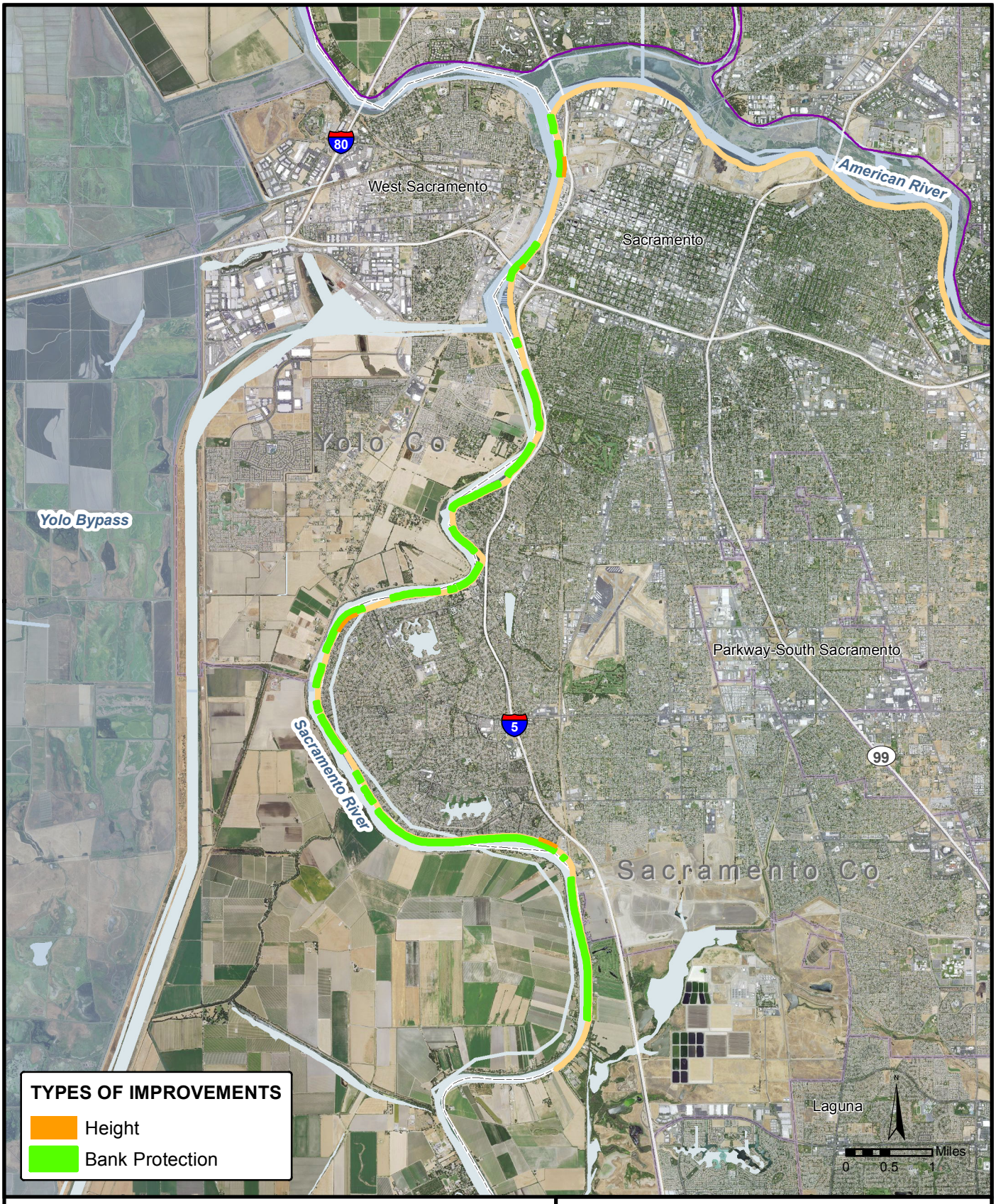
- ARN Levees
- ARCF Levees
- Floodways
- County Lines
- Cities

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

LOCATIONS OF HEIGHT AND EROSION IMPROVEMENTS ALONG THE AMERICAN RIVER AND EAST SIDE TRIBUTARIES

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Aug 2015



LEGEND

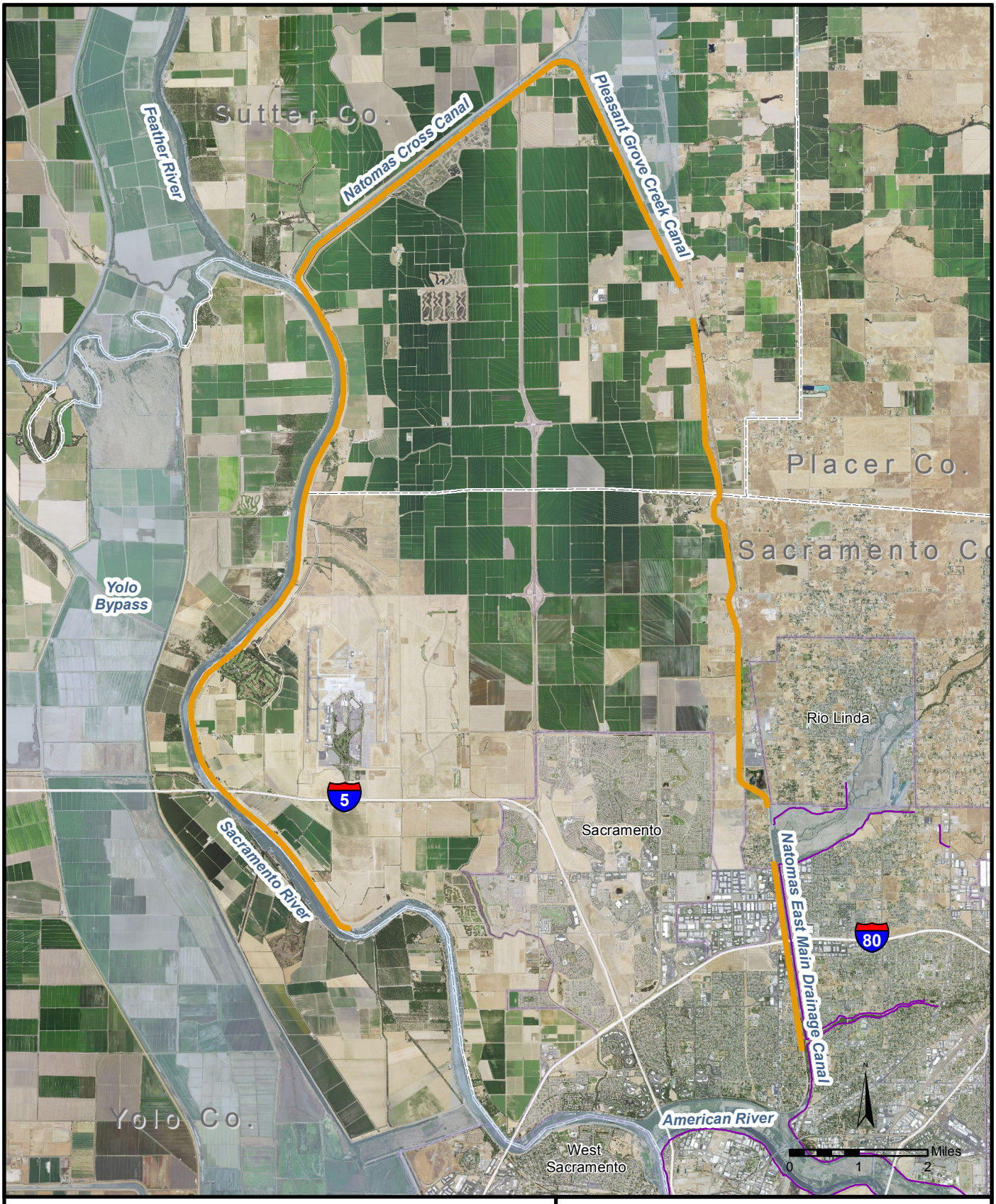
- ARCF Levees
- ARS Levees
- Floodways
- County Lines
- Cities

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

LOCATIONS OF HEIGHT AND EROSION IMPROVEMENTS ALONG THE SACRAMENTO RIVER

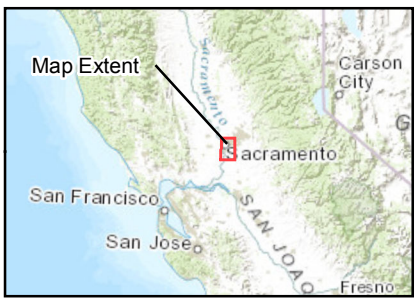
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Sept 2015



LEGEND

- Height
- ARCF Levees
- Floodways
- Cities
- County Lines



AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

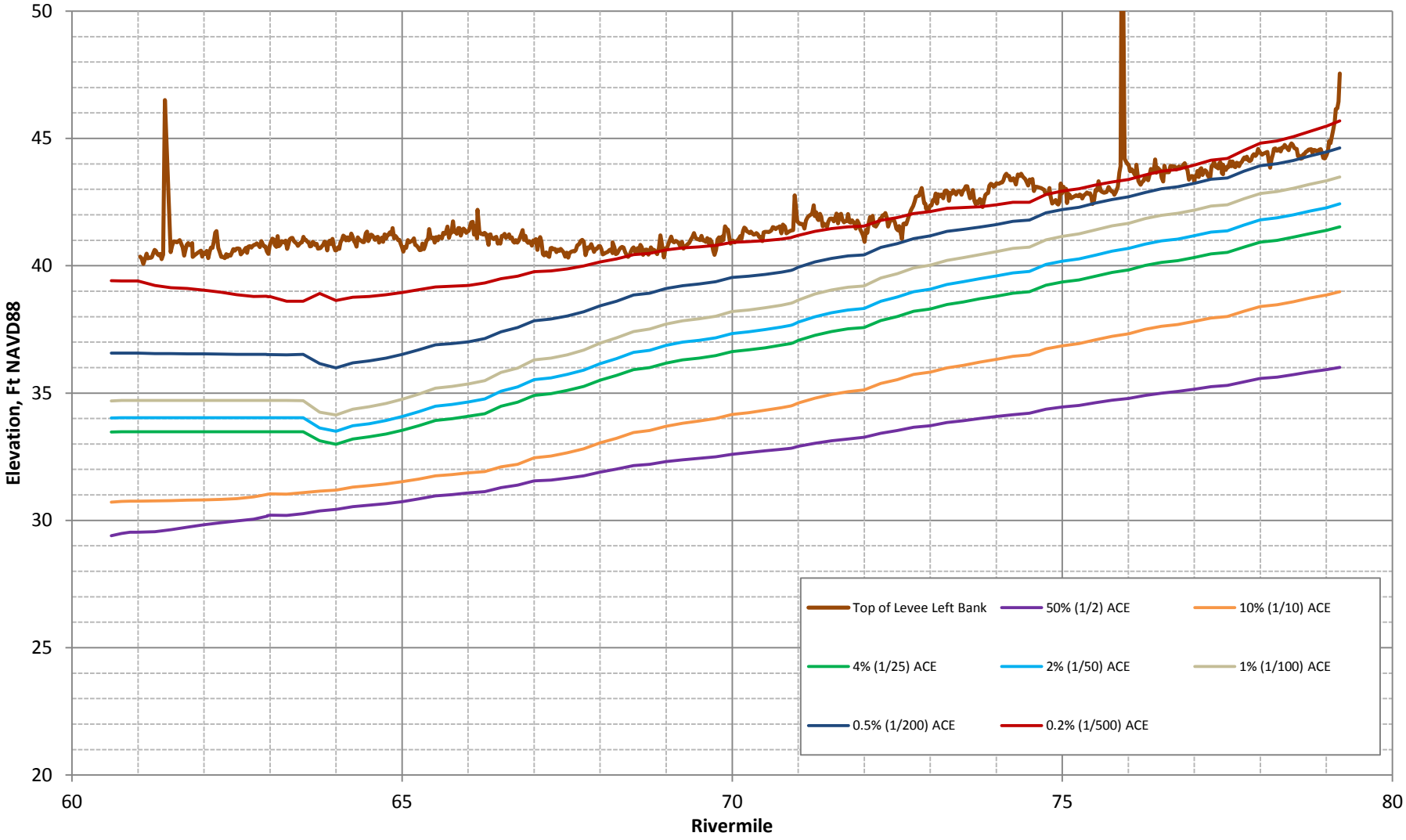
LOCATIONS OF HEIGHT IMPROVEMENTS ALONG THE NATOMAS BASIN

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Sept 2015

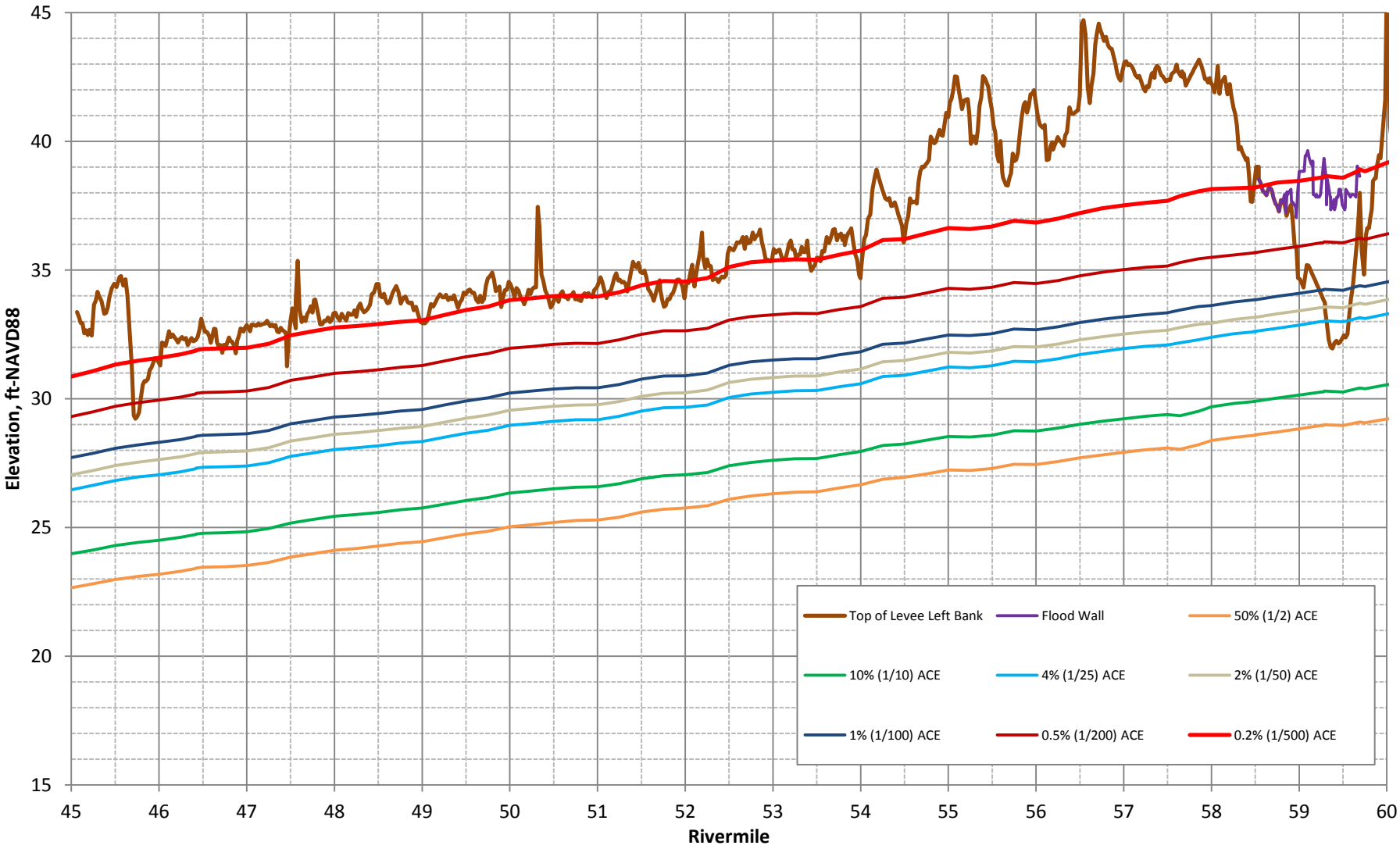
Plate 11

Sacramento River (Upstream of the American River) - Left Bank Levee



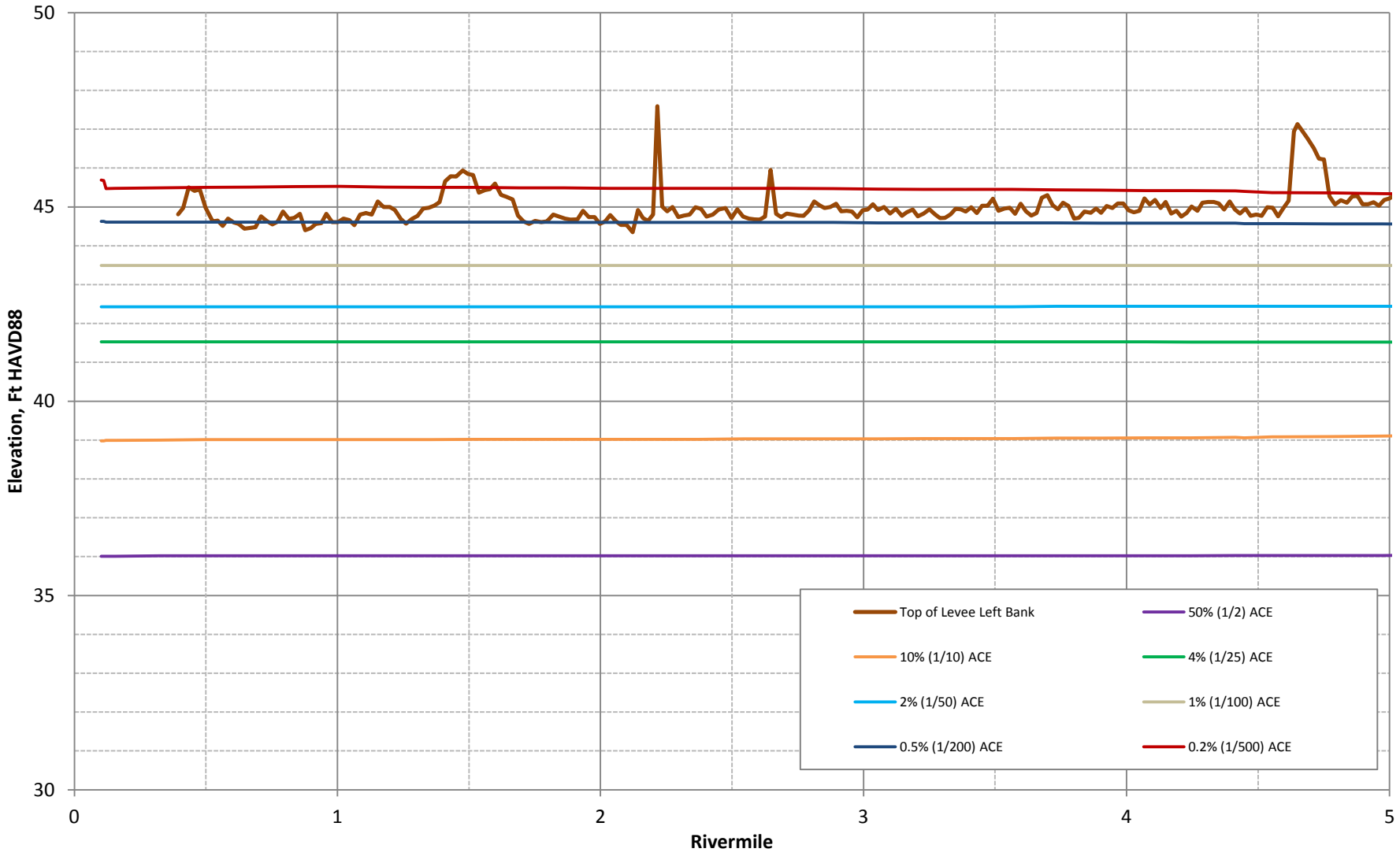
American River Common Features GRR Sacramento, California	**Sacramento River (U/S of the American River) – Left Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

Sacramento River (Downstream of the American River) - Left Bank Levee



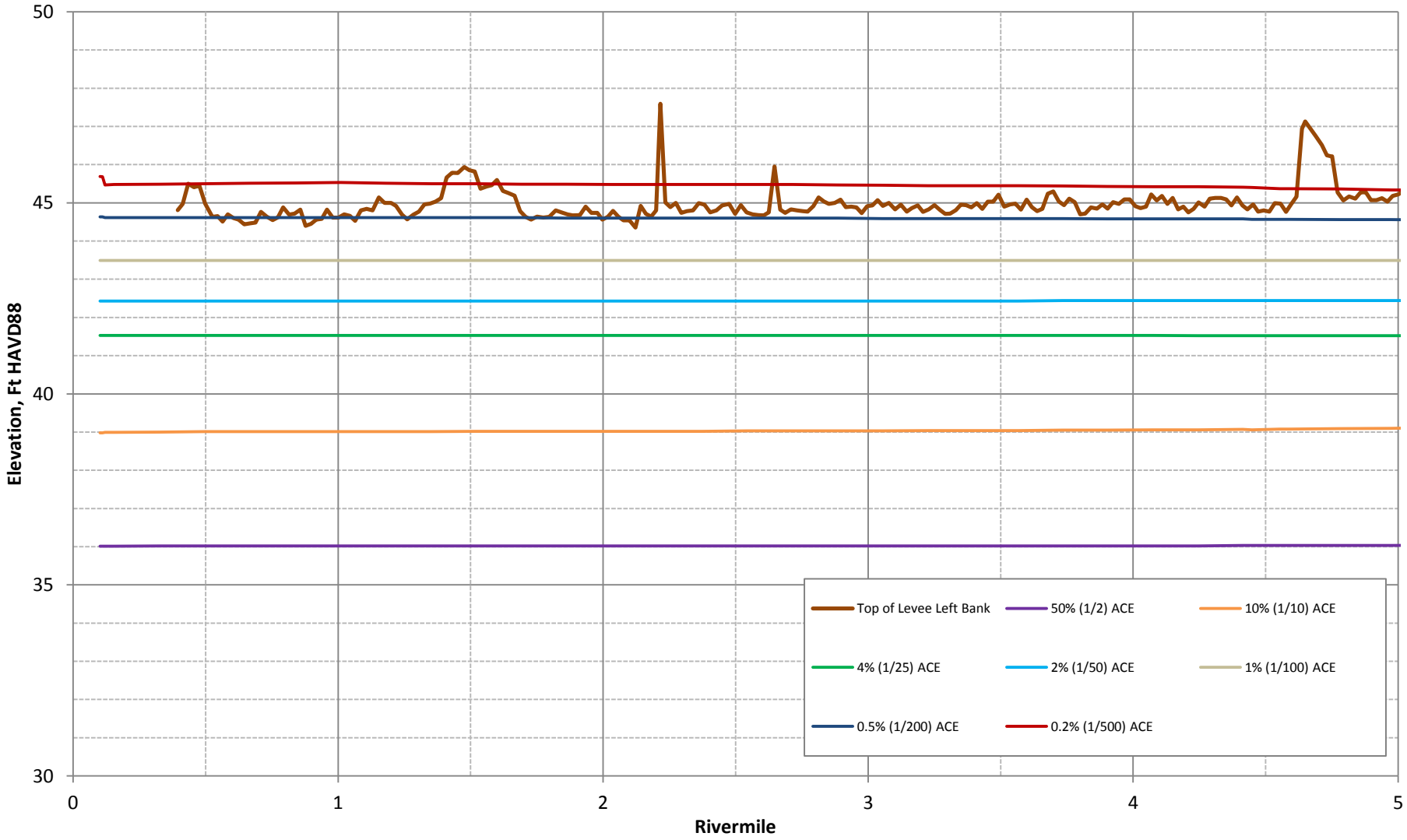
American River Common Features GRR Sacramento, California	**Sacramento River (D/S of the American River) – Left Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

Natomas Cross Canal - Left Bank Levee



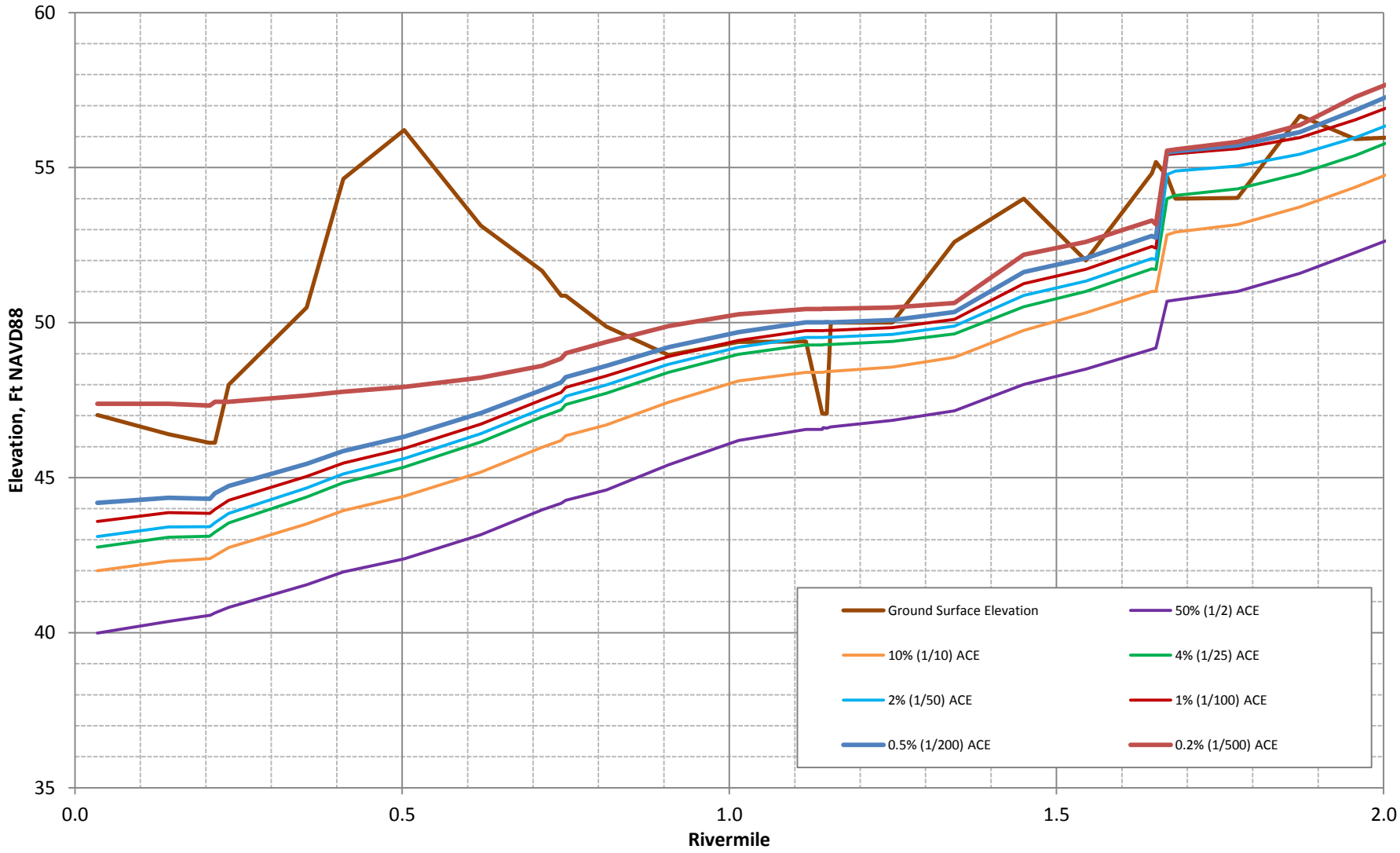
American River Common Features GRR Sacramento, California	**Natomas Cross Canal – Left Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

Natomas Cross Canal - Left Bank Levee



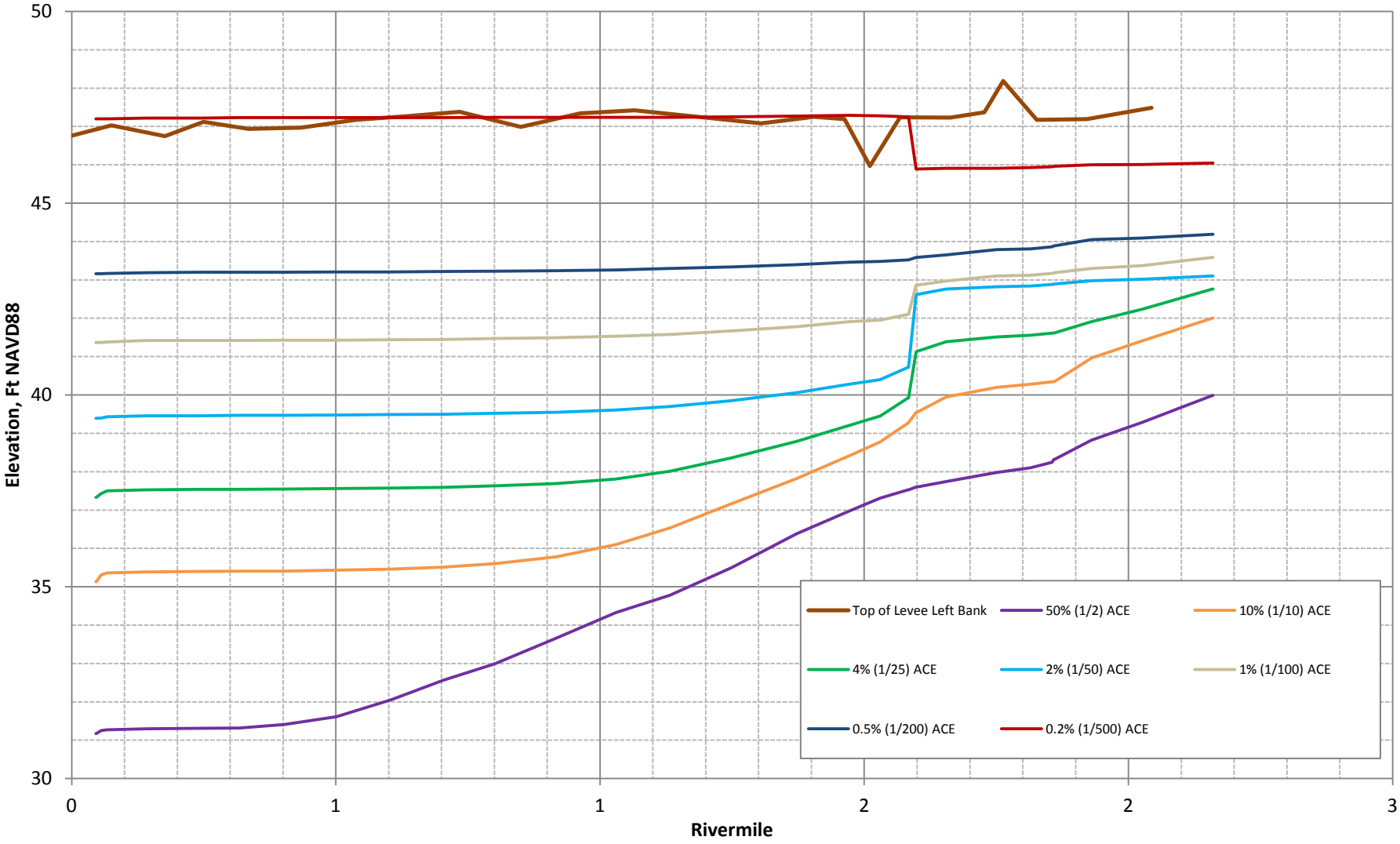
American River Common Features GRR Sacramento, California	**Pleasant Grove Creek Canal – Left Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

Magpie Creek - Left Bank



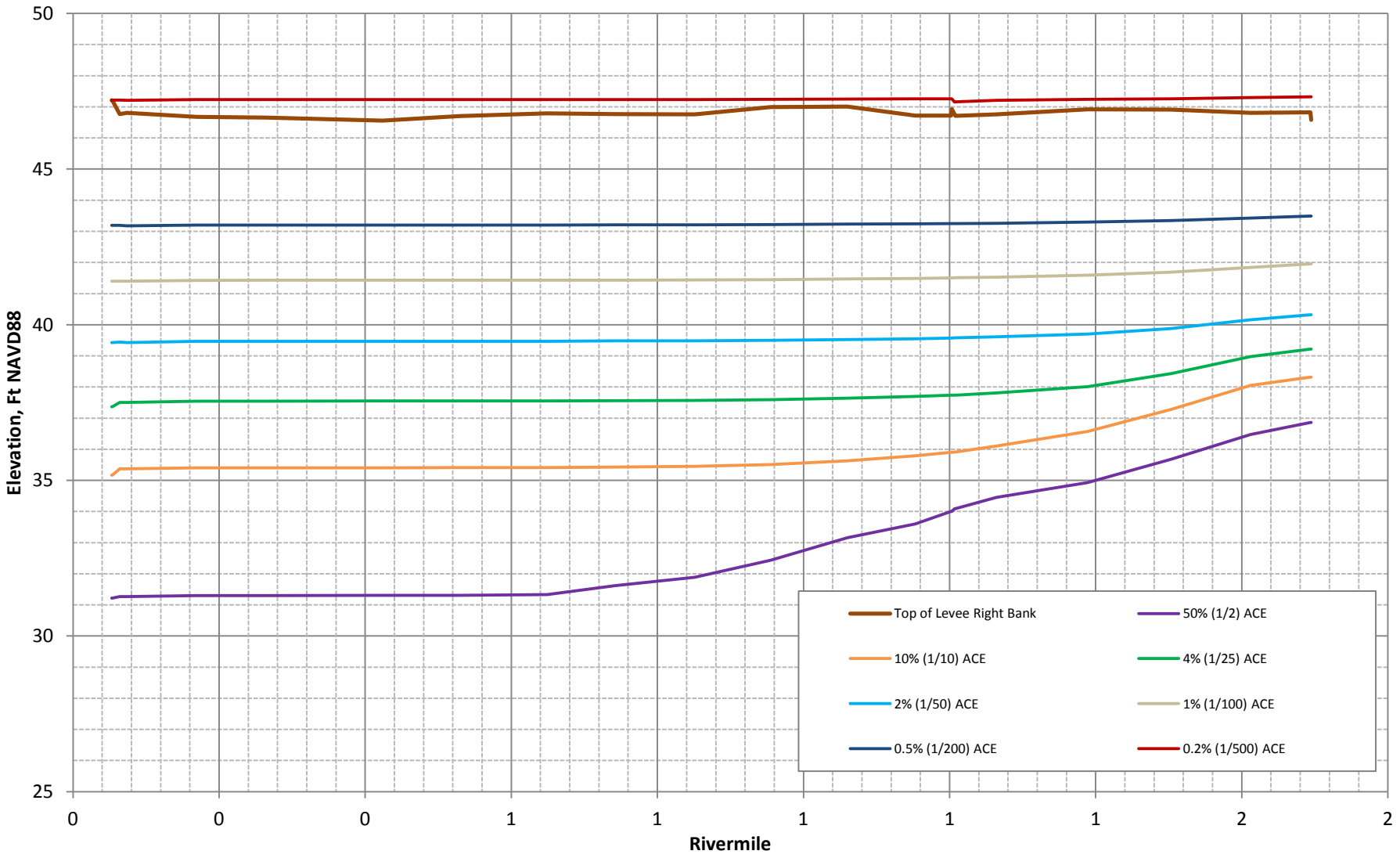
American River Common Features GRR Sacramento, California	**Magpie Creek – Left Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

Dry Creek - Left Bank



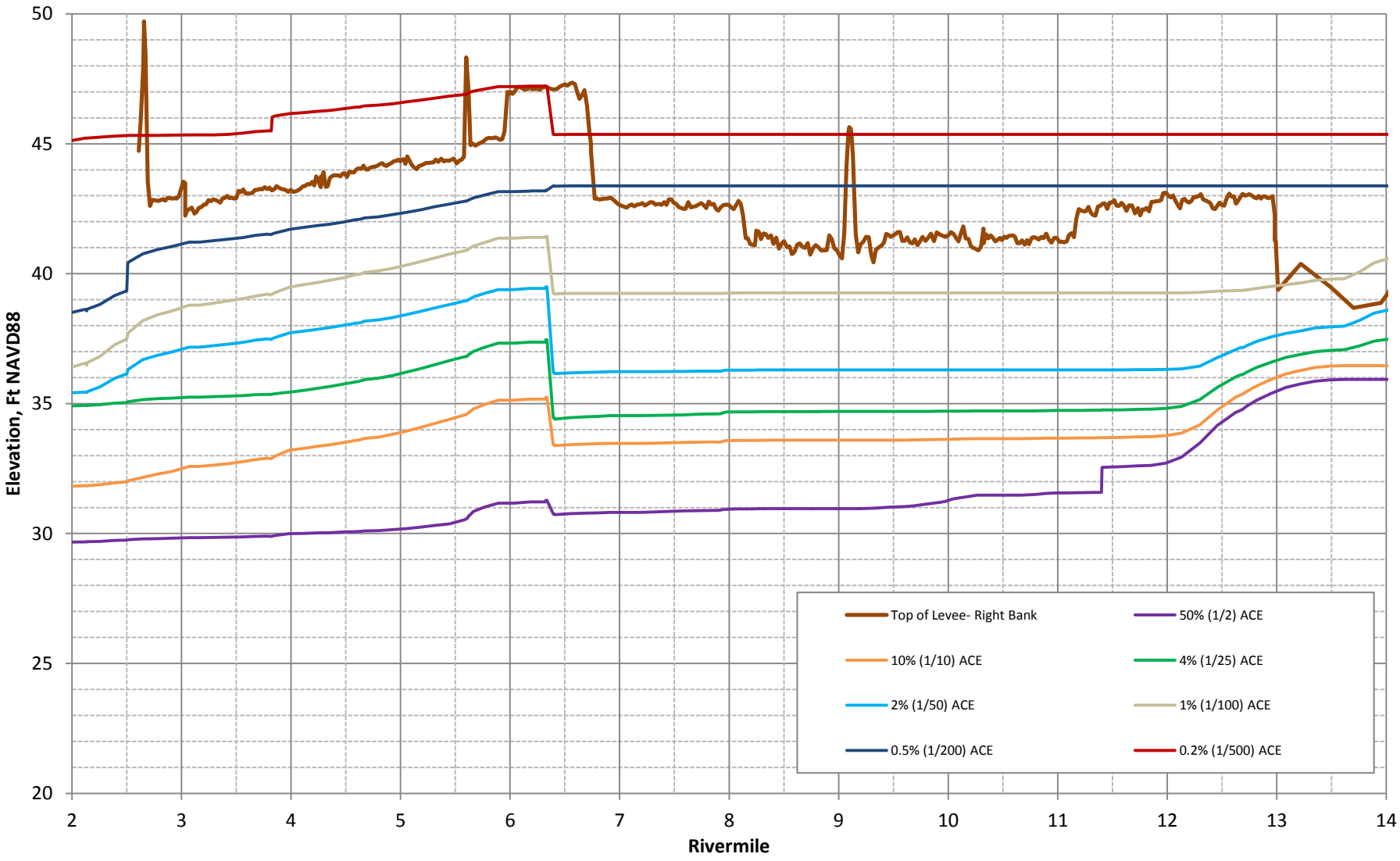
American River Common Features GRR Sacramento, California	**Dry Creek – Left Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

Dry Creek - Right Bank



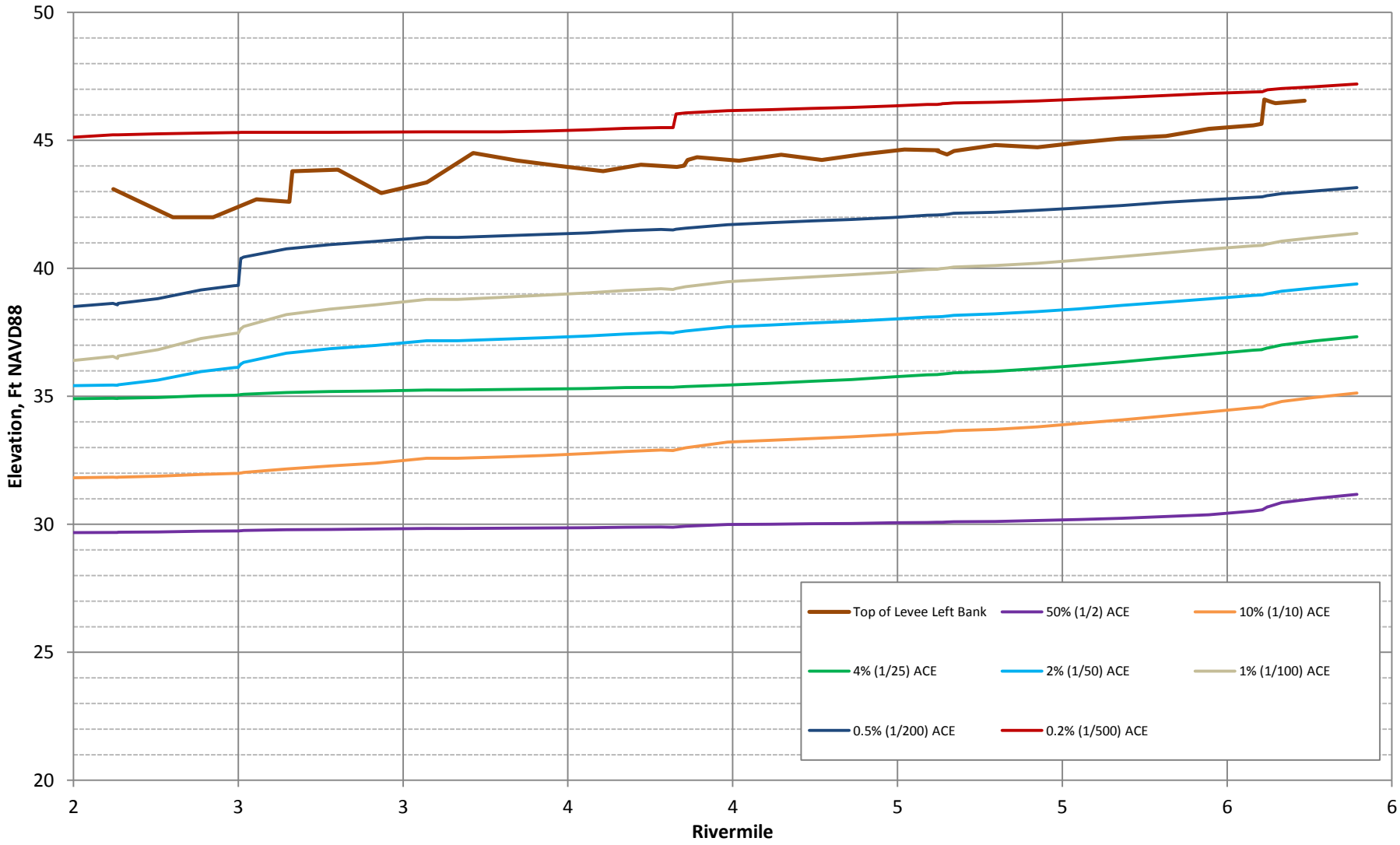
American River Common Features GRR Sacramento, California	**Dry Creek – Right Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

NEMDC- Right Bank



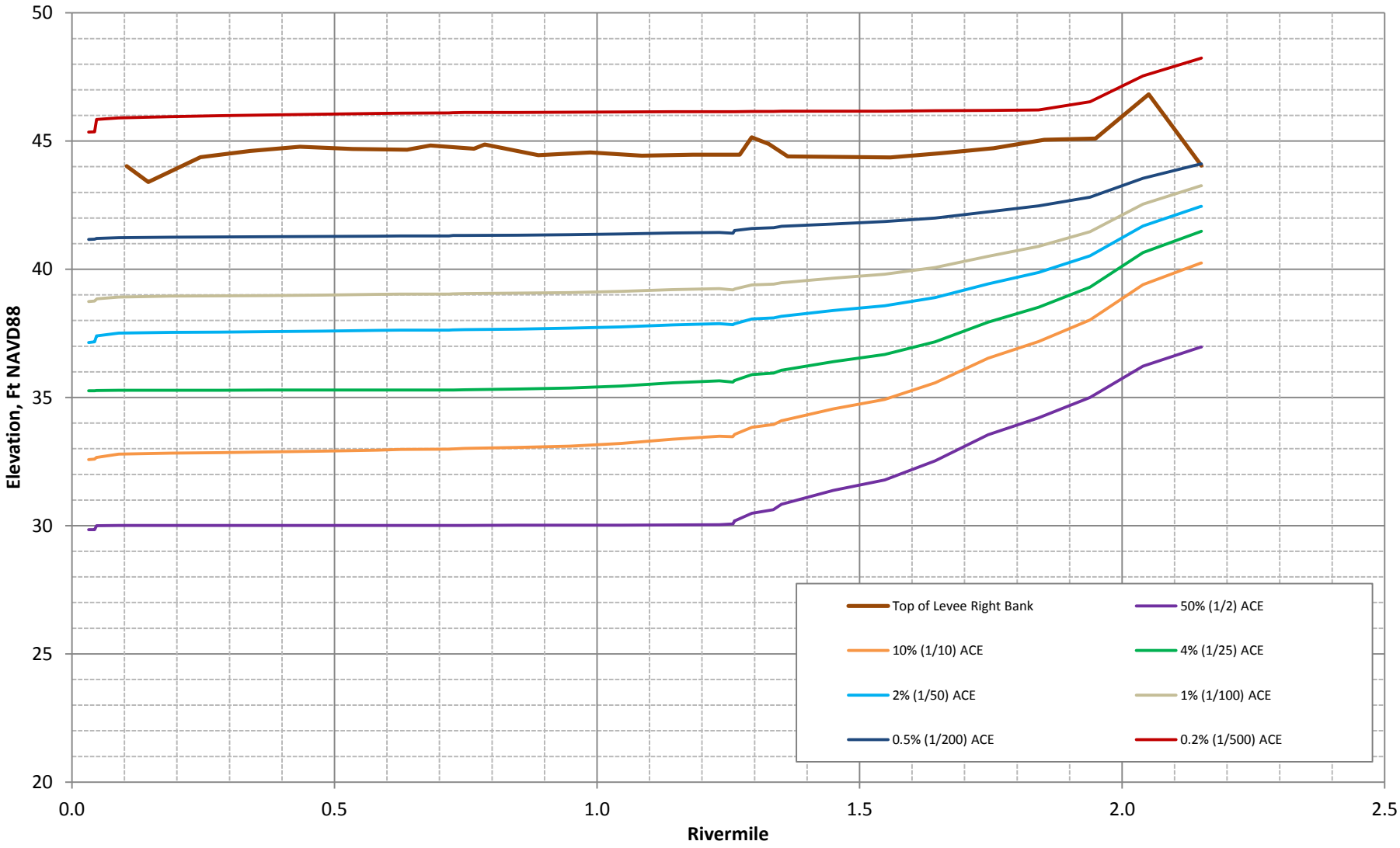
American River Common Features GRR Sacramento, California	**NEMDC – Right Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

NEMDC - Left Bank



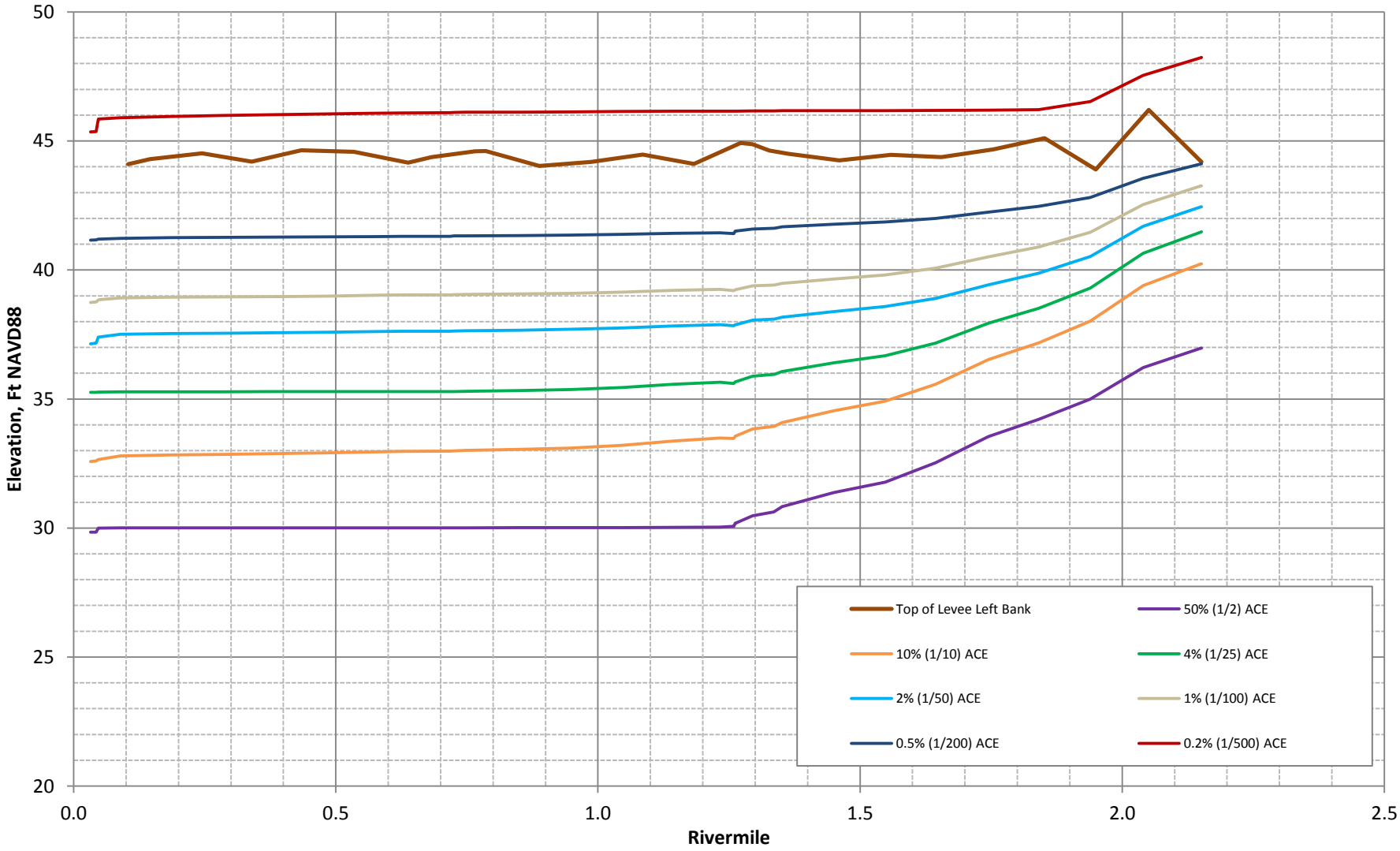
American River Common Features GRR **Sacramento, California**	**NEMDC – Left Bank Levee** **N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers** **Sacramento District**

Arcade Creek - Right Bank



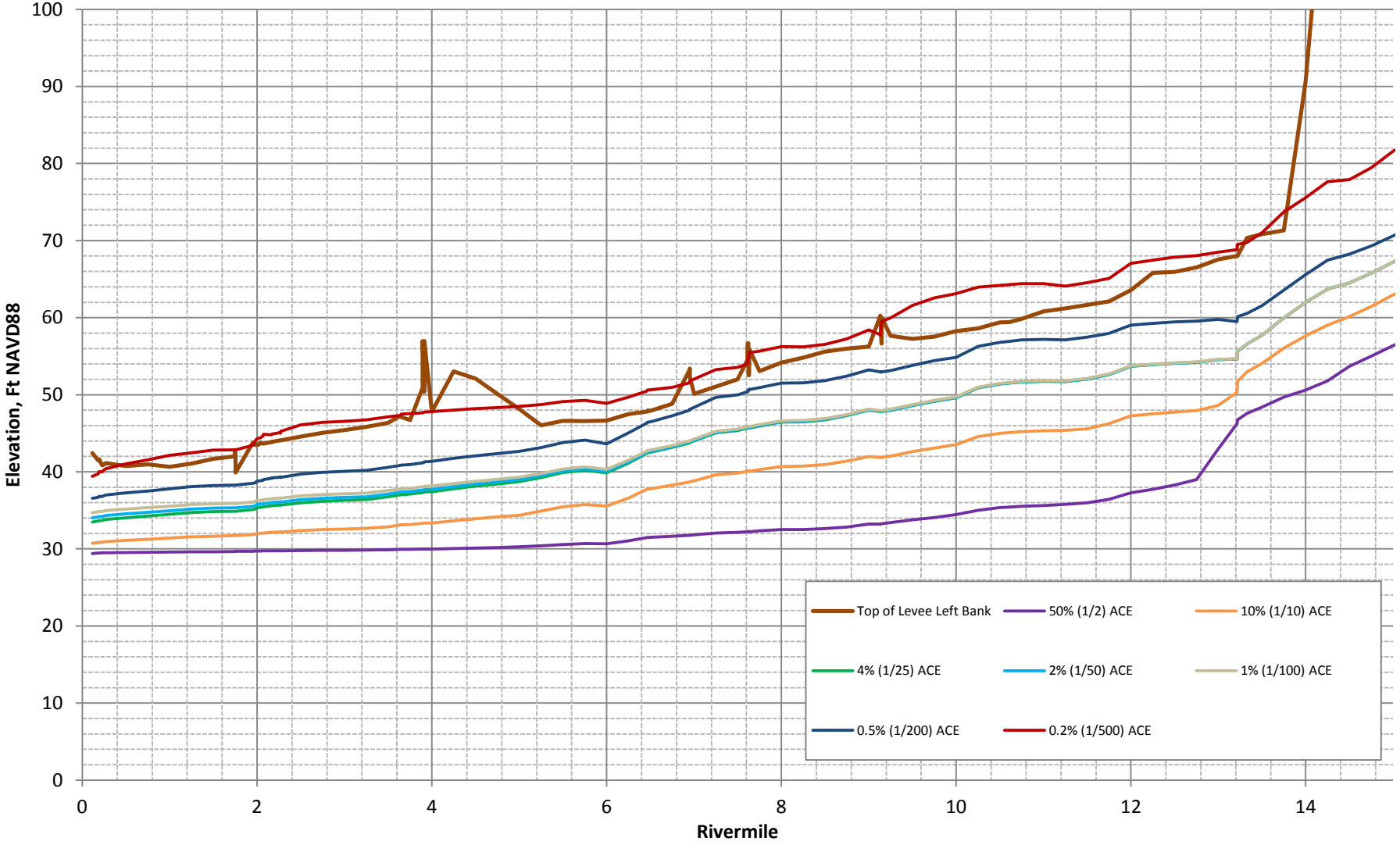
American River Common Features GRR **Sacramento, California**	**Arcade Creek – Right Bank Levee** **N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers** **Sacramento District**

Arcade Creek - Left Bank



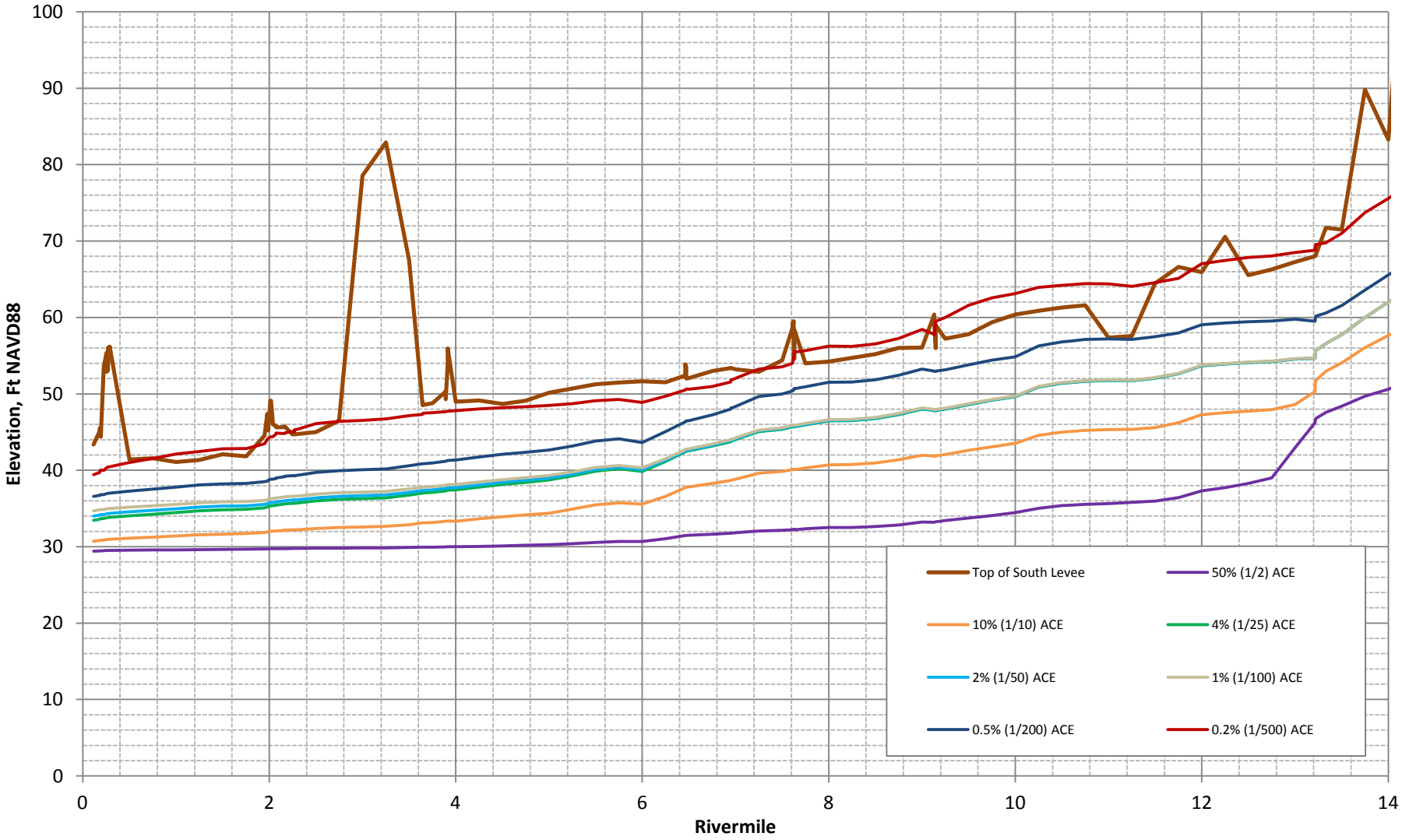
American River Common Features GRR Sacramento, California	**Arcade Creek – Left Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

American River - Right Bank

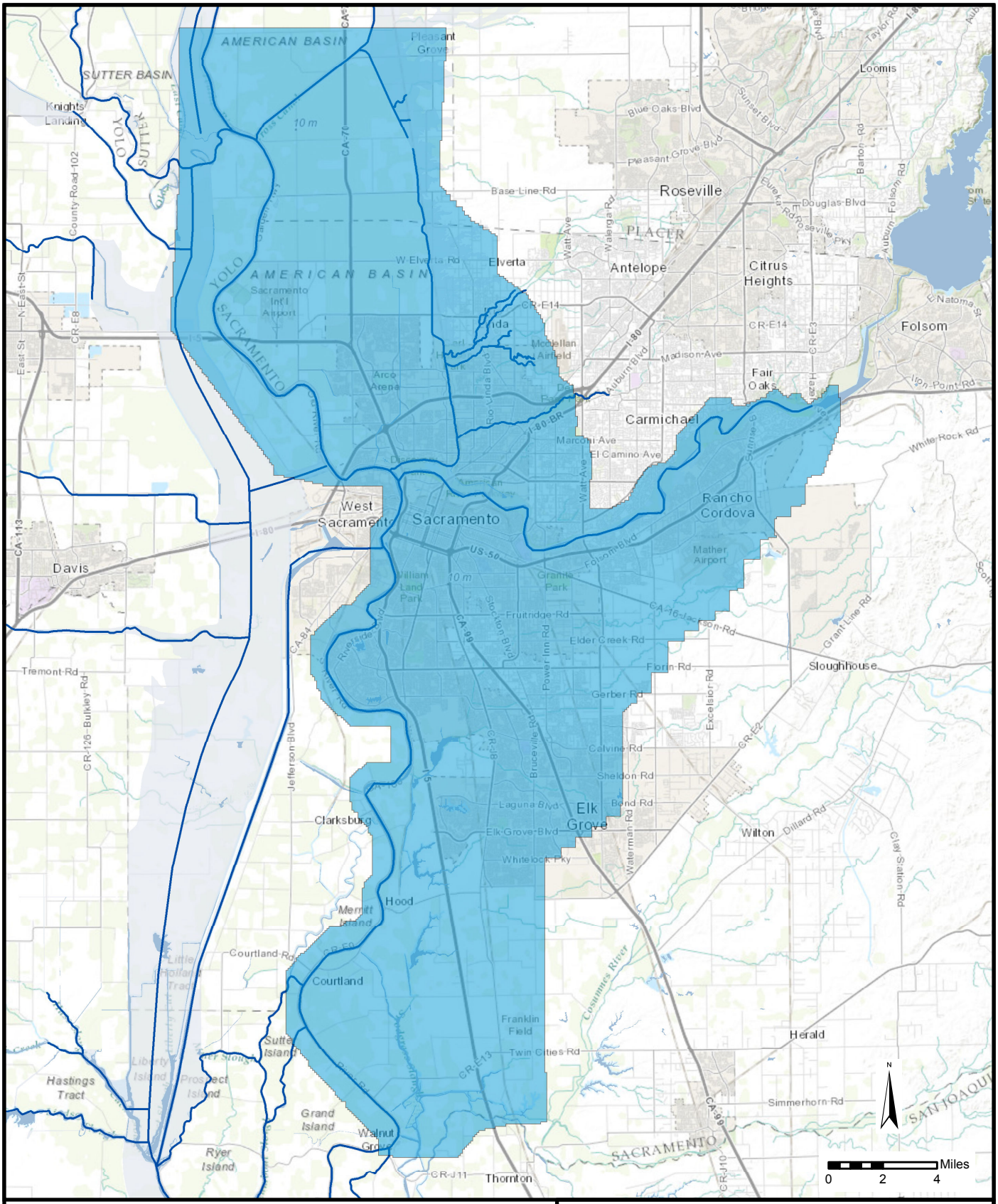


American River Common Features GRR Sacramento, California	**American River – Right Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**

American River - Left Bank



American River Common Features GRR Sacramento, California	**American River – Left Bank Levee N-Yr Water Surface Profiles Future Without-Project Condition**	**U.S. Army Corps of Engineers Sacramento District**



LEGEND

- FLO2D Extents
- Rivers and Streams

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

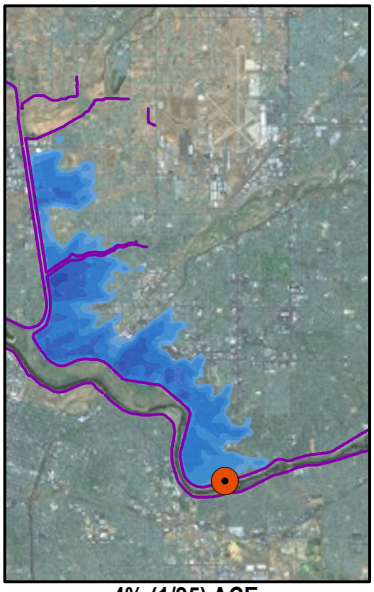
FLO2D MODEL EXTENTS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Jan 2013

50% (1/2) ACE

10% (1/10) ACE



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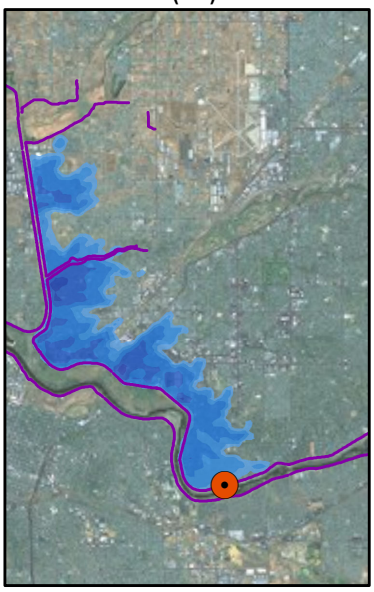

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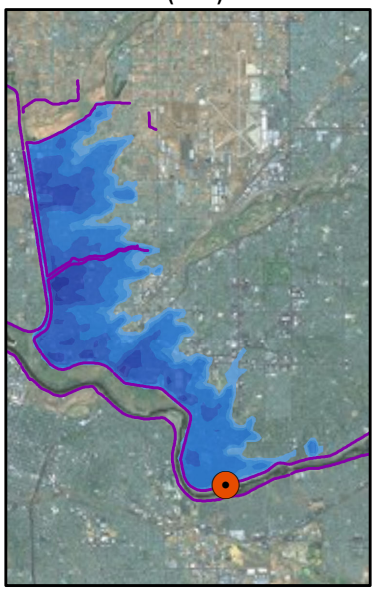

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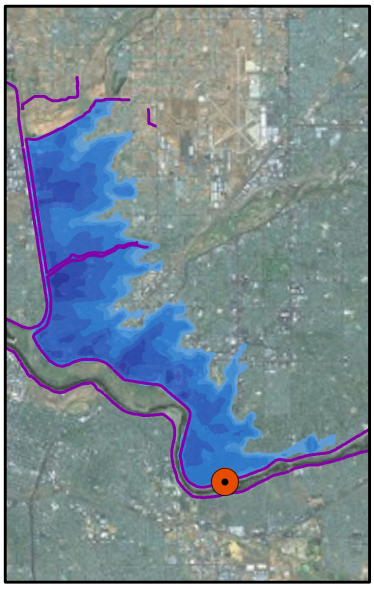

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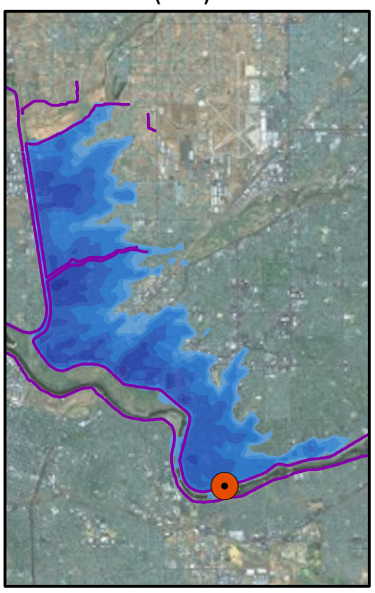
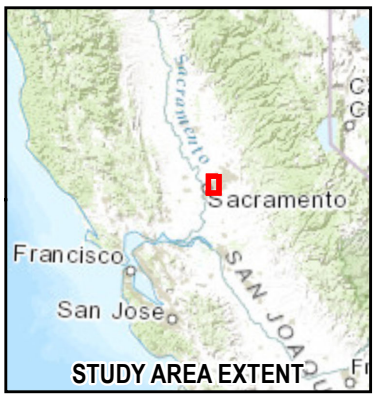


0.2% (1/500) ACE

LEGEND

Depths of Flooding (Feet)

- < 1
- 1.1 - 3
- 3.1 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 +



N

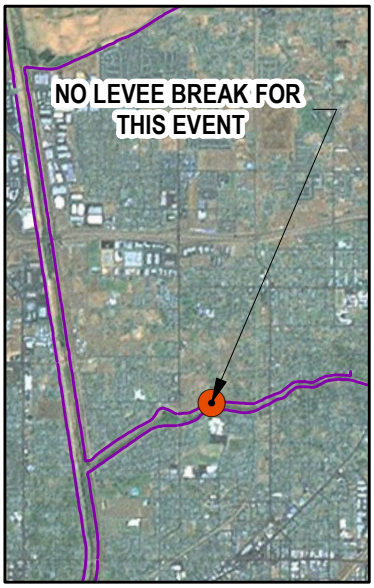
0 1.5 3 Miles

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

ECONOMIC FLOODPLAINS
BASED ON A LEVEE BREACH SIMULATION
AMERICAN RIVER NORTH INDEX PT A.

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013



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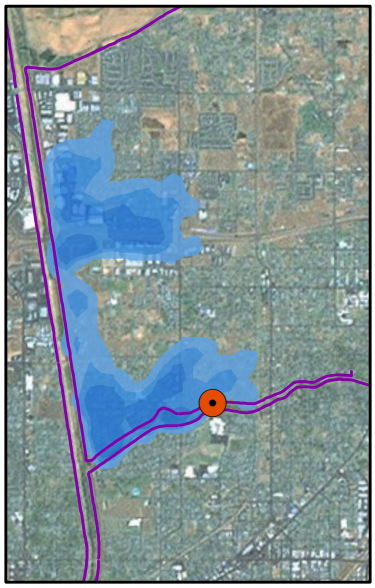

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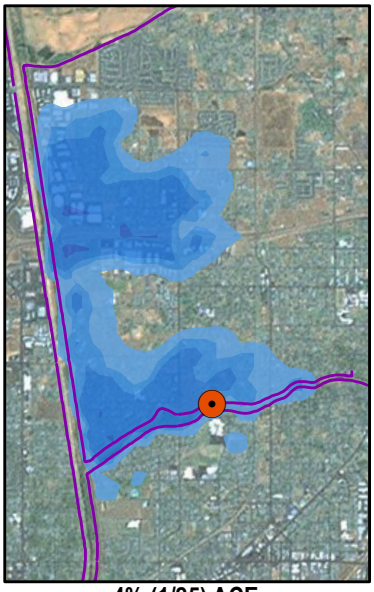

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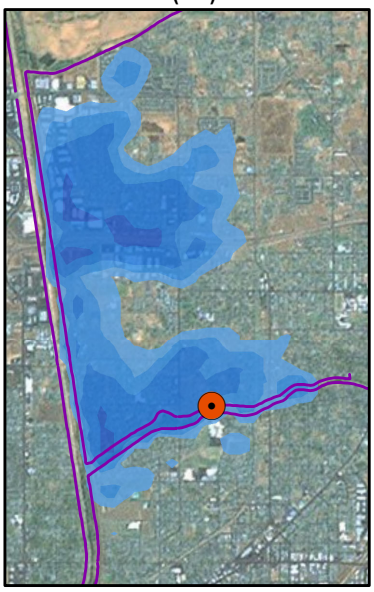

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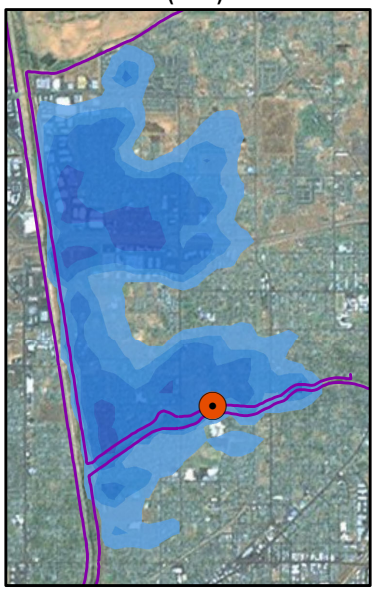

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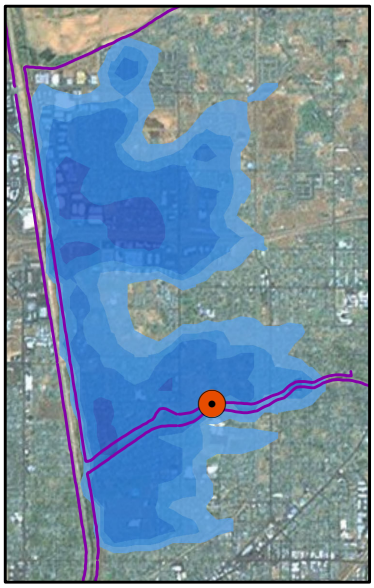

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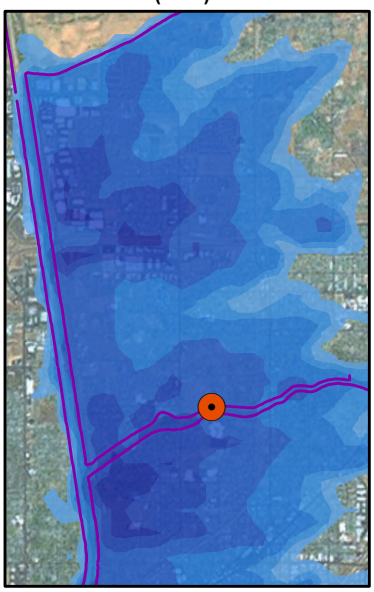
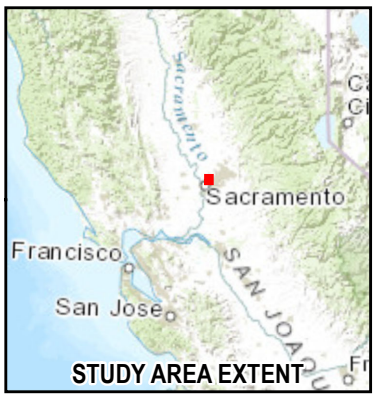


0.2% (1/500) ACE

LEGEND

Depths of Flooding (Feet)

- < 1
- 1.1 - 3
- 3.1 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 +



N

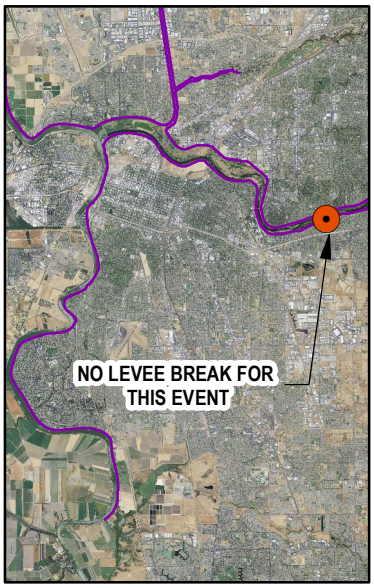
Miles

0 0.5 1

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

ECONOMIC FLOODPLAINS BASED ON A LEVEE BREACH SIMULATION AMERICAN RIVER NORTH INDEX PT E.

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



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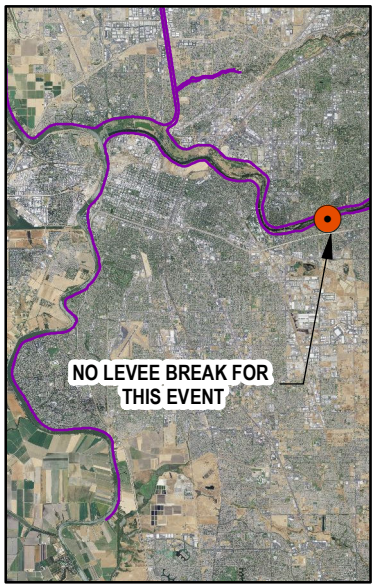

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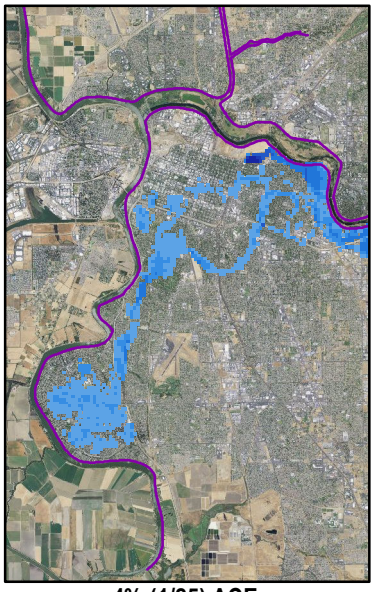

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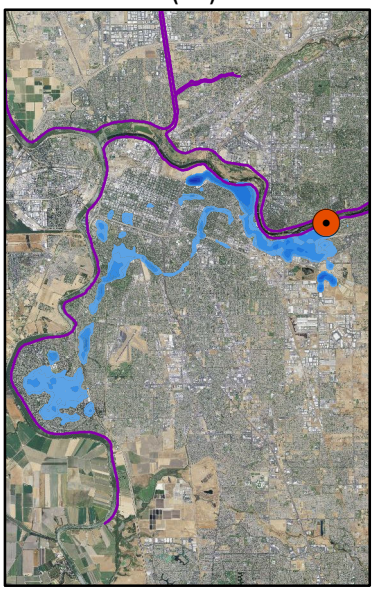

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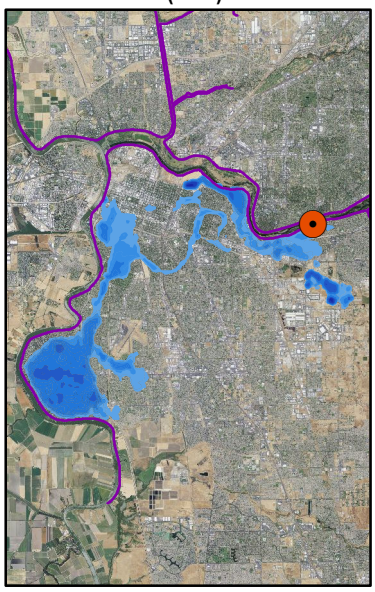

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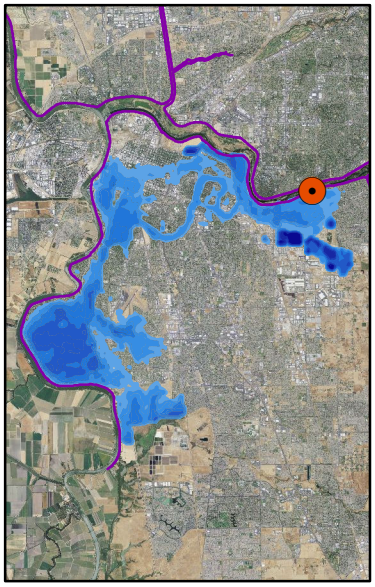

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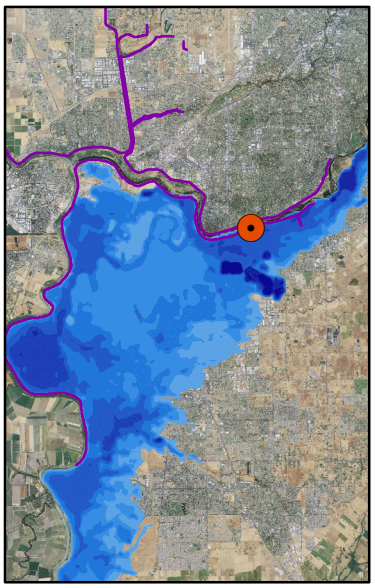


0.2% (1/500) ACE

LEGEND

Depths of Flooding (Feet)

- < 1
- 1.1 - 3
- 3.1 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 +

STUDY AREA EXTENT

N

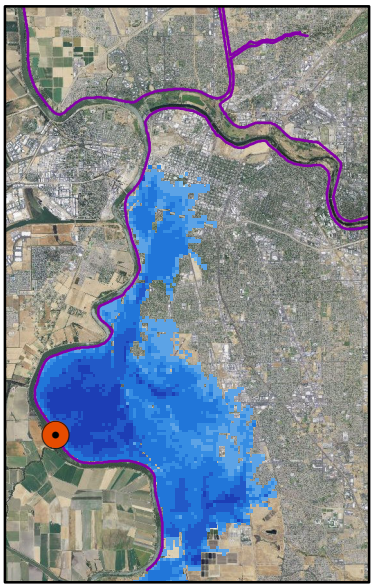
0 3 6 Miles

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

ECONOMIC FLOODPLAINS BASED ON A LEVEE BREACH SIMULATION AMERICAN RIVER SOUTH INDEX PT A.

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2014



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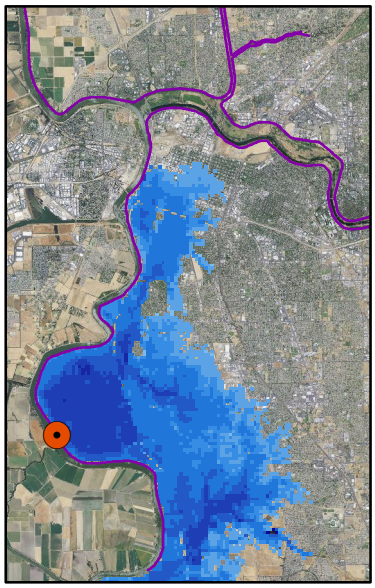

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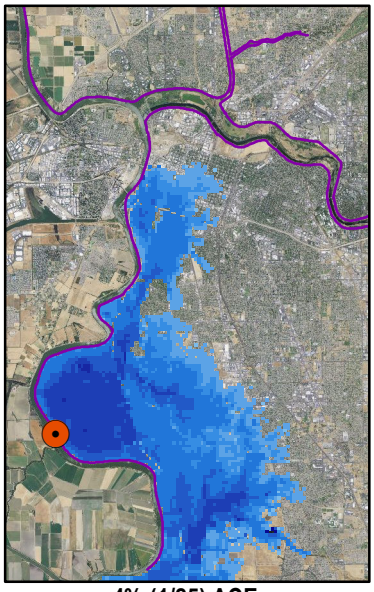

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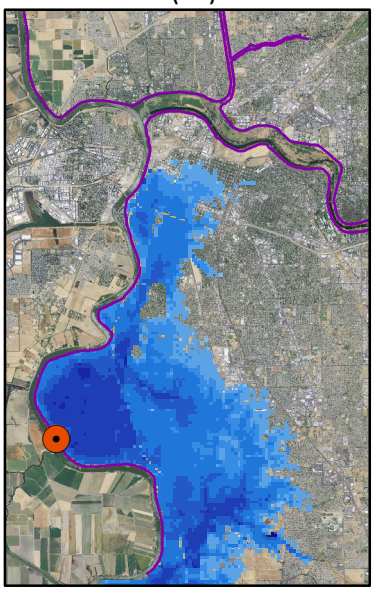

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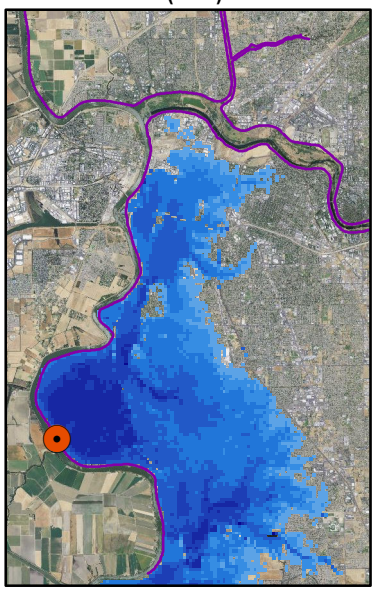

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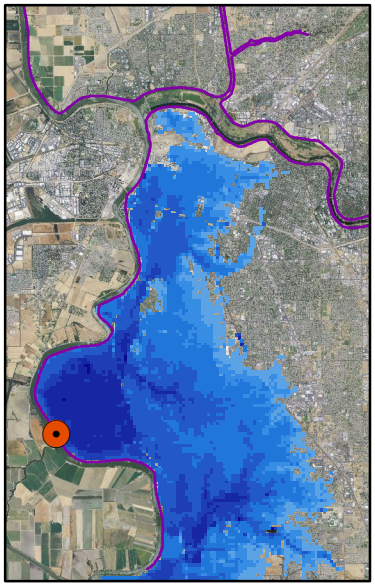

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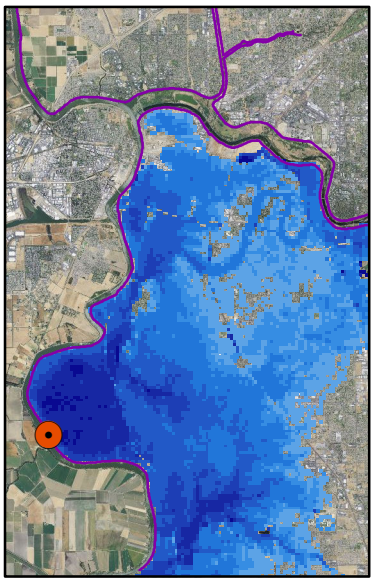
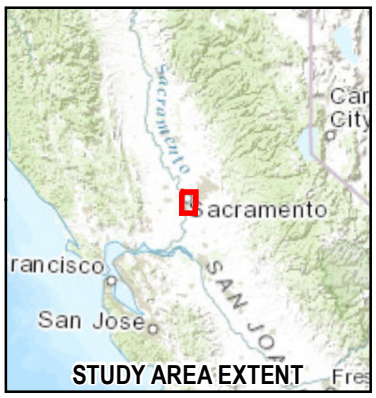


0.2% (1/500) ACE

LEGEND

Depths of Flooding (Feet)

- < 1
- 1.1 - 3
- 3.1 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 +



N

Miles

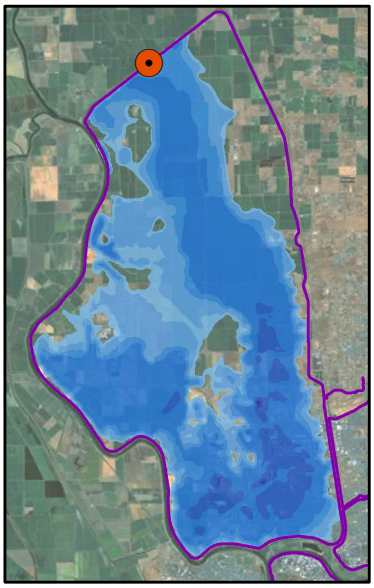
0 2 4

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

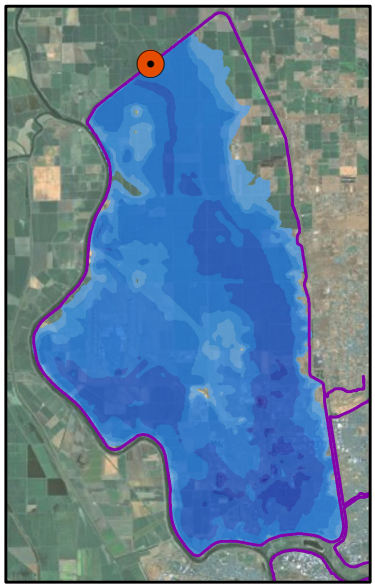
ECONOMIC FLOODPLAINS BASED ON A LEVEE BREACH SIMULATION AMERICAN RIVER SOUTH INDEX PT F.

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

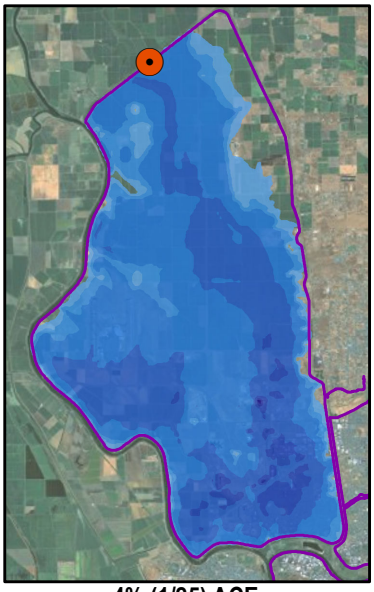
June 2014



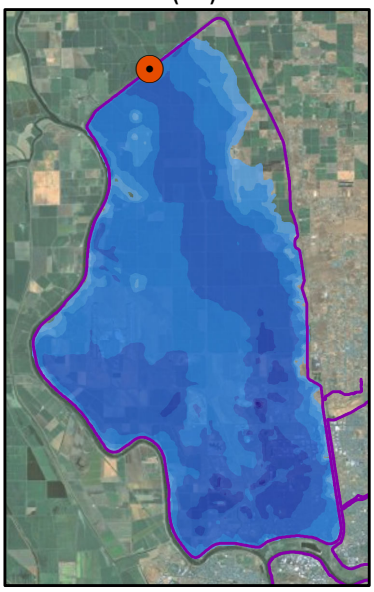
50% (1/2) ACE



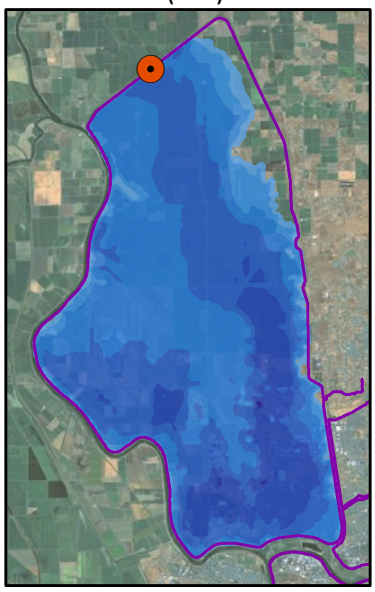
10% (1/10) ACE



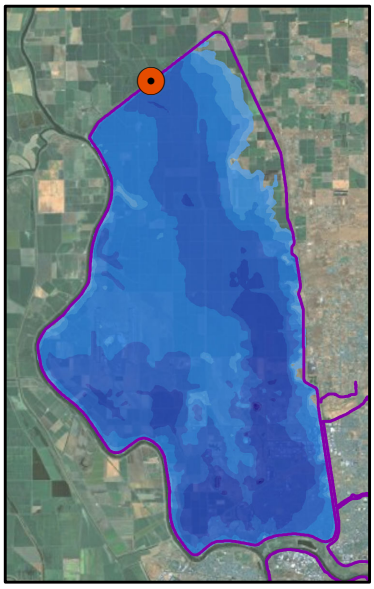
4% (1/25) ACE



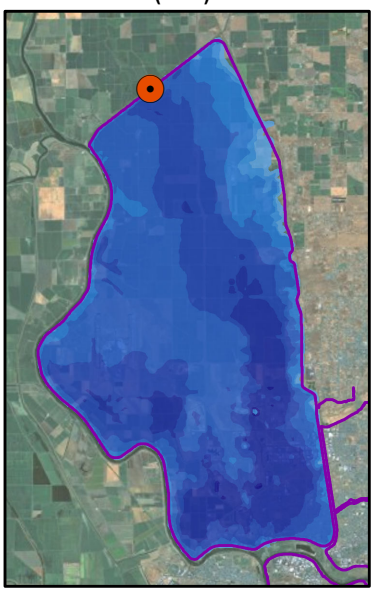
2% (1/50) ACE



1% (1/100) ACE



0.5% (1/200) ACE

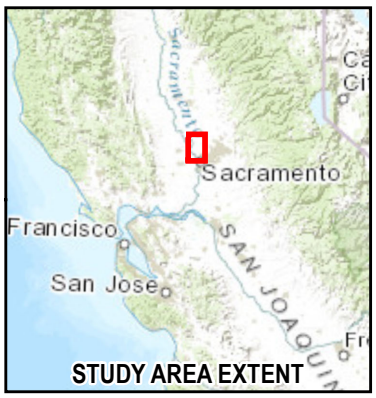


0.2% (1/500) ACE

LEGEND

Depths of Flooding (Feet)

- < 1
- 1.1 - 3
- 3.1 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 +



N

0 2.5 5 Miles

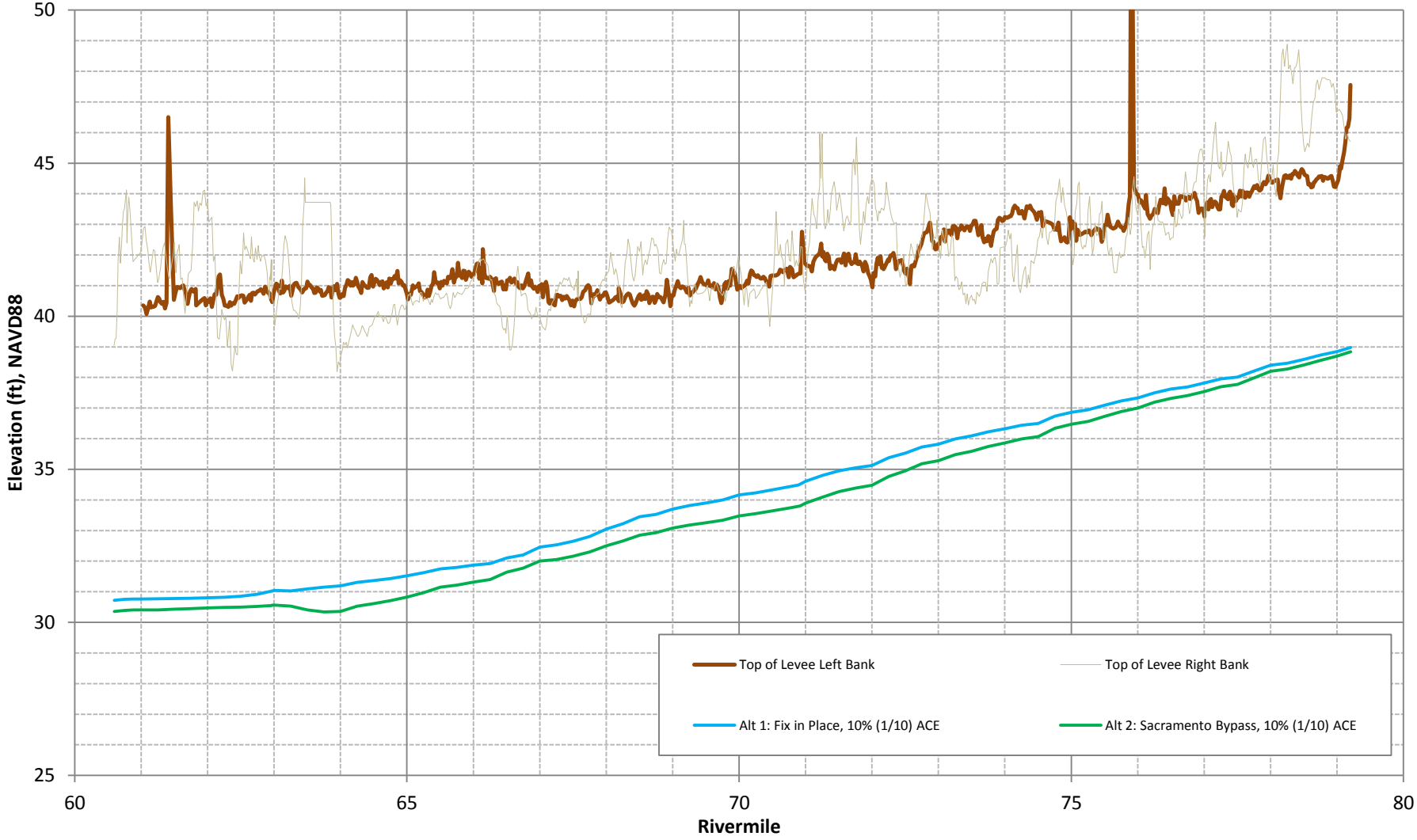
AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

ECONOMIC FLOODPLAINS BASED ON A LEVEE BREACH SIMULATION NATOMAS BASIN INDEX PT D.

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

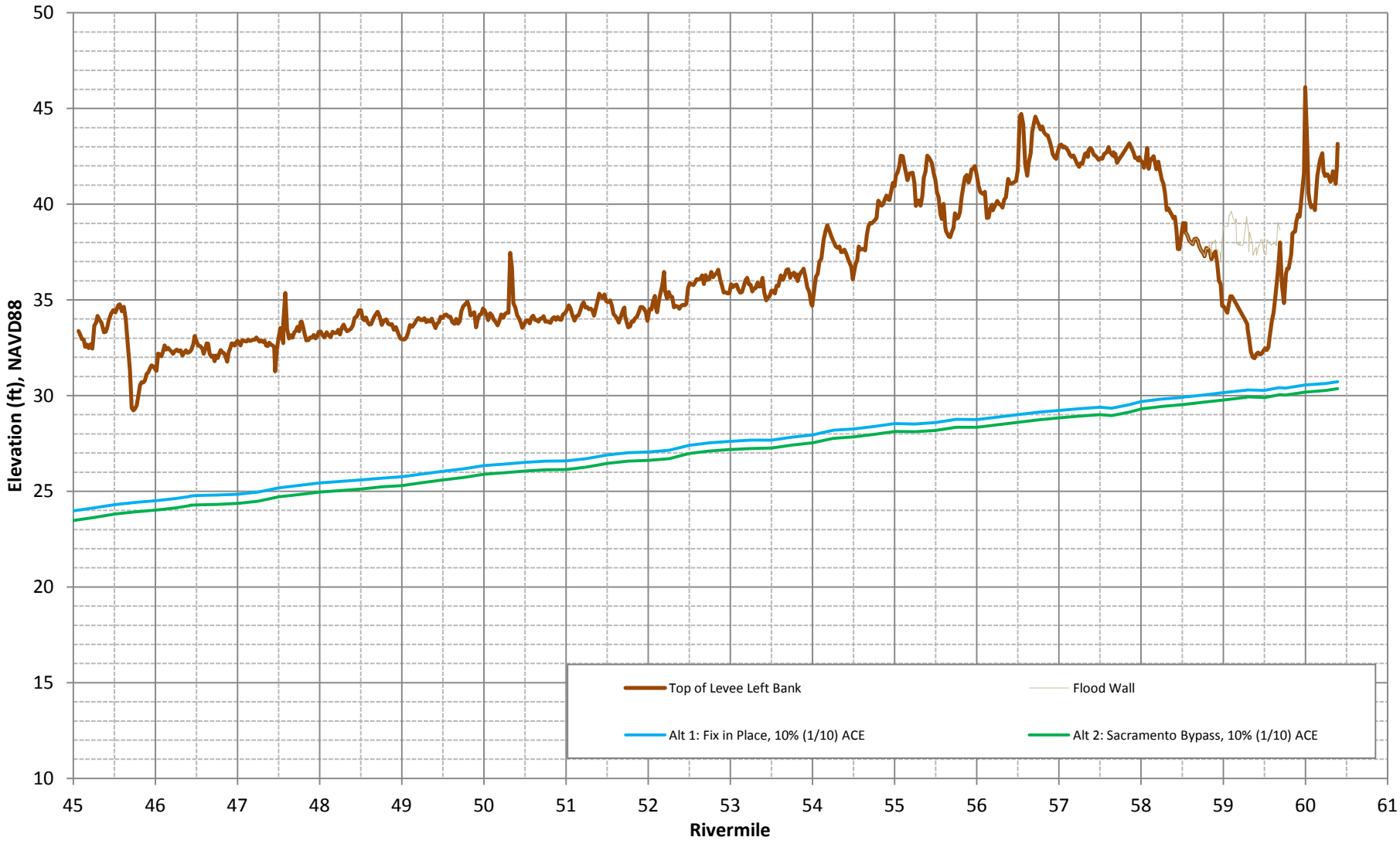
Feb 2013

Sacramento River (Upstream of the American River) - 10% (1/10) ACE Water Surface Profile



American River Common Features GRR Sacramento, California	Sacramento River (U/S of the American River) – Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives	U.S. Army Corps of Engineers Sacramento District

Sacramento River (Downstream of the American River) - 10% (1/10) ACE Water Surface Profile

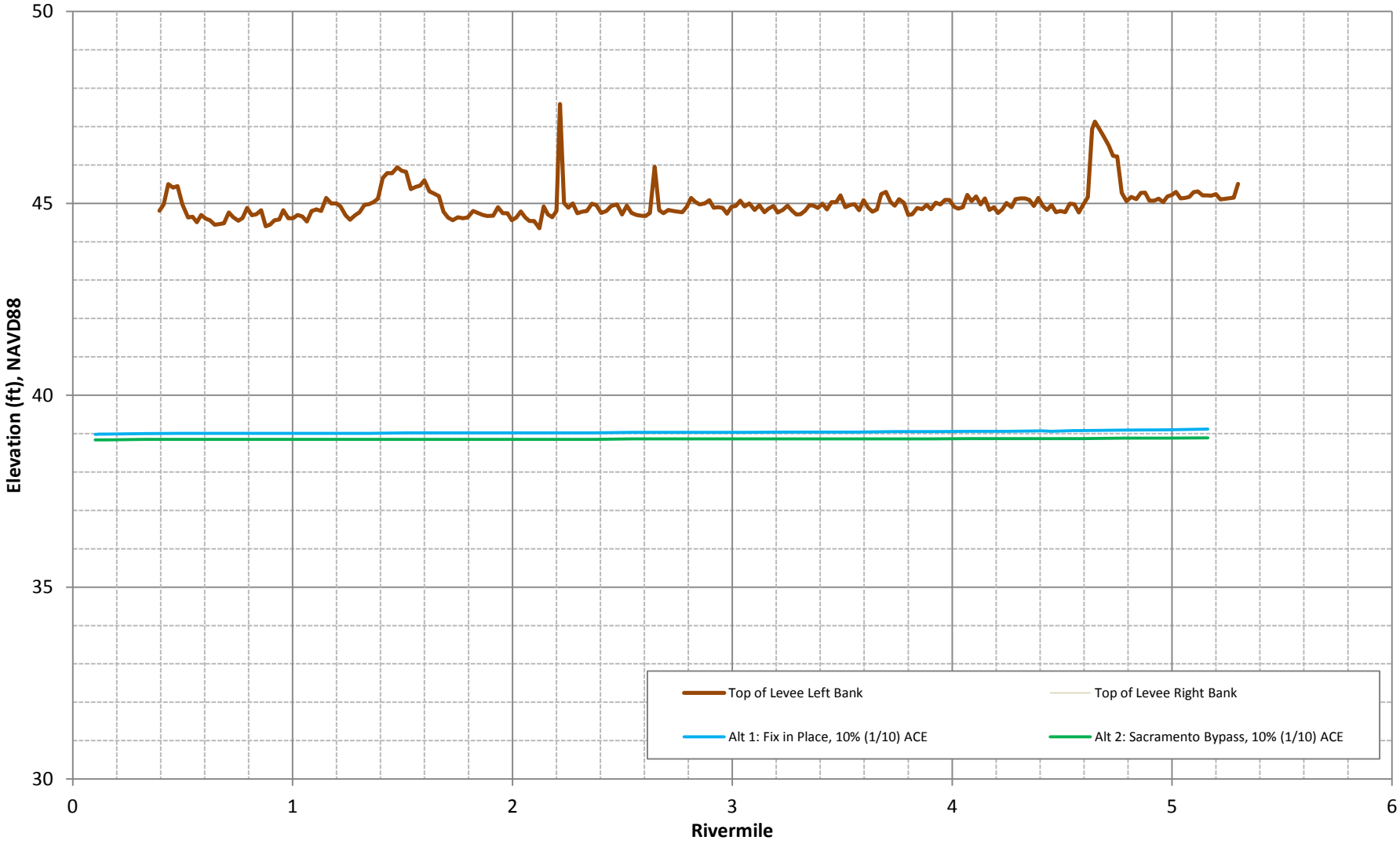


American River Common Features GRR Sacramento, California	Sacramento River (D/S of the American River) – Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives	U.S. Army Corps of Engineers Sacramento District

August 2015

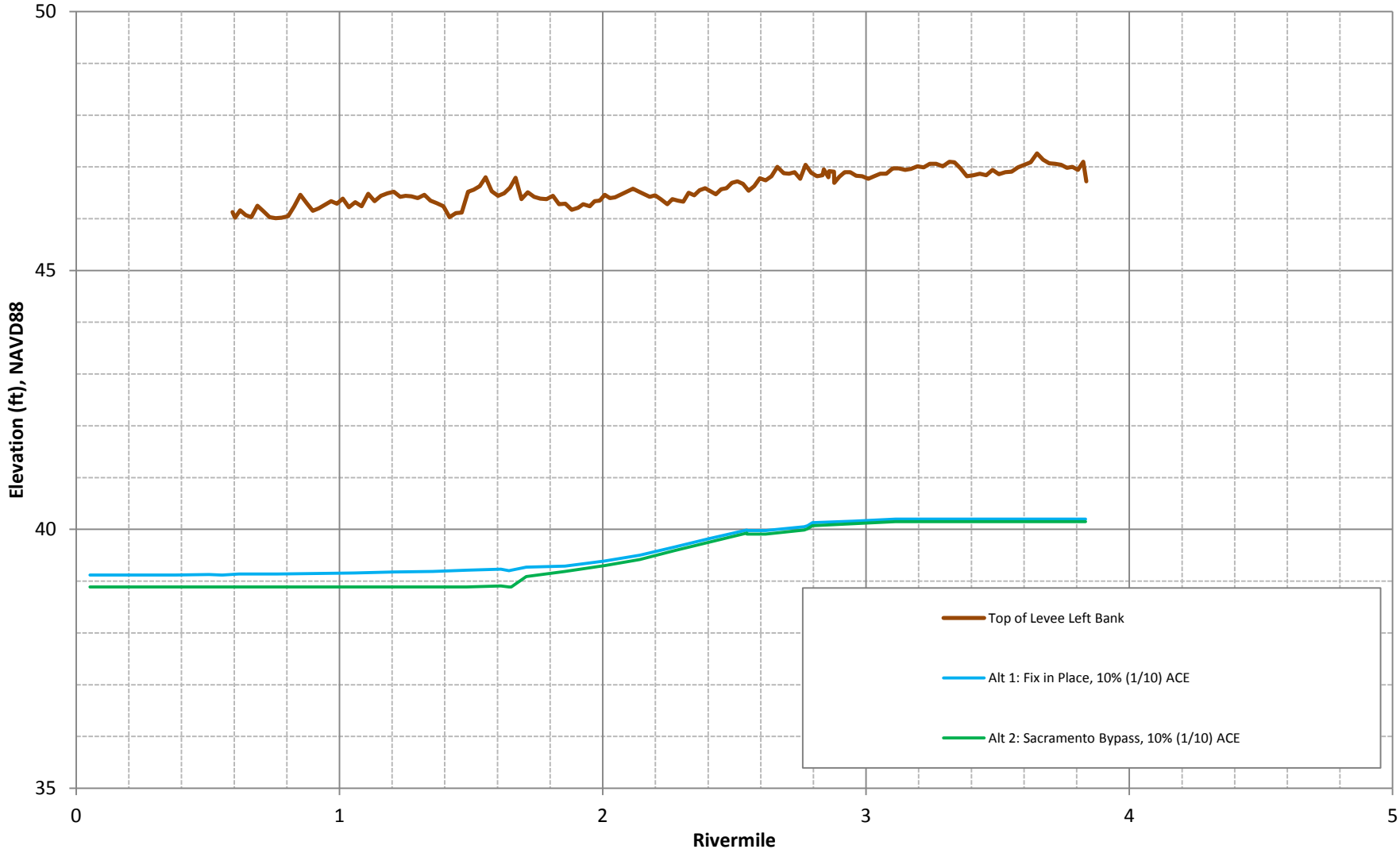
Plate 32

Natomas Cross Canal - 10% (1/10) ACE Water Surface Profile



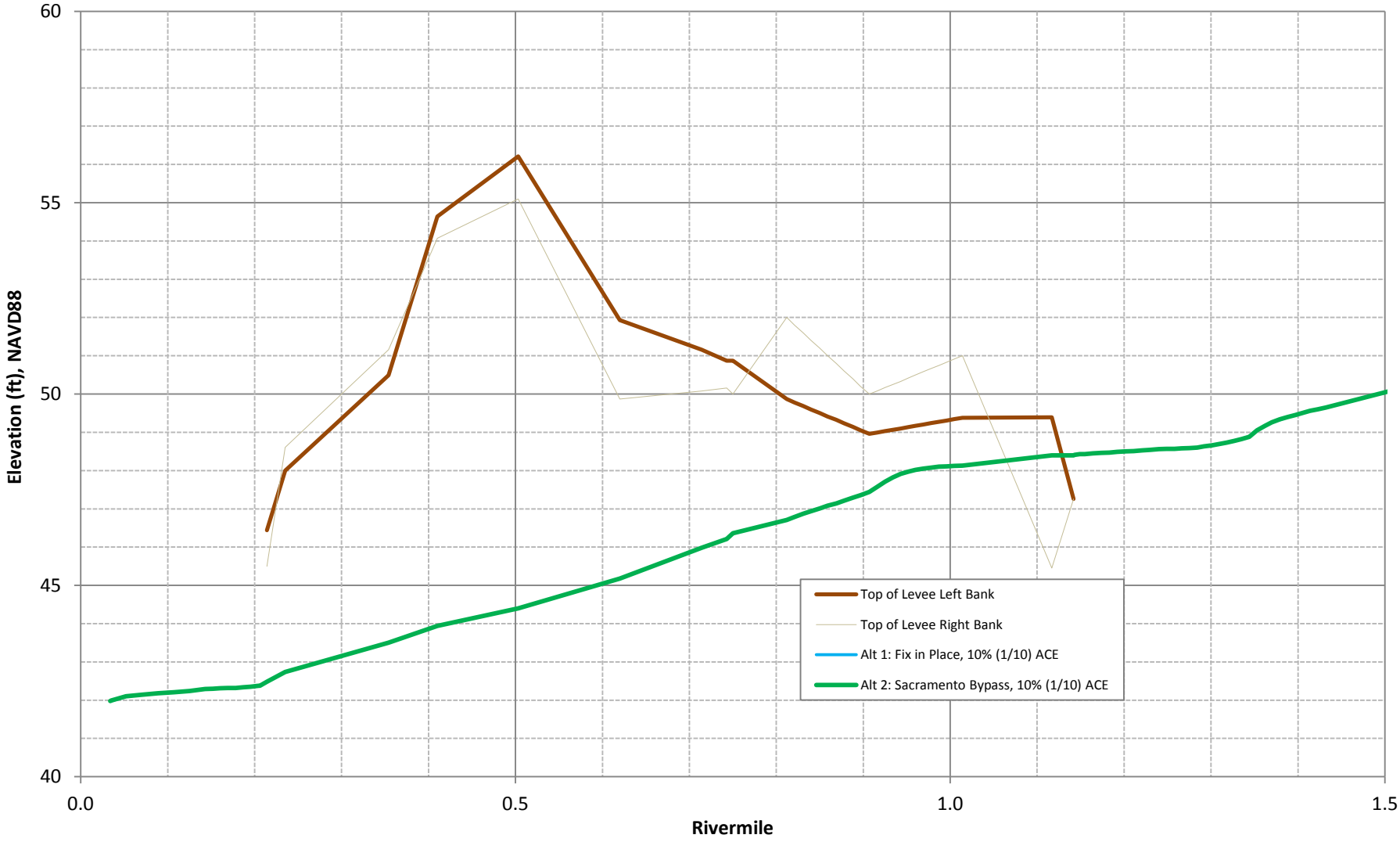
American River Common Features GRR Sacramento, California	**Natomas Cross Canal – Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Pleasant Grove Creek Canal - 10% (1/10) ACE Water Surface Profile



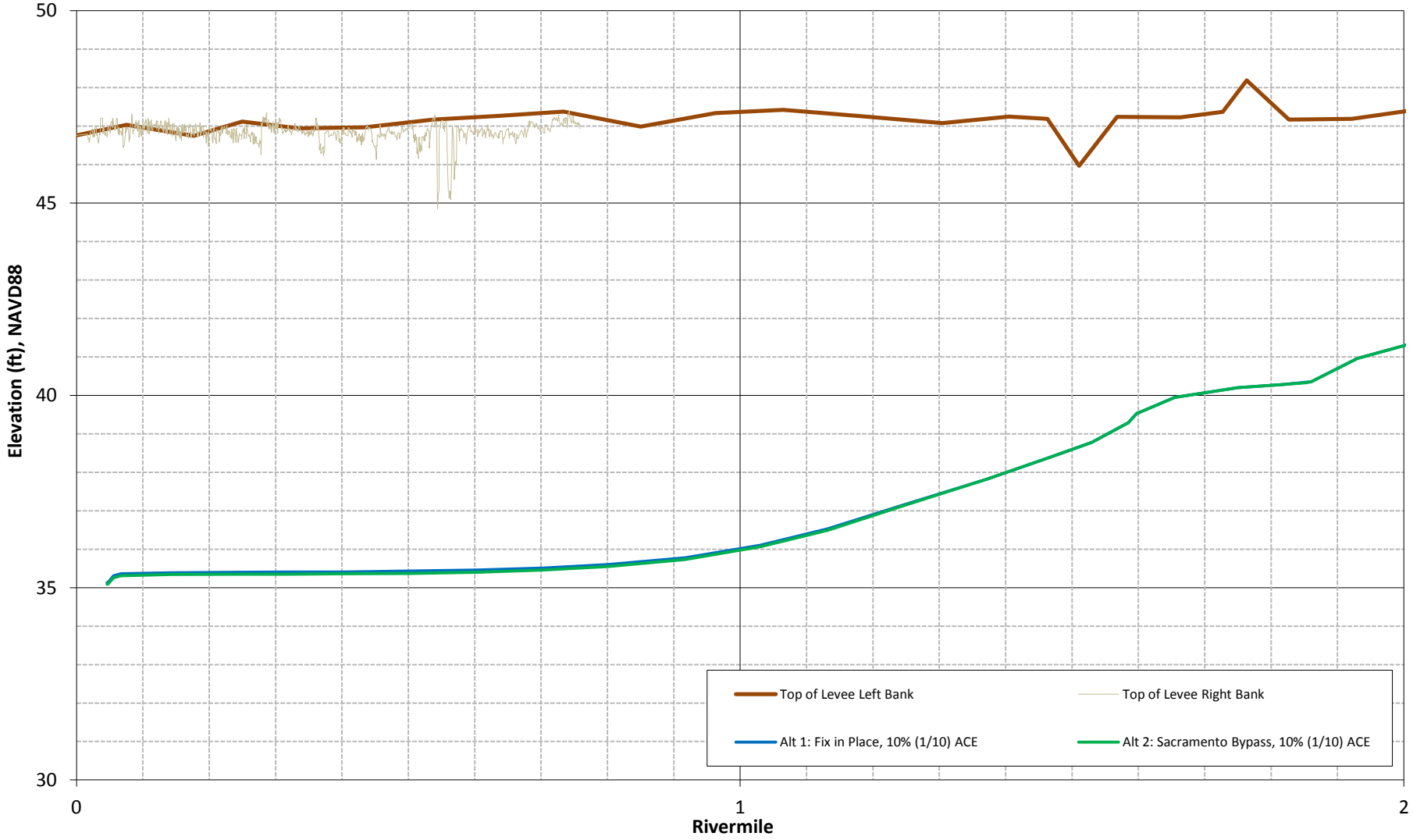
American River Common Features GRR Sacramento, California	**Pleasant Grove Creek Canal – Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Magpie Creek Left Bank Levee - 10% (1/10) ACE Water Surface Profile



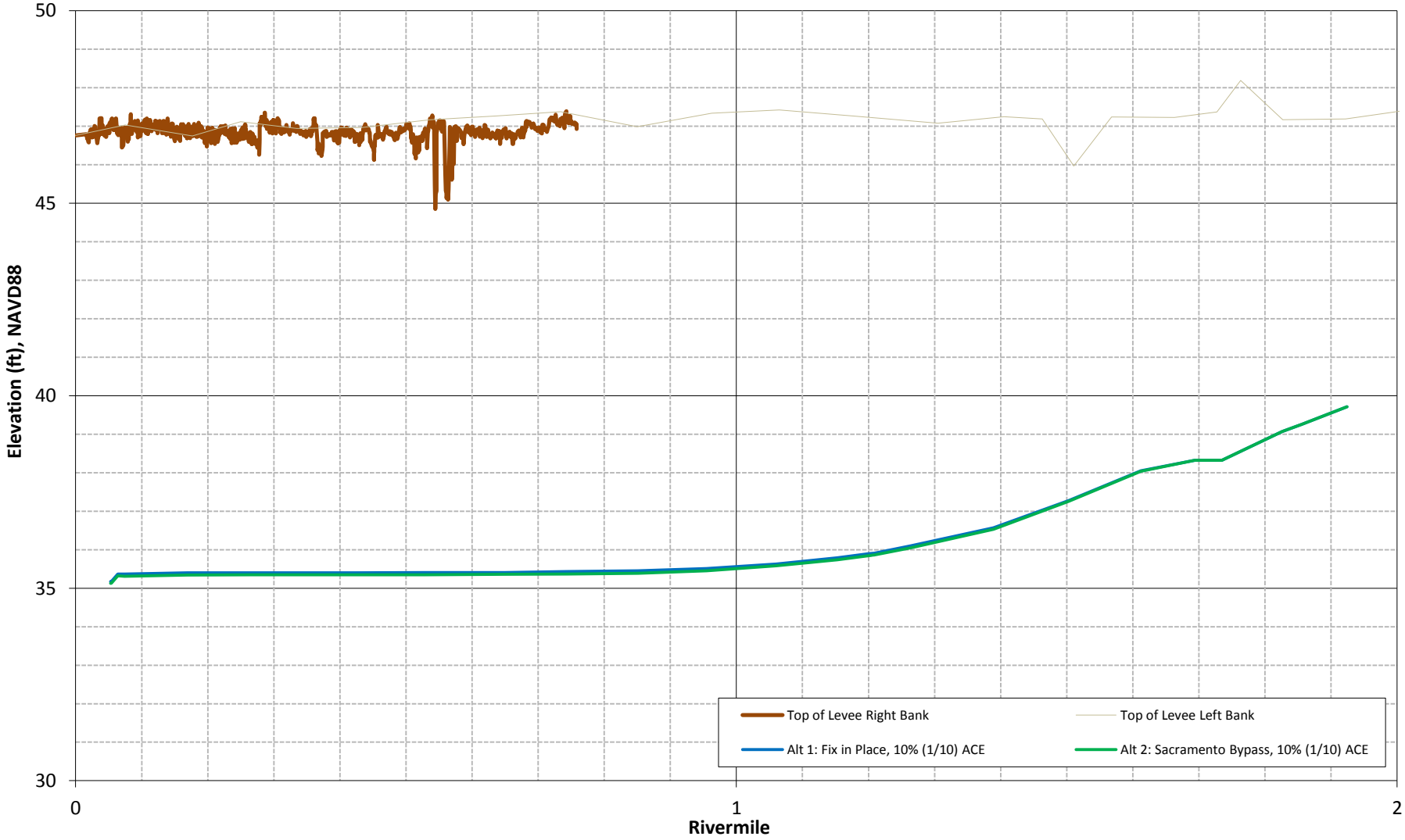
American River Common Features GRR Sacramento, California	**Magpie Creek – Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Dry Creek Left Bank Levee - 10% (1/10) ACE Water Surface Profile



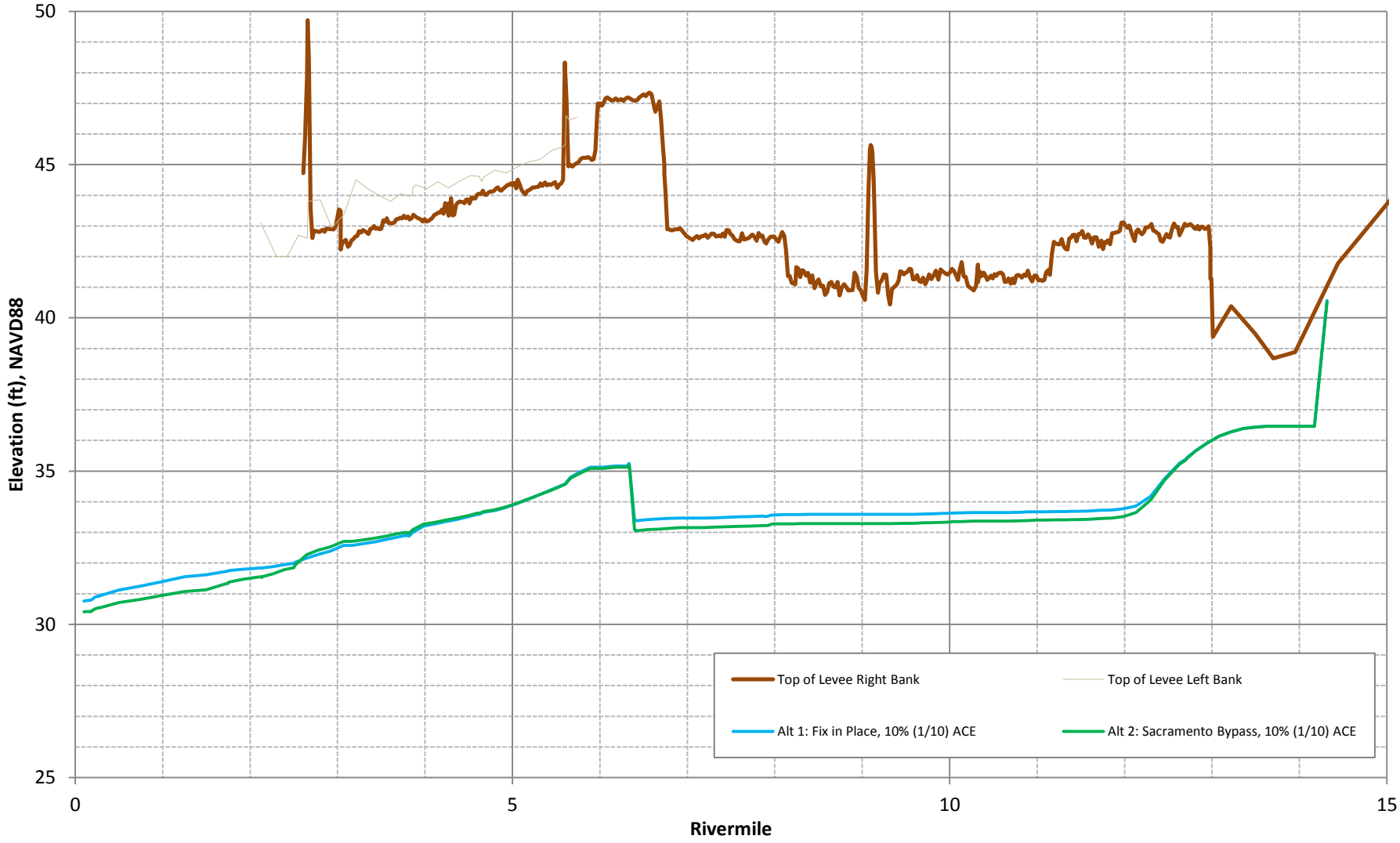
American River Common Features GRR Sacramento, California	**Dry Creek – Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Dry Creek Right Bank Levee - 10% (1/10) ACE Water Surface Profile



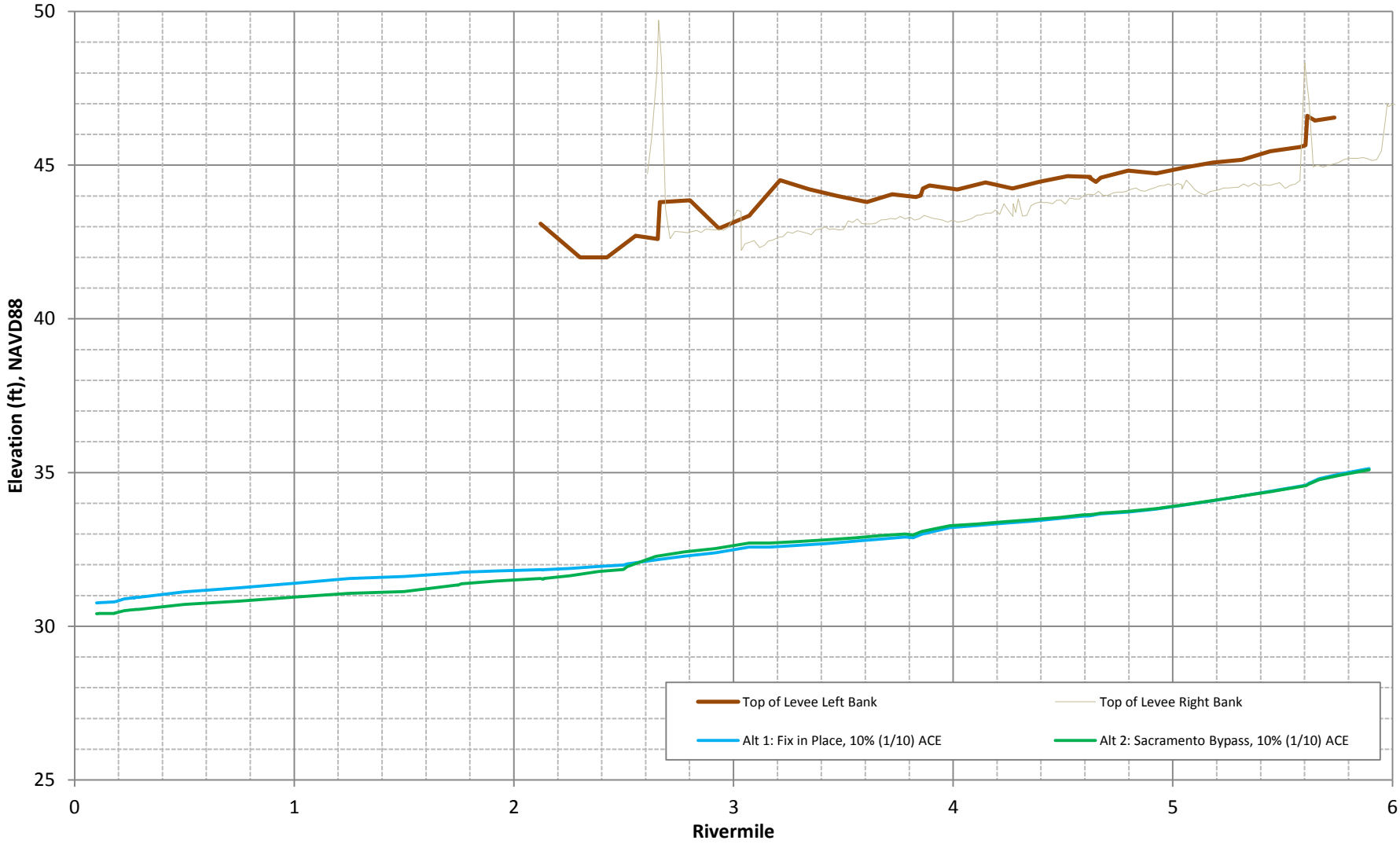
American River Common Features GRR Sacramento, California	**Dry Creek – Right Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

NEMDC Right Levee - 10% (1/10) ACE Mean Water Surface Profile



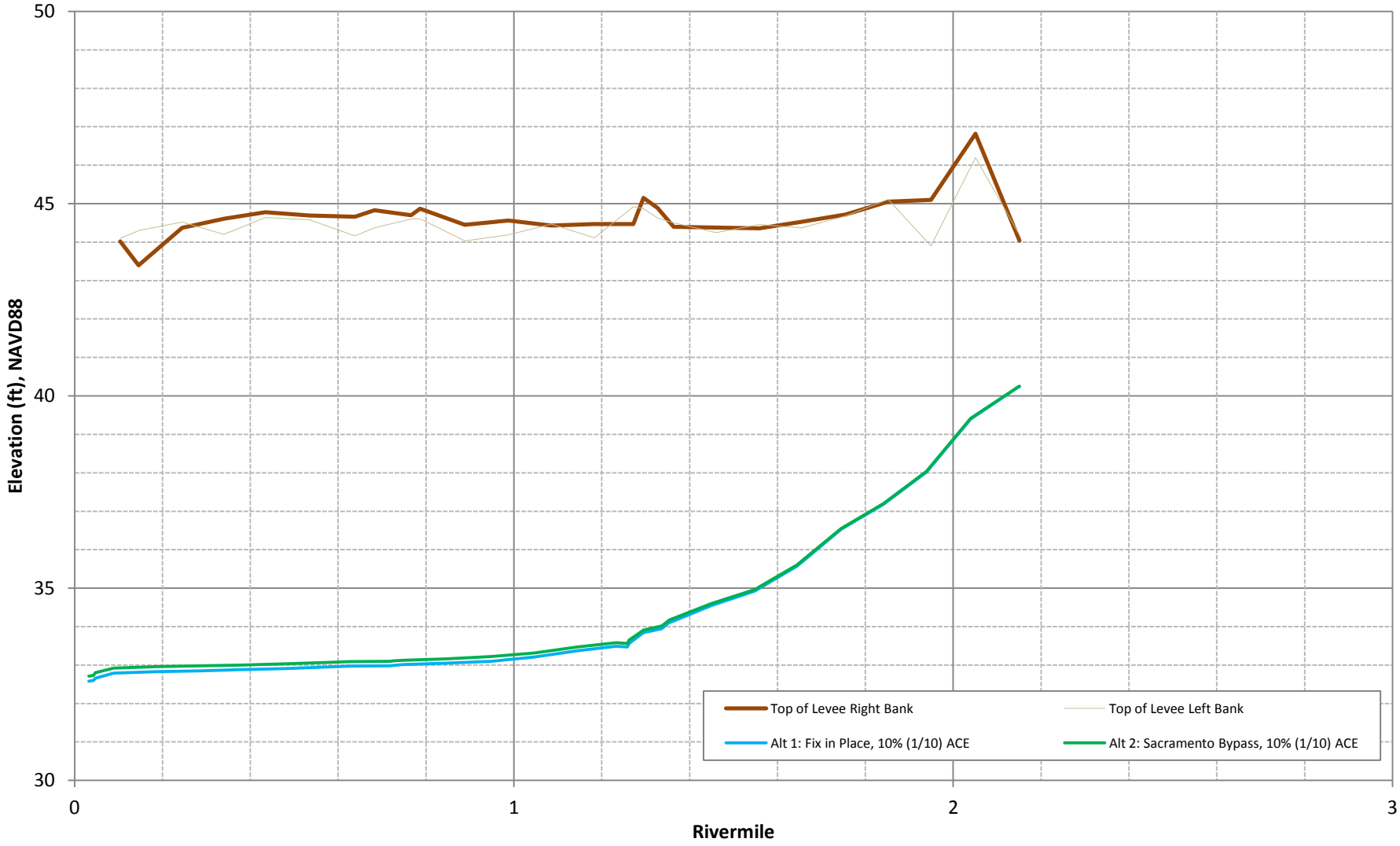
American River Common Features GRR Sacramento, California	**NEMDC – Right Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

NEMDC Left Levee - 10% (1/10) ACE Water Surface Profile



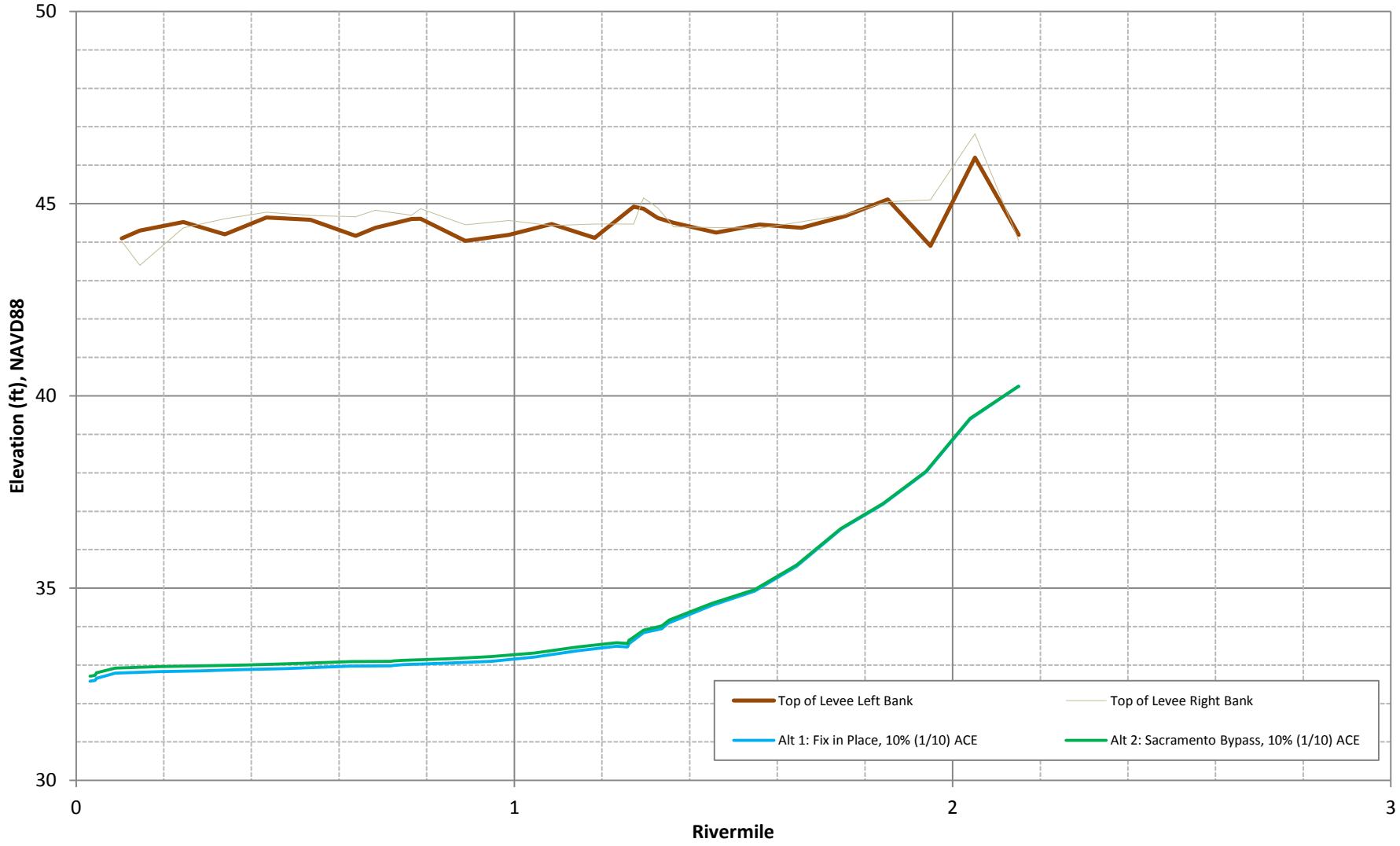
American River Common Features GRR Sacramento, California	**NEMDC – Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Arcade Creek Right Bank Levee - 10% (1/10) ACE Water Surface Profile



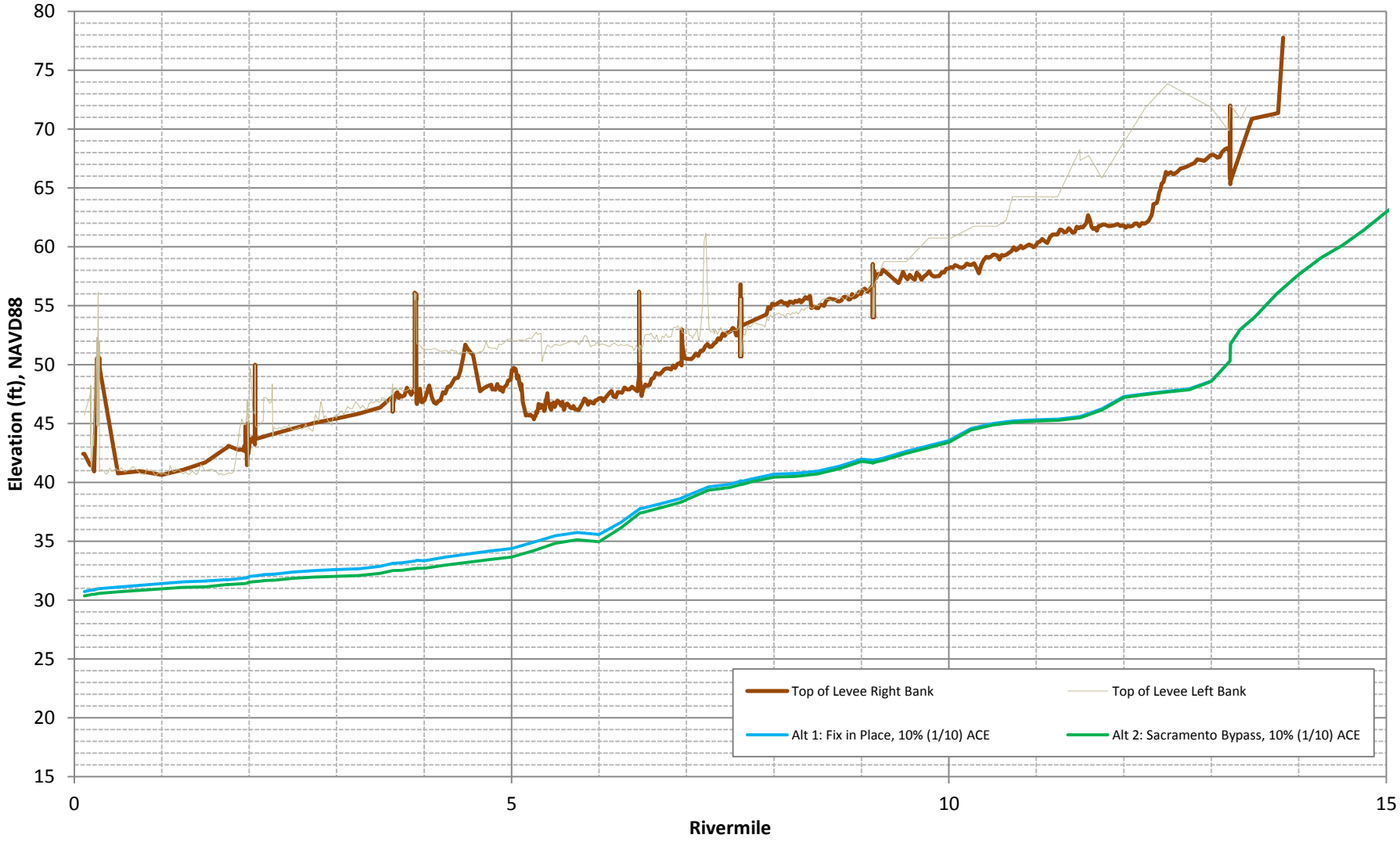
American River Common Features GRR Sacramento, California	**Arcade Creek - Right Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Arcade Creek Left Bank Levee - 10% (1/10) ACE Water Surface Profile



American River Common Features GRR Sacramento, California	**Arcade Creek - Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

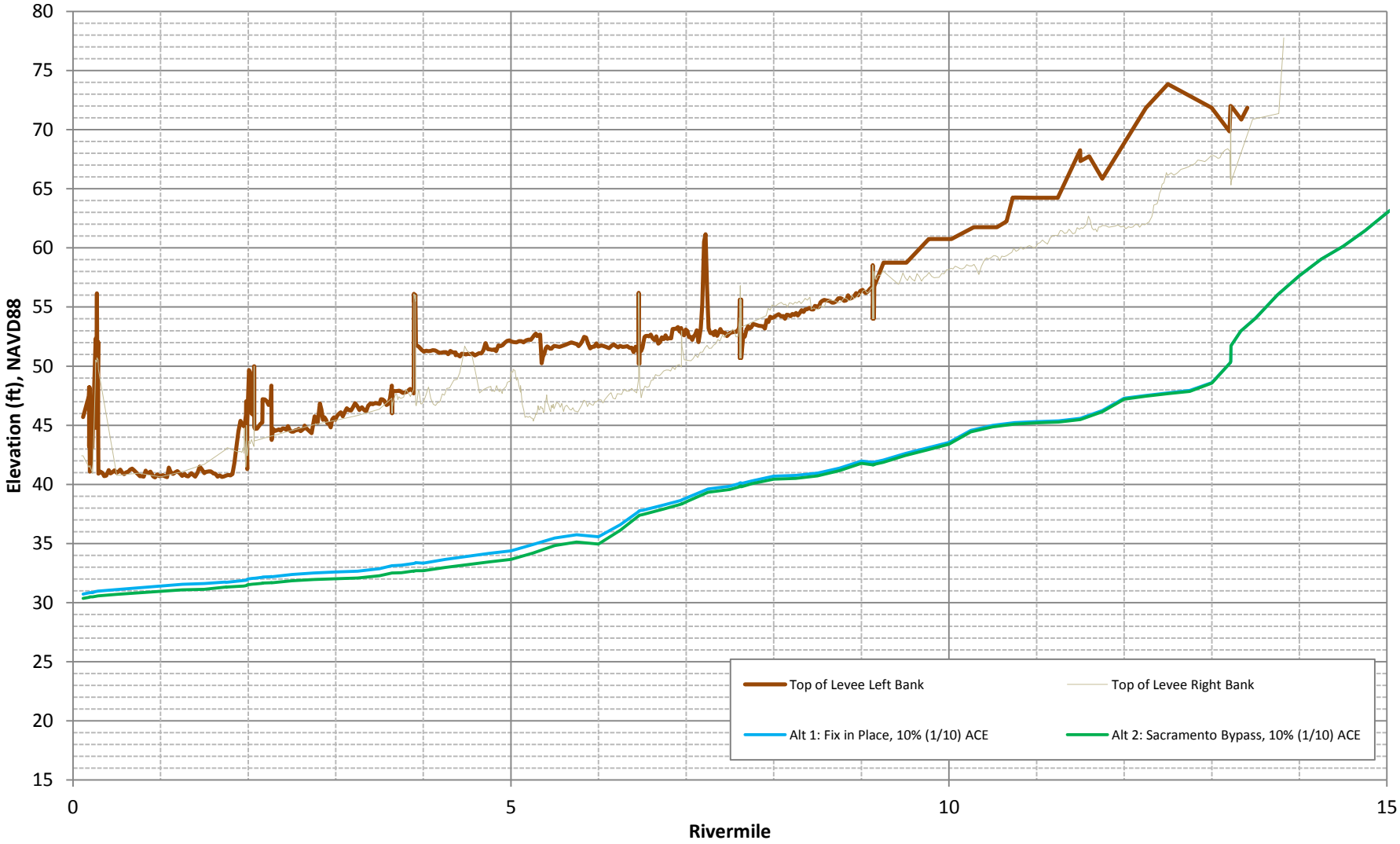
American River Right Bank Levee - 10% (1/10) ACE Mean Water Surface Profile



American River Common Features GRR Sacramento, California	**American River – Right Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

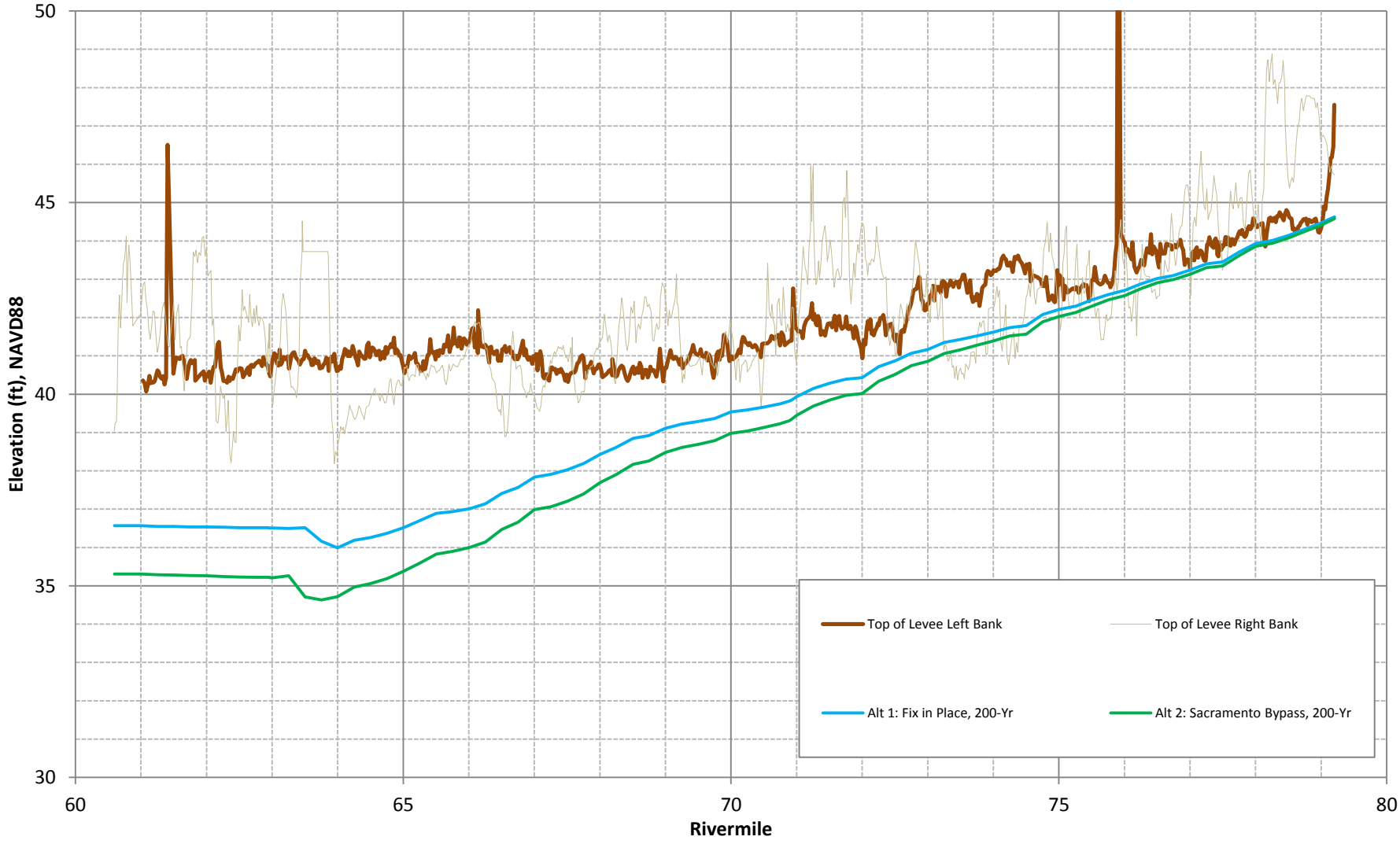
August 2015

American River Left Bank Levee - 10% (1/10) ACE Water Surface Profile



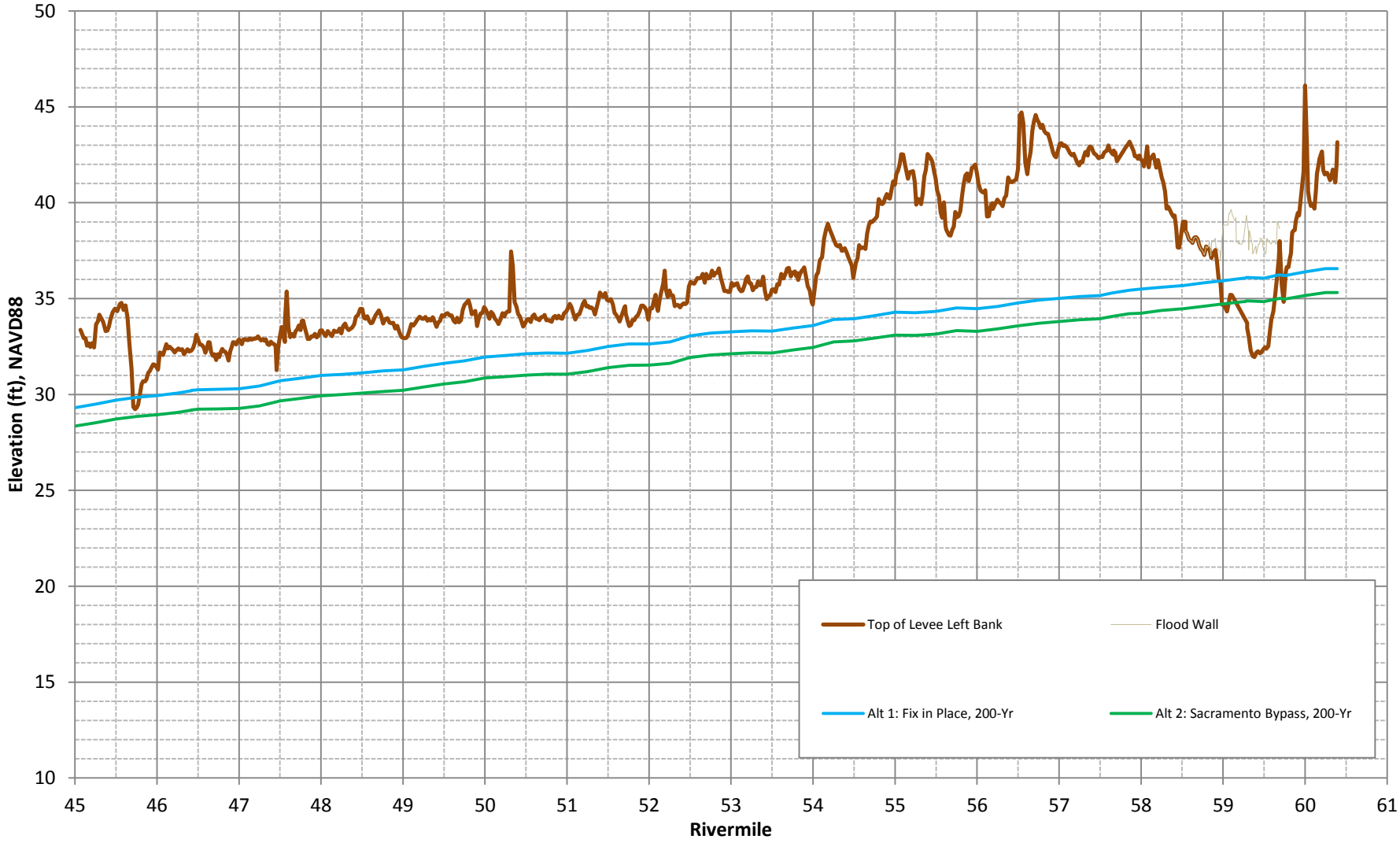
American River Common Features GRR Sacramento, California	**American River – Left Bank Levee 10% (1/10) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Sacramento River (Upstream of the American River) - 0.5% (1/200) ACE Water Surface Profile



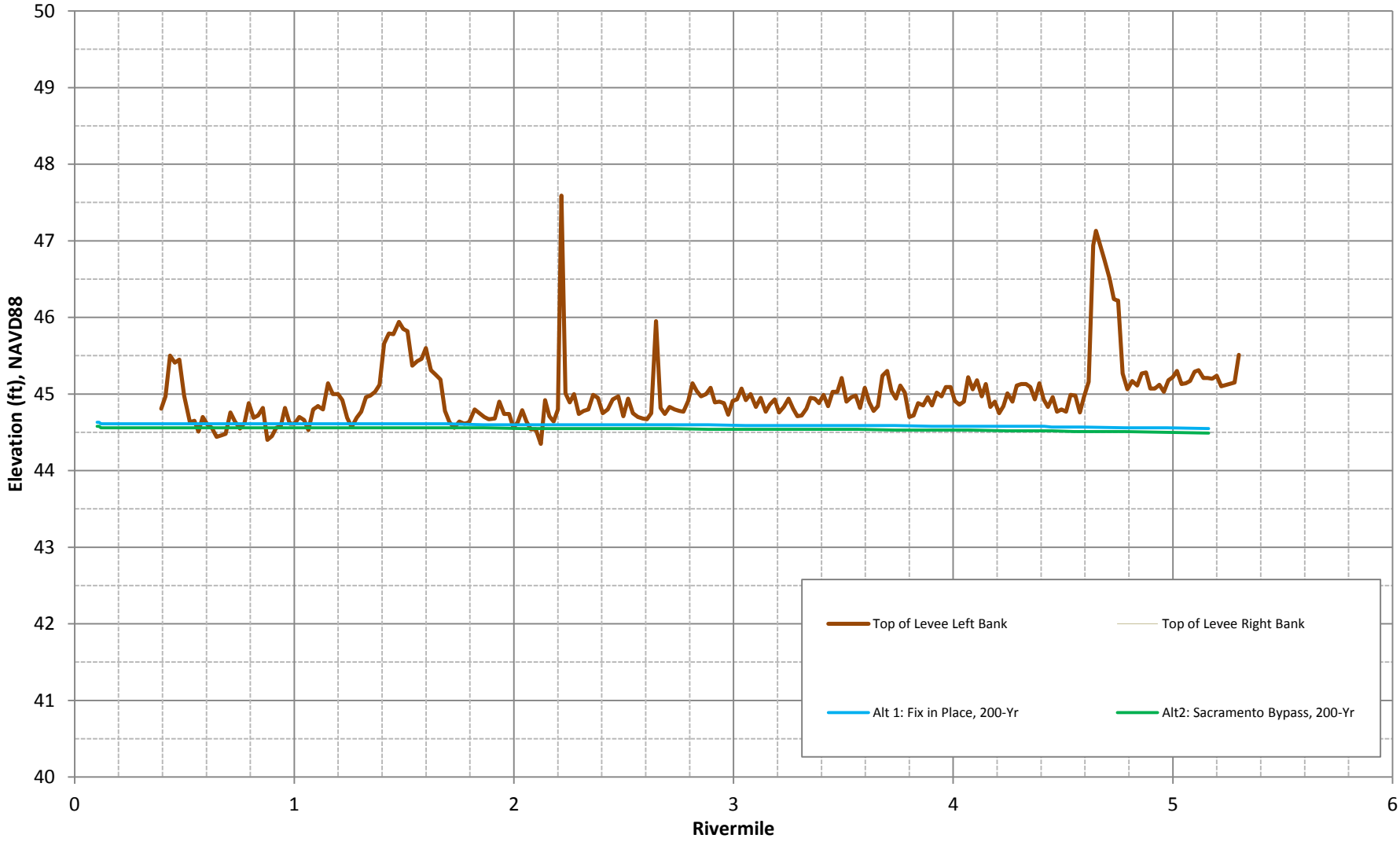
American River Common Features GRR Sacramento, California	**Sacramento River (U/S of the American River) – Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Sacramento River (Downstream of the American River) - 0.5% (1/200) ACE Water Surface Profile



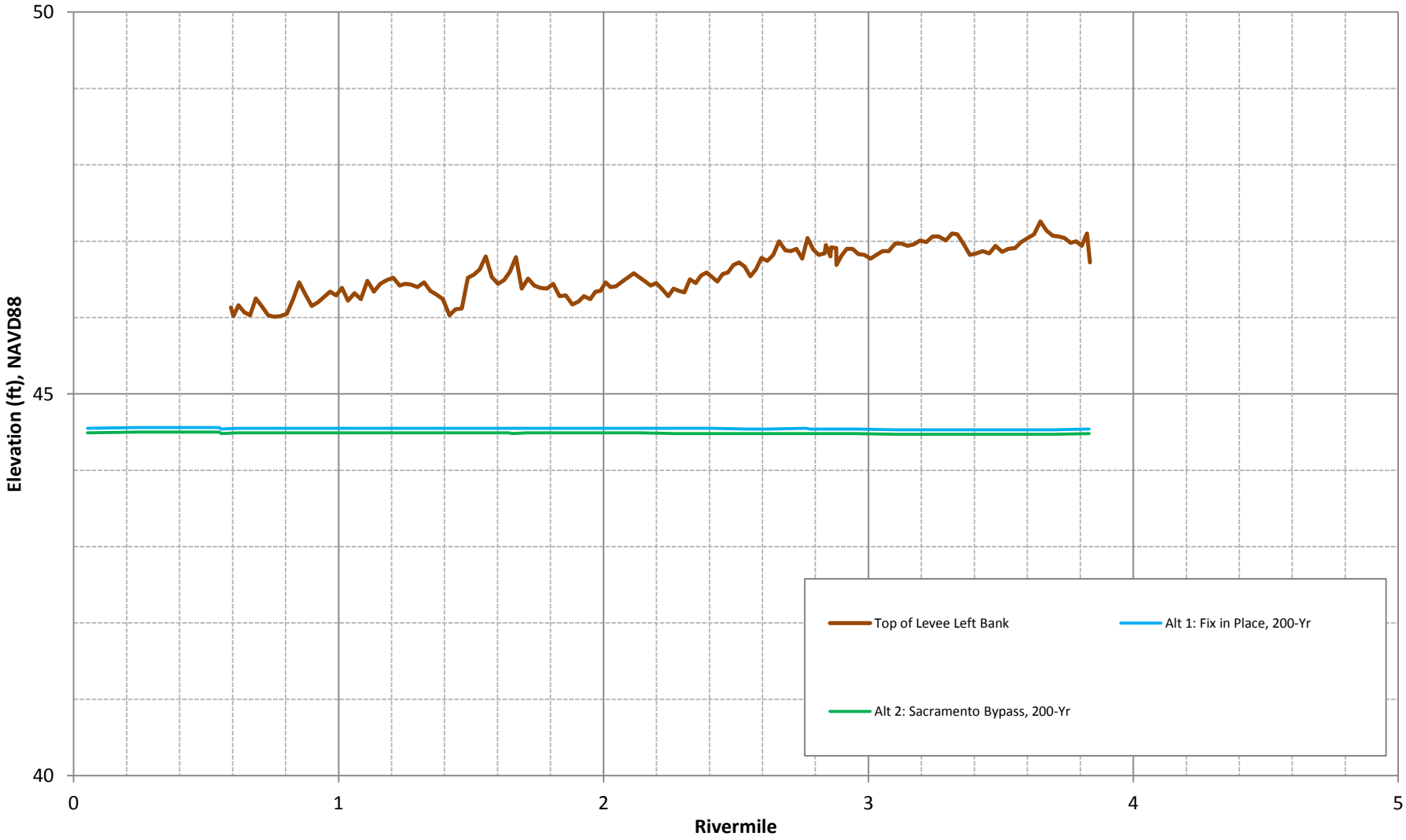
American River Common Features GRR Sacramento, California	**Sacramento River (D/S of the American River) – Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Natomas Cross Canal - 0.5% (1/200) ACE Water Surface Profile



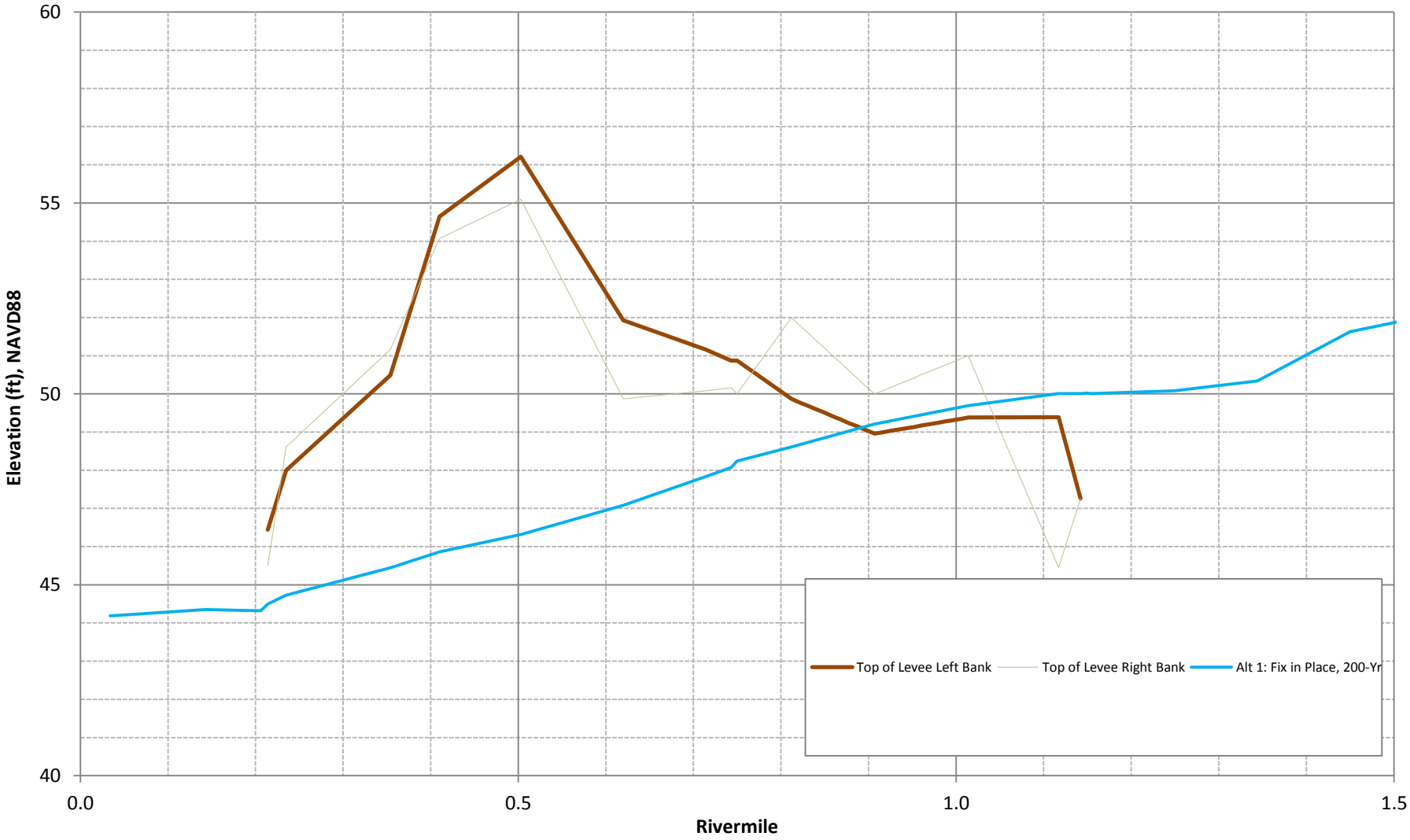
American River Common Features GRR Sacramento, California	**Natomas Cross Canal – Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Pleasant Grove Creek Canal - 0.5% (1/200) ACE Water Surface Profile



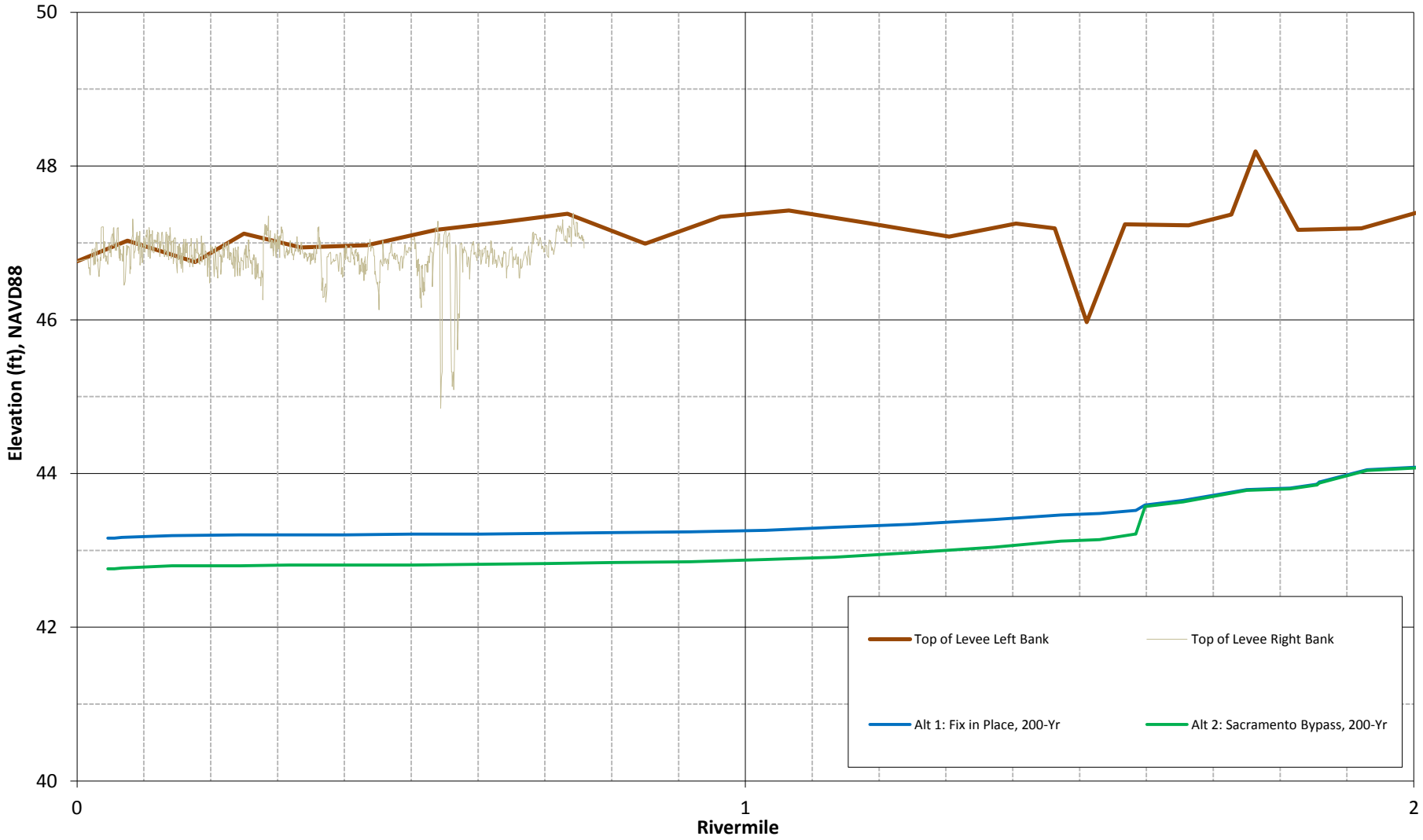
American River Common Features GRR Sacramento, California	**Pleasant Grove Creek Canal – Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Magpie Creek Left Bank Levee - 0.5% (1/200) ACE Water Surface Profile



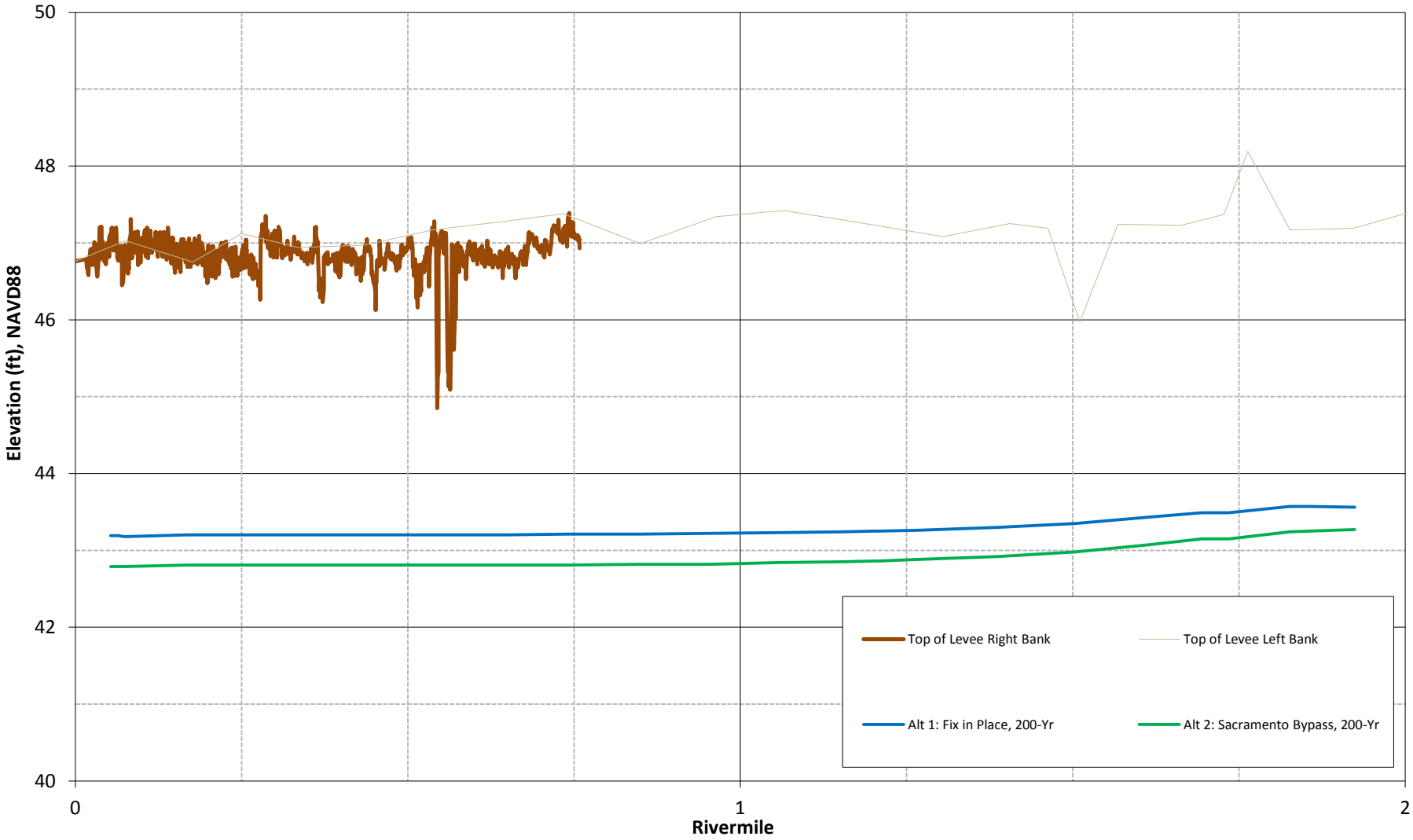
American River Common Features GRR Sacramento, California	**Magpie Creek – Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Dry Creek Left Bank Levee - 0.5% (1/200) ACE Water Surface Profile



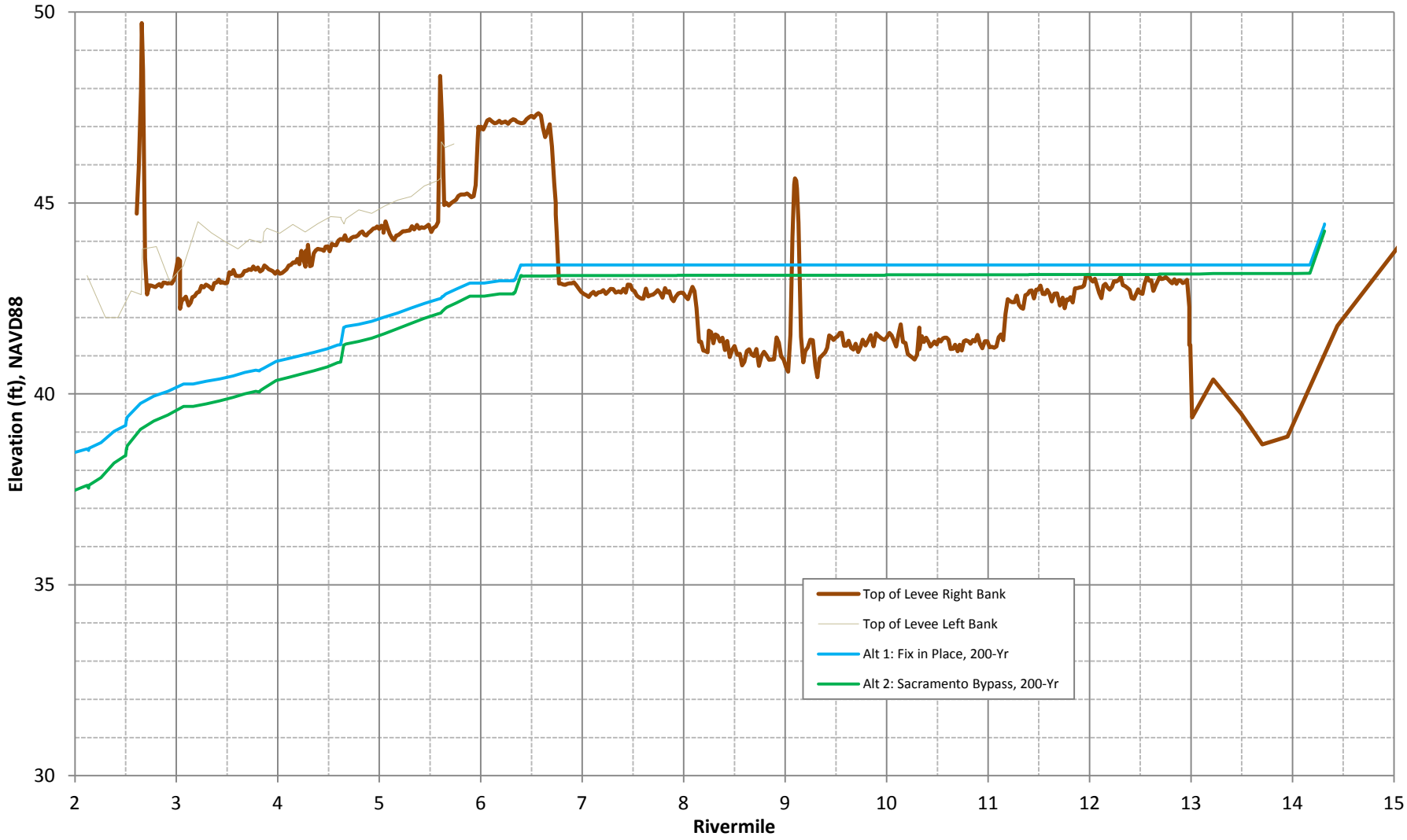
American River Common Features GRR Sacramento, California	**Dry Creek – Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Dry Creek Right Bank Levee - 0.5% (1/200) ACE Water Surface Profile



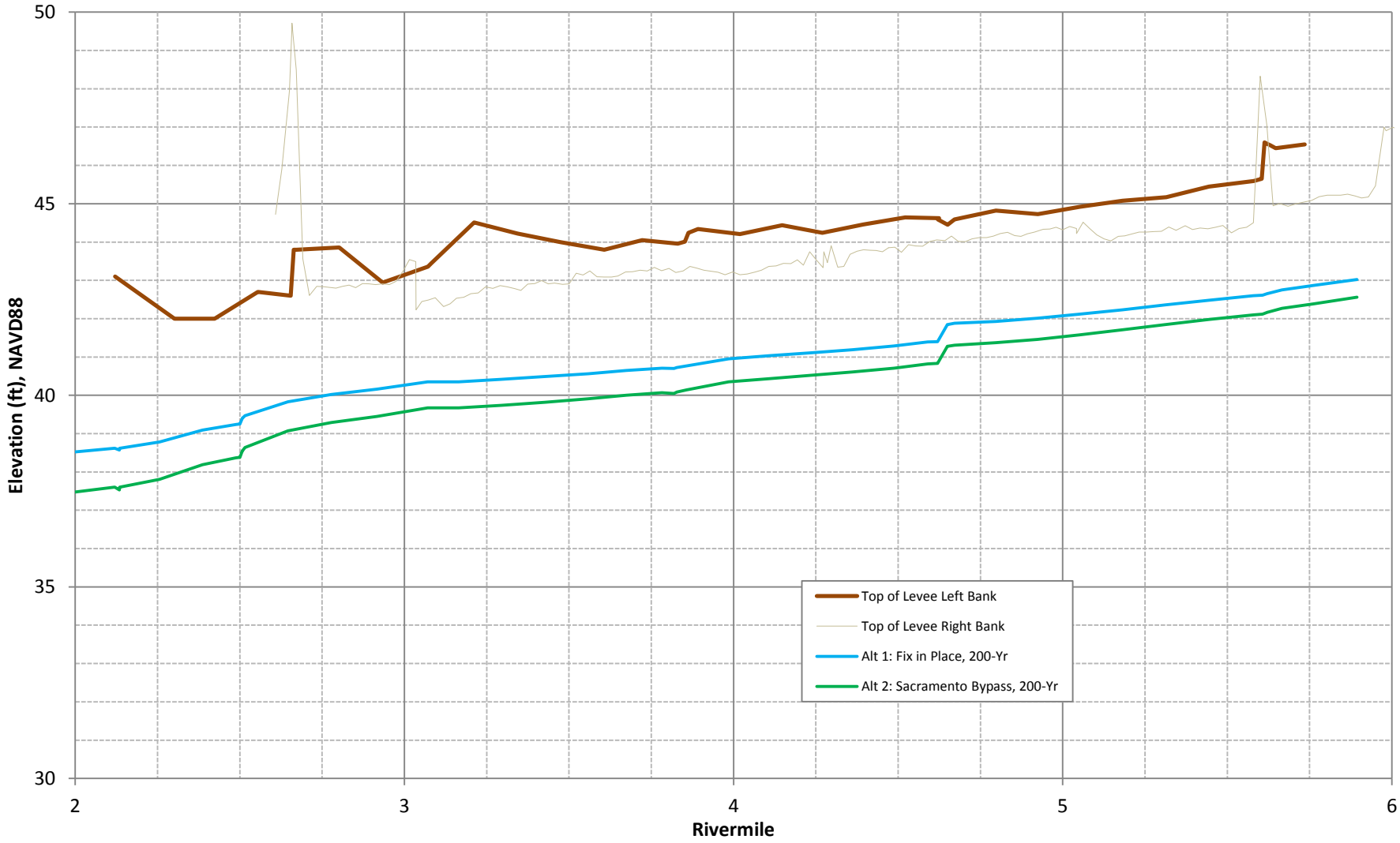
American River Common Features GRR Sacramento, California	**Dry Creek – Right Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

NEMDC Right Levee - 0.5% (1/200) ACE Water Surface Profile



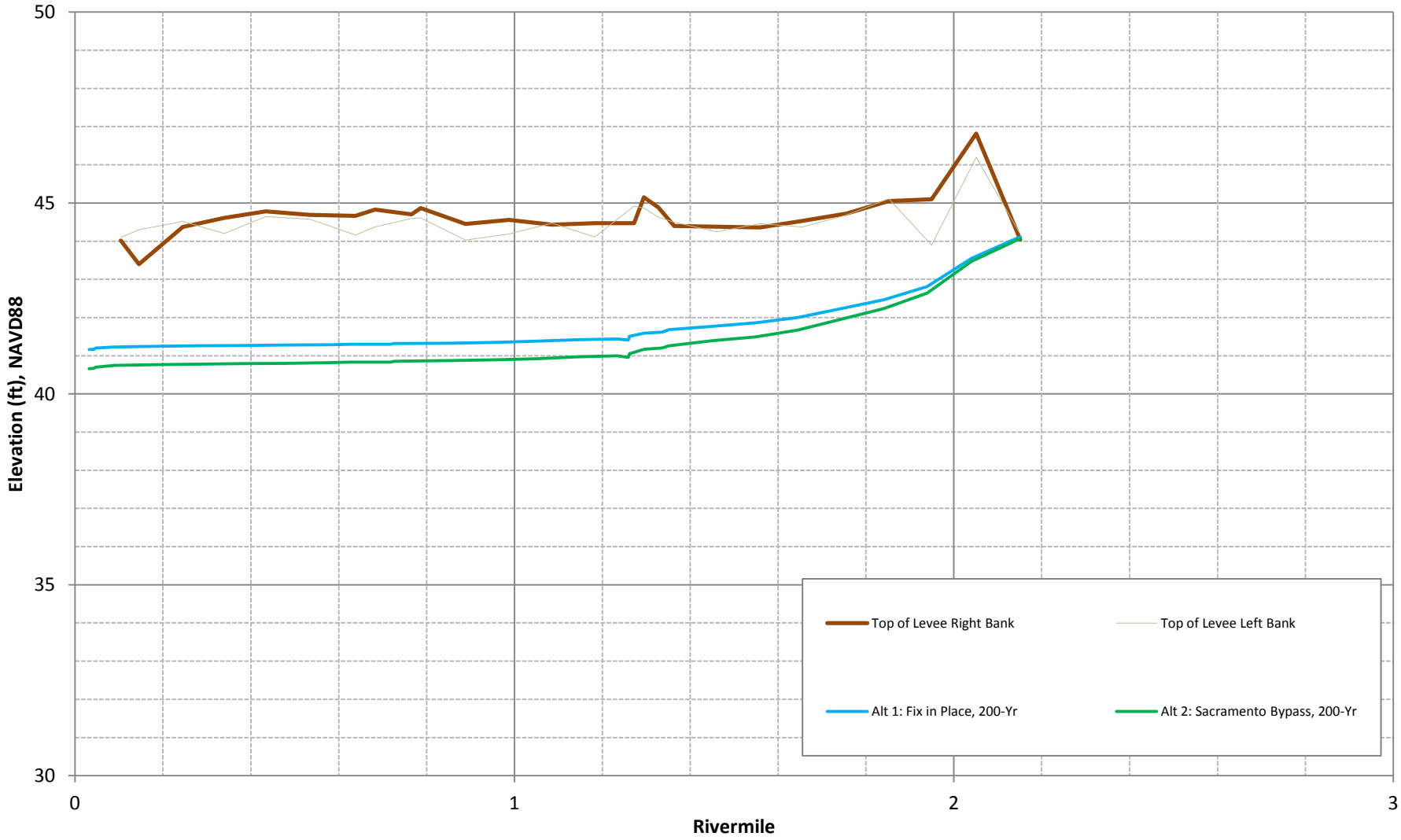
American River Common Features GRR **Sacramento, California**	**NEMDC – Right Bank Levee** **0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers** **Sacramento District**

NEMDC Left Levee - 0.5% (1/200) ACE Water Surface Profile



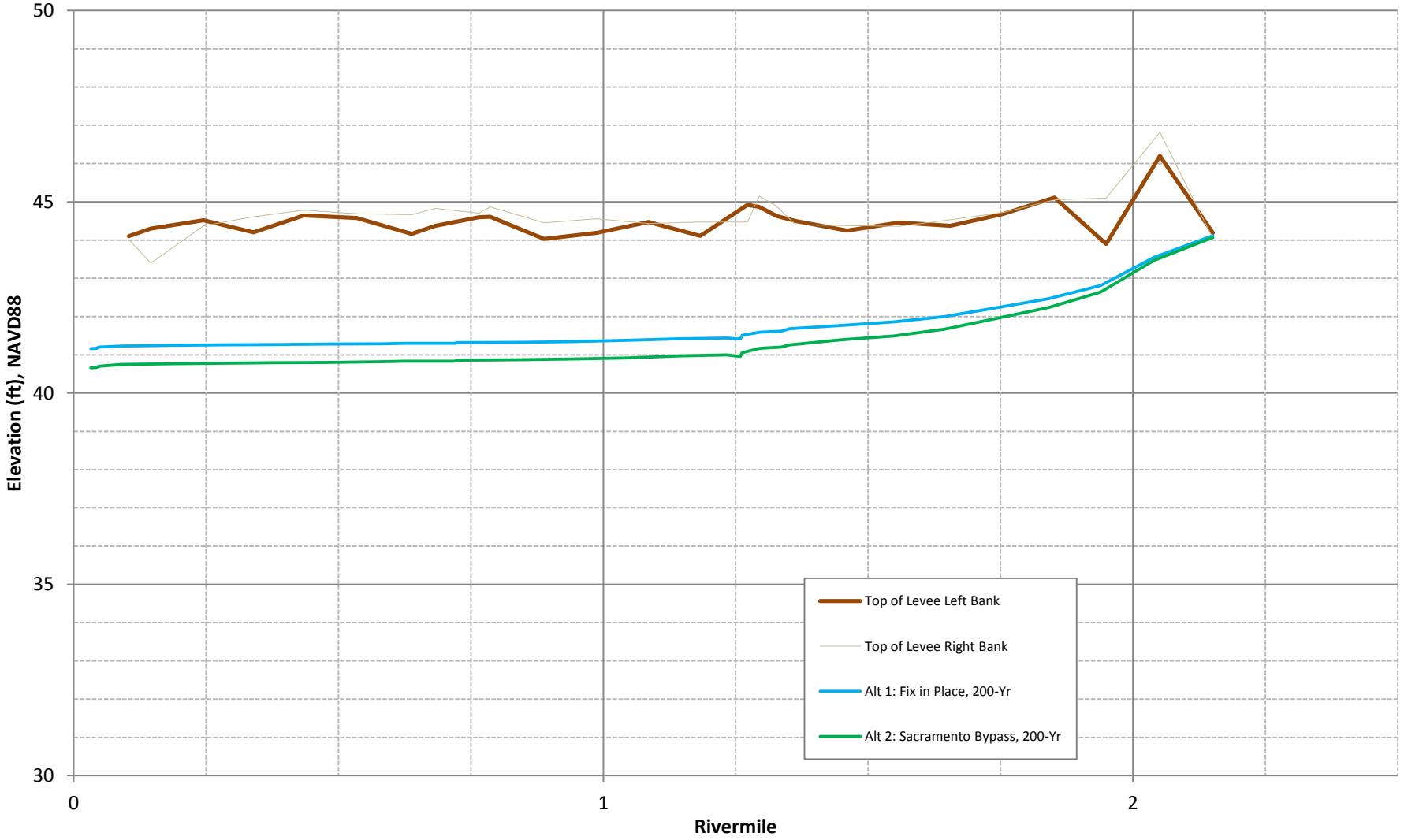
American River Common Features GRR Sacramento, California	**NEMDC – Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Arcade Creek Right Bank Levee - 0.5% (1/200) ACE Water Surface Profile



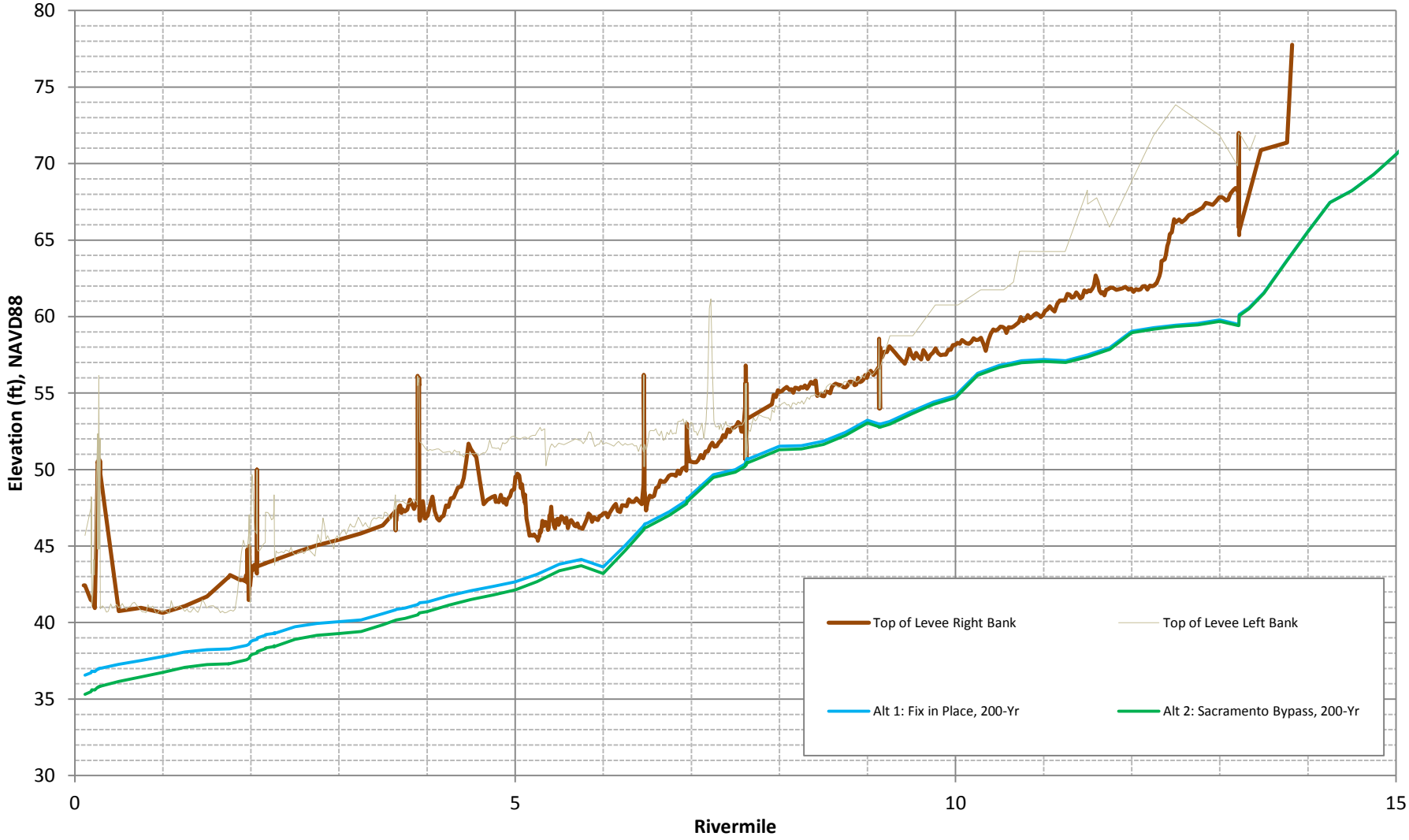
American River Common Features GRR Sacramento, California	**Arcade Creek - Right Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

Arcade Creek Left Bank Levee - 0.5% (1/200) ACE Water Surface Profile



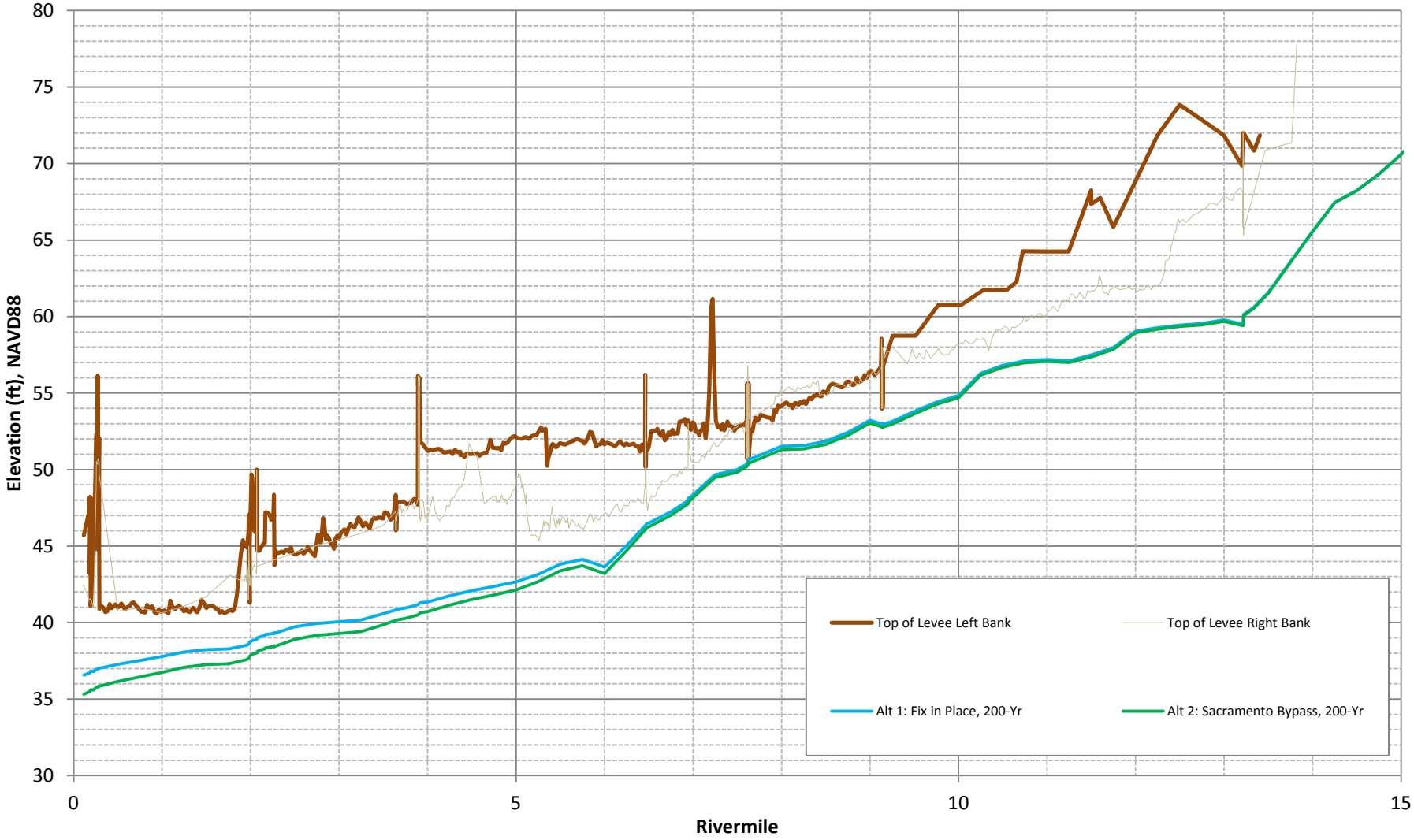
American River Common Features GRR Sacramento, California	**Arcade Creek - Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

American River Right Bank Levee - 0.5% (1/200) ACE Water Surface Profile

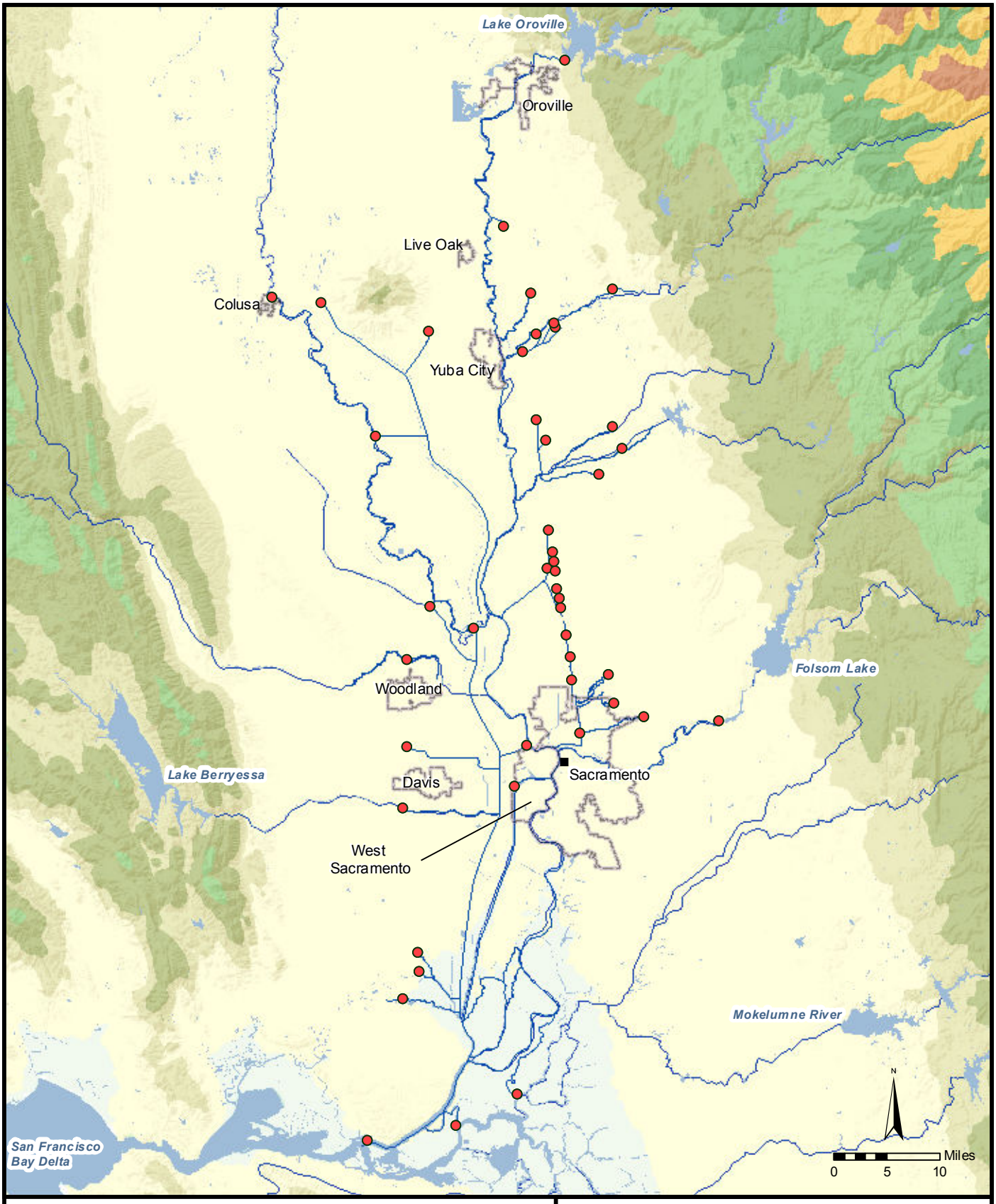


American River Common Features GRR Sacramento, California	**American River – Right Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**

American River Left Bank Levee - 0.5% (1/200) ACE Water Surface Profile



American River Common Features GRR Sacramento, California	**American River – Left Bank Levee 0.5% (1/200) ACE Water Surface Profiles With-Project Alternatives**	**U.S. Army Corps of Engineers Sacramento District**



LEGEND

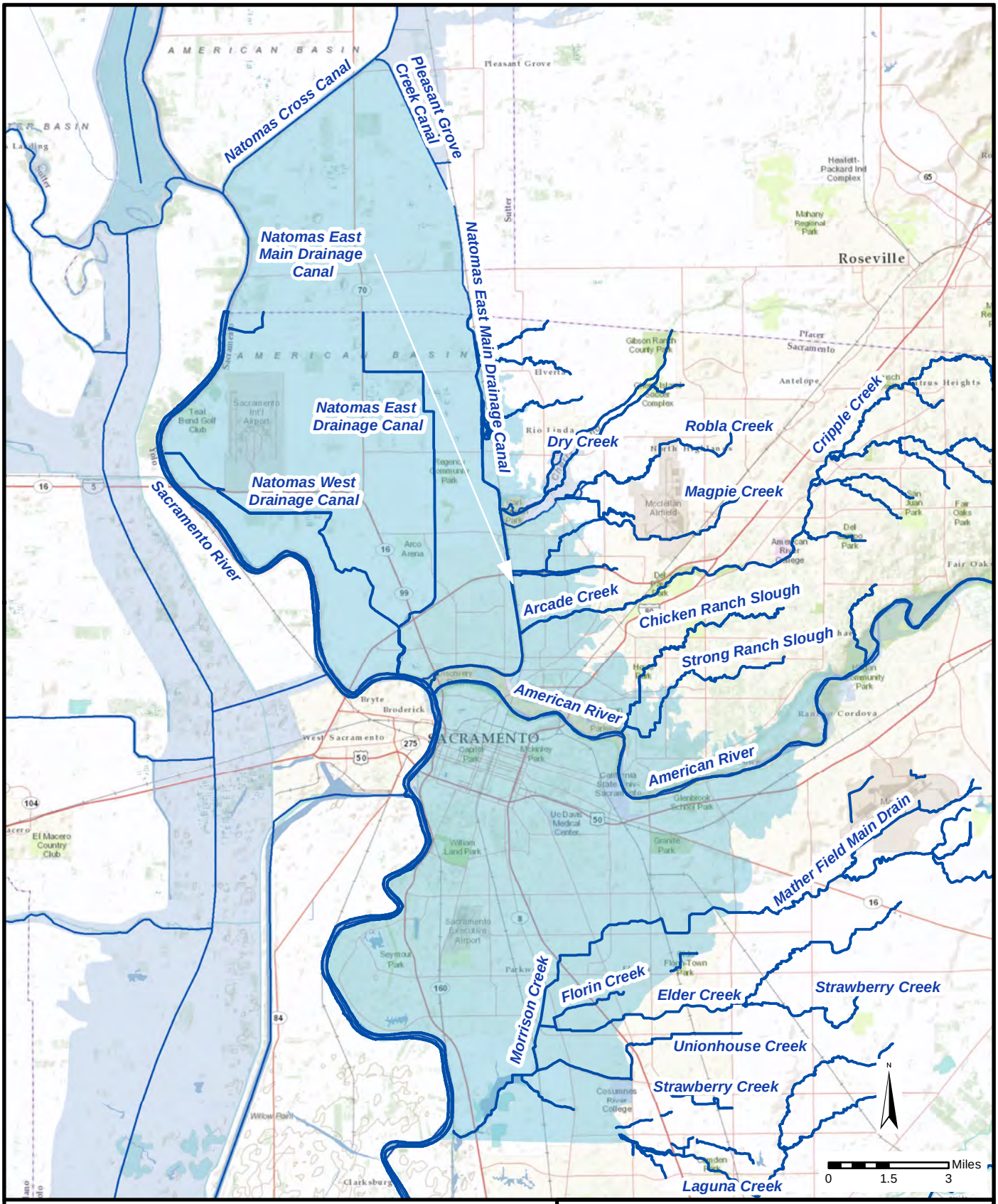
- Hydrologic - Hydraulic Handoff Points
- Rivers
- Cities

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

BOUNDARY CONDITIONS HYDROLOGIC - HYDRAULIC HANDOFF POINTS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013



LEGEND

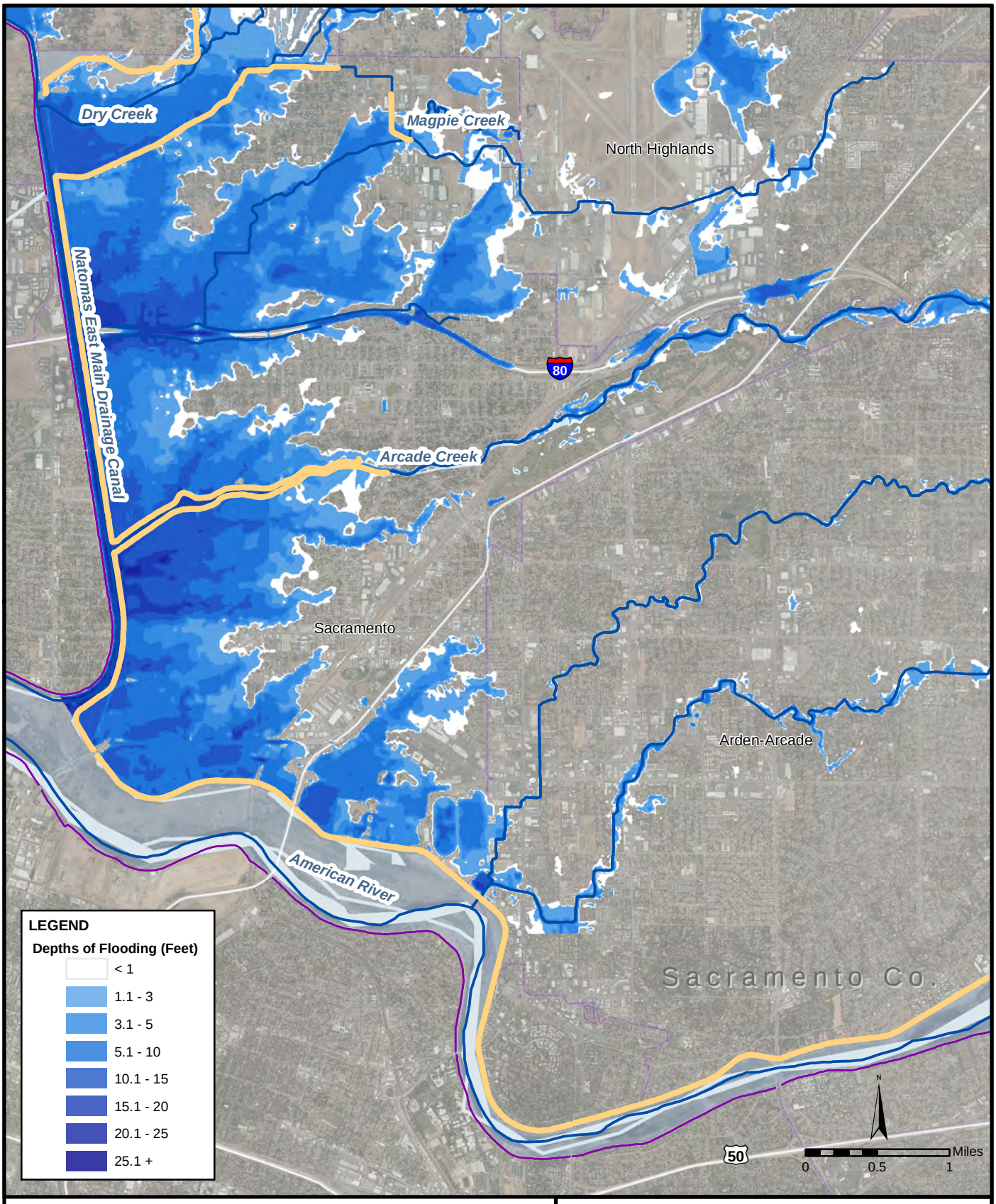
- Streams
- Floodways
- ARCF Study Area

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

INTERIOR DRAINAGE STUDY AREA MAP

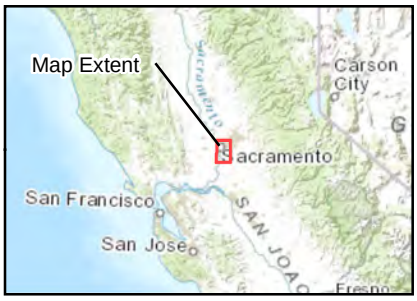
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013



LEGEND

- ARCF Levees
- ARN Levees
- Streams
- Floodways
- County Lines
- Cities

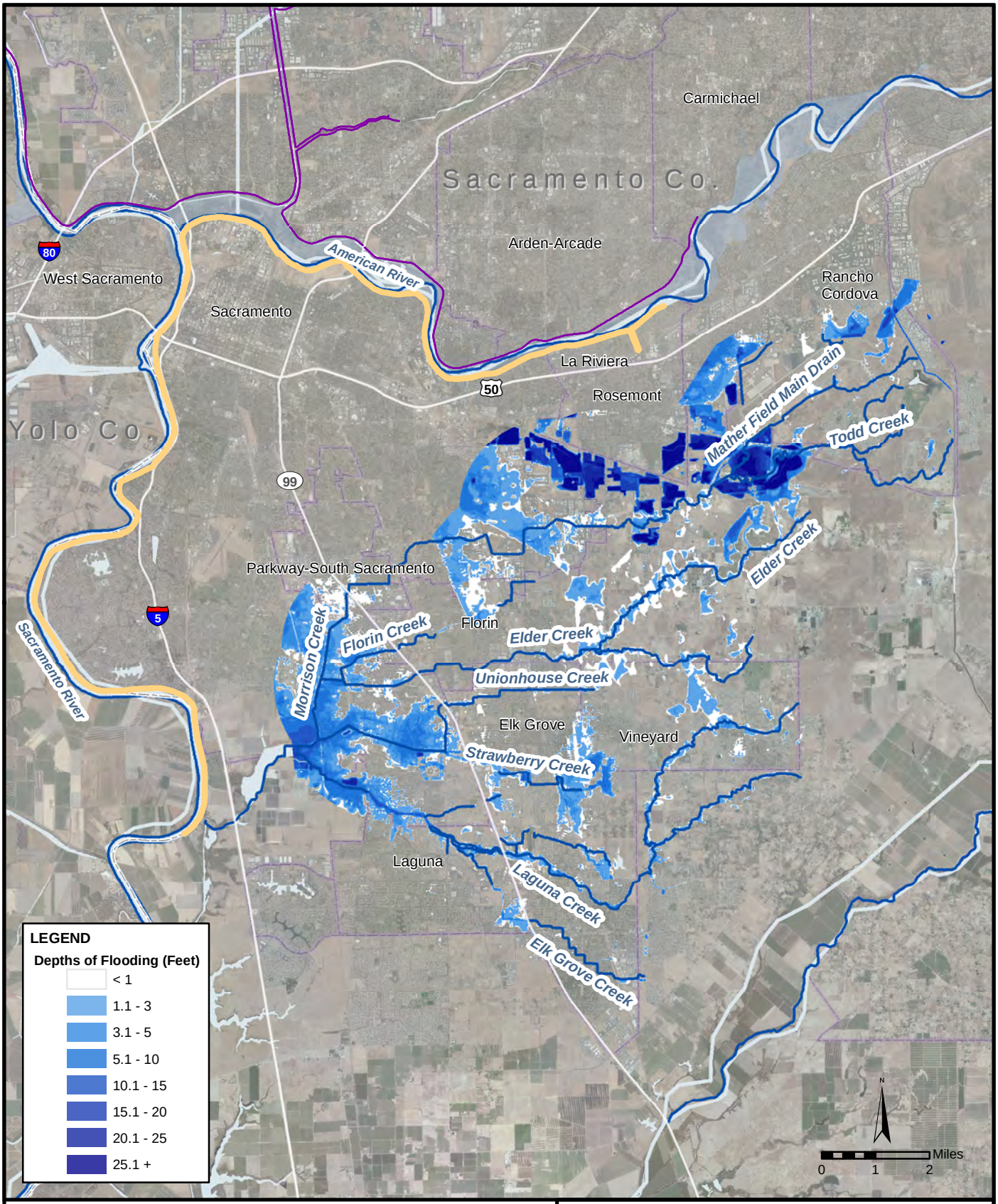


AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER NORTH
1% ACE (100 YEAR)
INTERIOR DRAINAGE FLOODPLAIN

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013



LEGEND

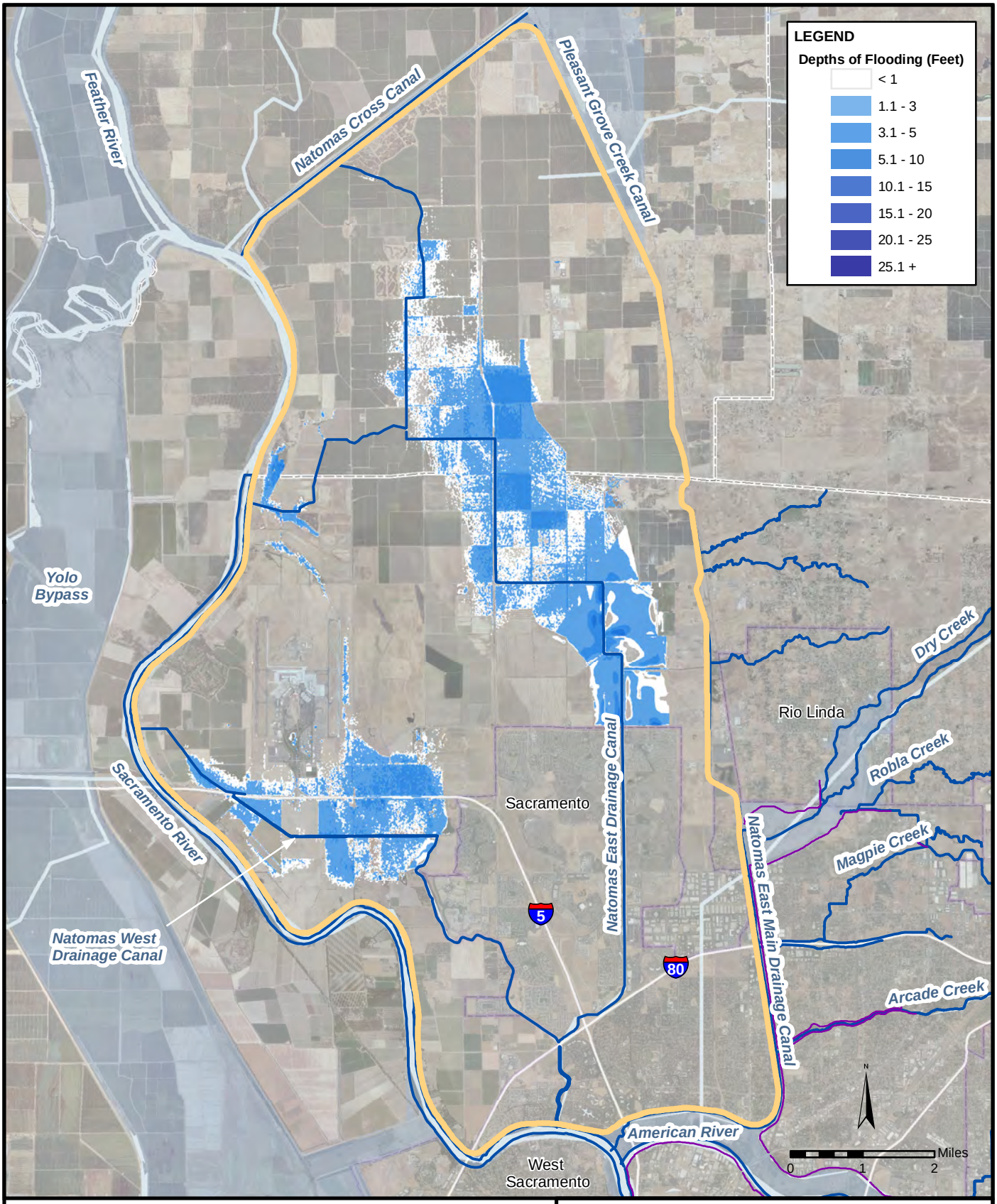
- ARCF Levees
- ARS Levees
- Streams
- Floodways
- County Lines
- Cities

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER SOUTH
1% ACE (100 YEAR)
INTERIOR DRAINAGE FLOODPLAIN

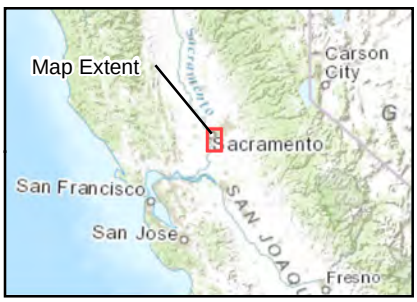
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013



LEGEND

- ARCF Levees
- Natomas Levees
- Streams
- Floodways
- Cities
- County Lines

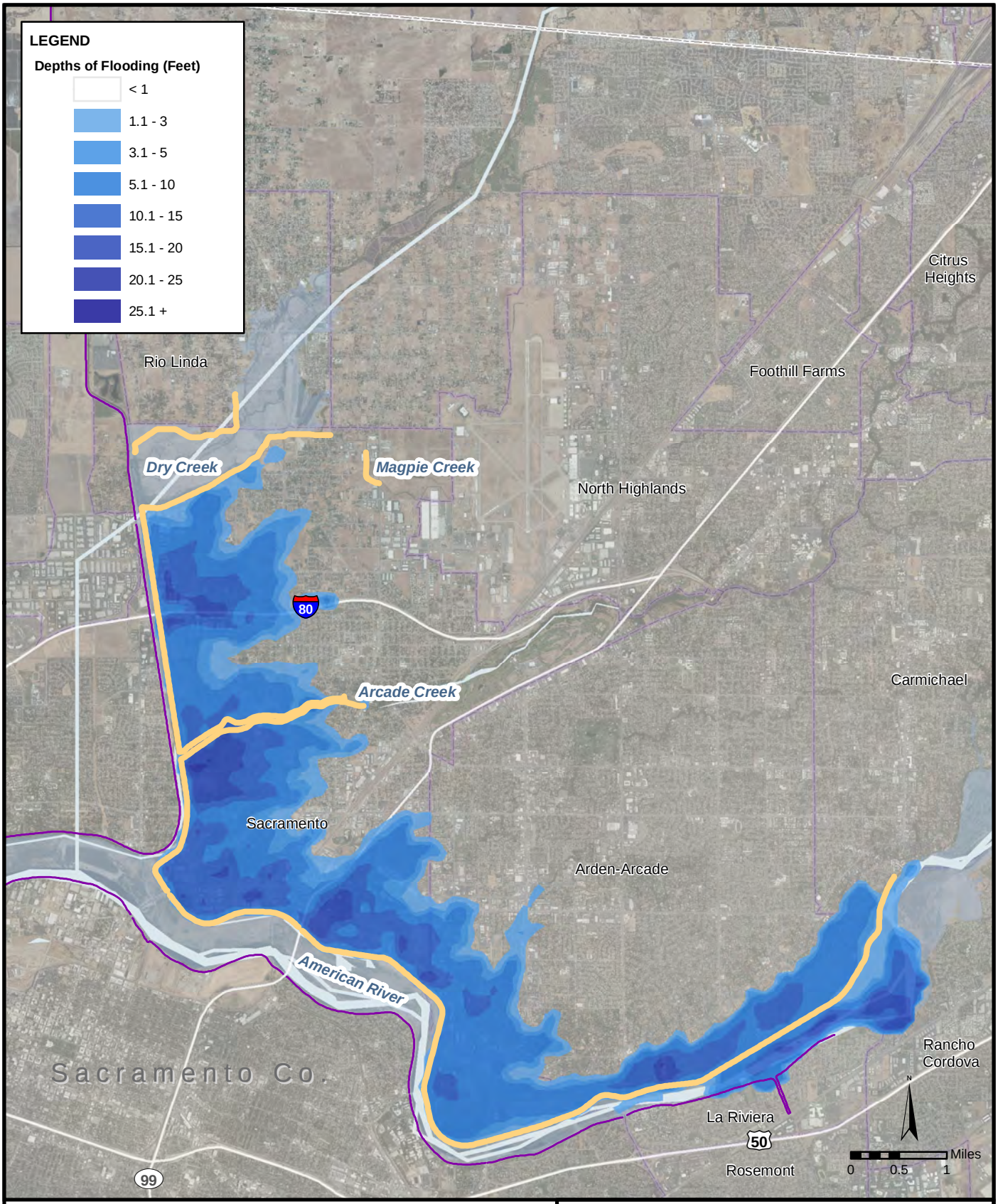


AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

NATOMAS BASIN
1% (1/100) ACE
INTERIOR DRAINAGE FLOODPLAIN

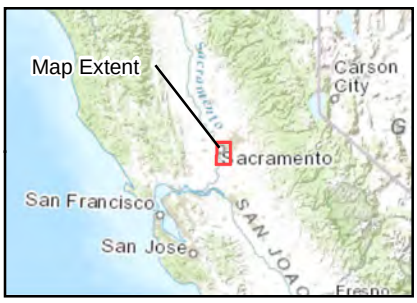
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Jan 2013



LEGEND

- ARN Levees
- ARCF Levees
- Floodways
- County Lines
- Cities

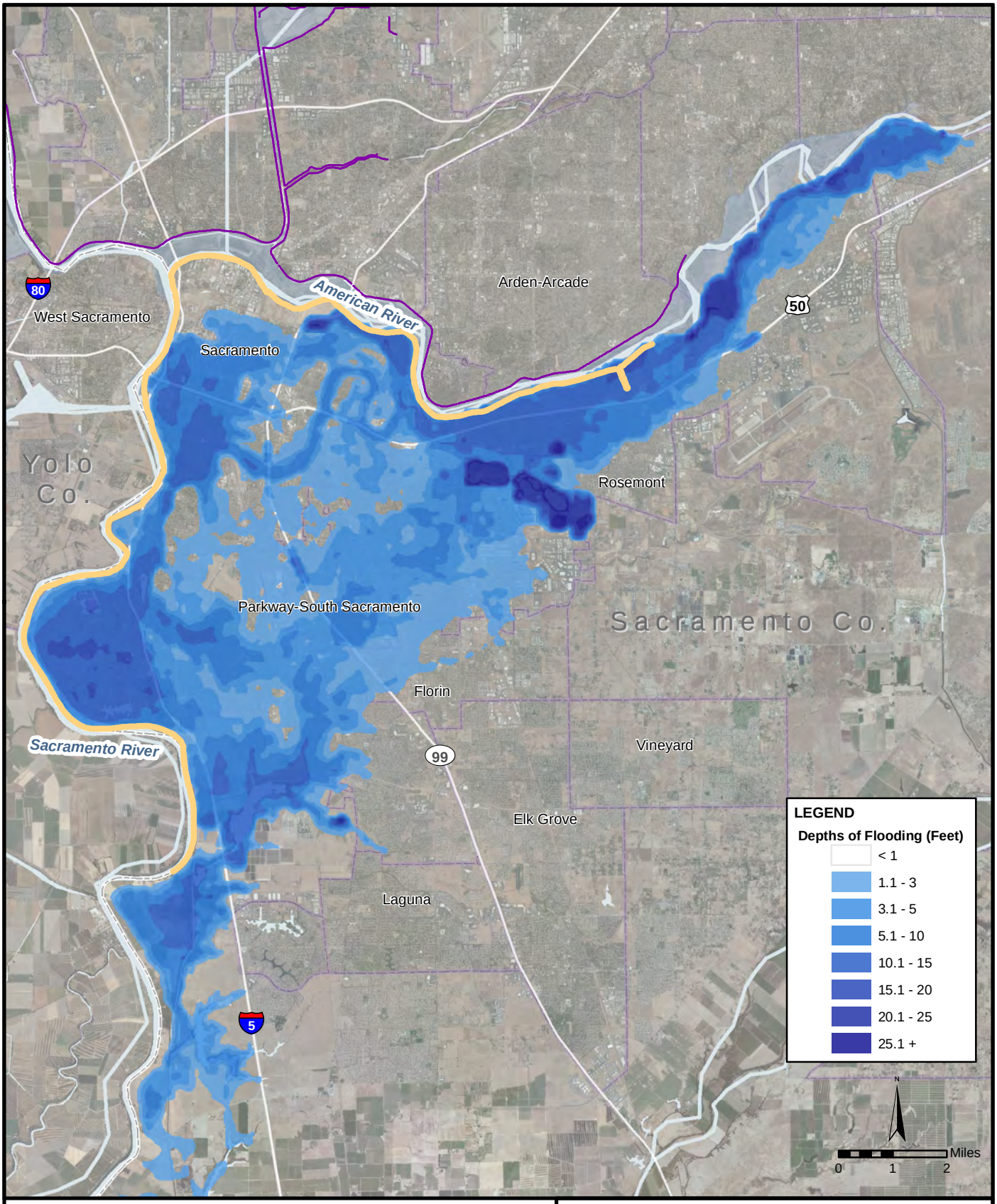


AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

RESIDUAL FLOODING FROM UPSTREAM CHANNEL OUTFLANKING INTO THE AMERICAN RIVER BASIN

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013



LEGEND

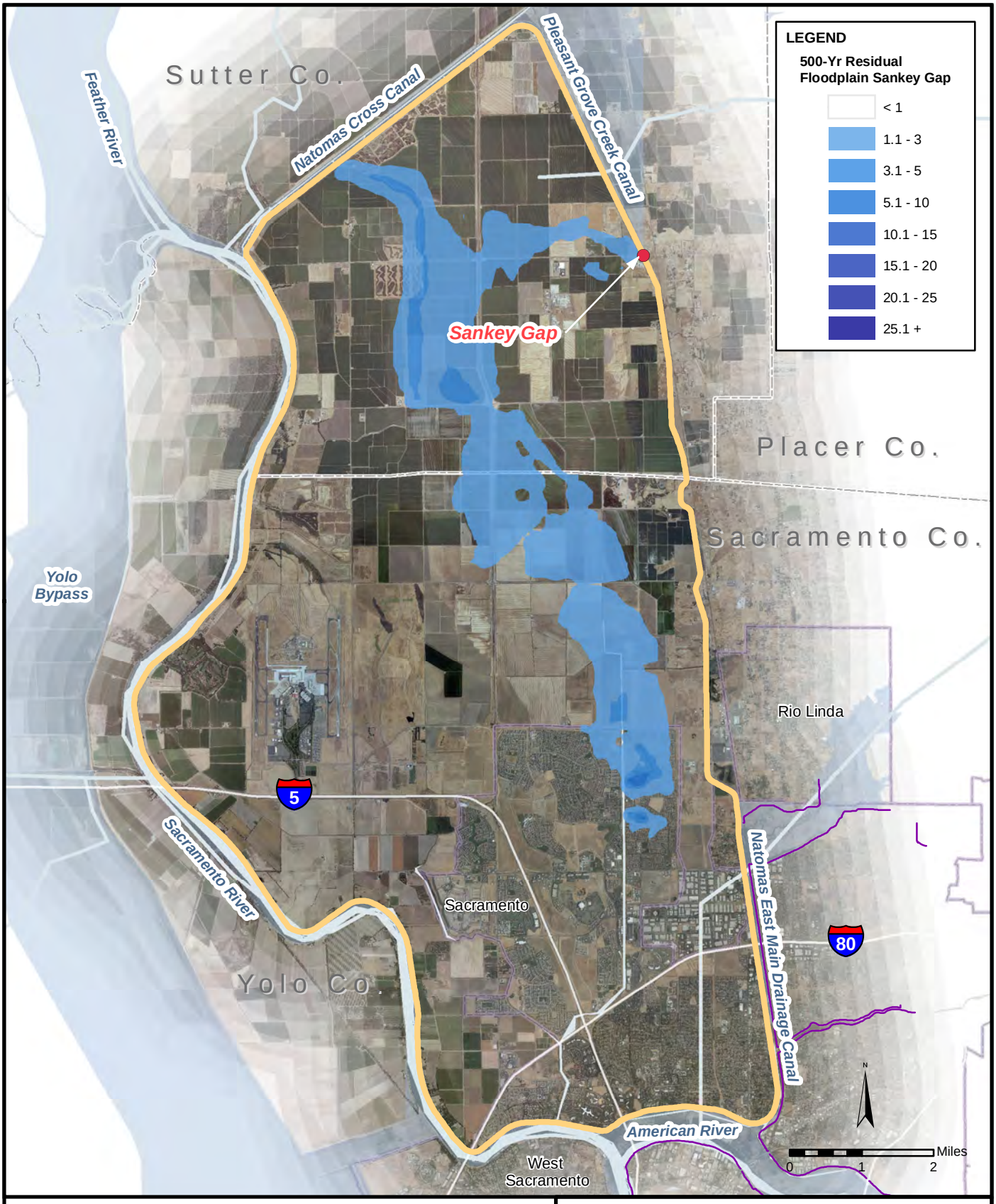
- ARCF Levees
- ARS Levees
- County Lines
- Floodways
- Cities

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

RESIDUAL FLOODING FROM CHANNEL OUTFLANKING INTO THE AMERICAN RIVER SOUTH BASIN

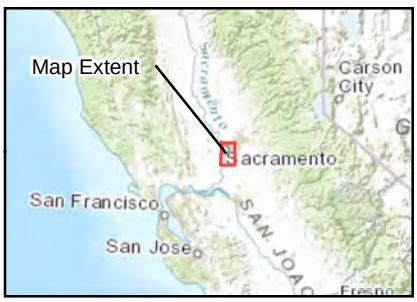
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013



LEGEND

- ARCF Levees
- Natomas Levees
- Floodways
- Cities
- County Lines



AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

RESIDUAL FLOODING FROM SANKEY GAP INTO THE NATOMAS BASIN

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Feb 2013

American River South (ARS) IP A			
American River RM 7.8			
	Future Without Project Condition	**Fix In Place**	**Sacramento Bypass Widening**
Frequency	Stage, NAVD88		
1yr = .999	24.1	24.1	24.1
2yr = .5	31.9	31.9	31.9
10yr = .1	42.0	42.0	41.8
25yr = .04	48.0	48.0	47.9
50yr = .02	48.1	48.1	47.9
100yr = .01	48.2	48.2	48.0
200yr = .005	53.2	53.2	53.0
500yr = .002	58.1	58.1	58.1
Frequency	Flow		
1yr = .999	1423	1423	1439
2yr = .5	25977	25977	25998
10yr = .1	71654	71654	71655
25yr = .04	114993	114993	114990
50yr = .02	115000	115000	114999
100yr = .01	114999	114999	114999
200yr = .005	159995	159995	159982
500yr = .002	254357	254357	254410

Source: Hydraulic Analysis Section, Sacramento District, USACE

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER SOUTH
INDEX POINT A
RISK ANALYSIS INPUTS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

American River South (ARS) IP F			
Sacramento River RM 50.3			
	Future Without Project Condition	**Fix In Place**	**Sacramento Bypass Widening**
Frequency	Stage, NAVD88		
1yr = .999	11.1	11.1	11.1
2yr = .5	20.8	20.8	20.8
10yr = .1	26.4	26.4	26.0
25yr = .04	29.0	29.0	27.9
50yr = .02	29.6	29.6	28.5
100yr = .01	30.3	30.3	29.3
200yr = .005	32.0	32.0	30.9
500yr = .002	33.9	33.9	33.4
Frequency	Flow		
1yr = .999	52823	52823	47842
2yr = .5	94600	94600	87375
10yr = .1	100687	100687	99631
25yr = .04	115395	115395	107204
50yr = .02	118141	118141	110188
100yr = .01	121788	121788	113973
200yr = .005	133200	133200	124750
500yr = .002	152523	152523	144263

Source: Hydraulic Analysis Section, Sacramento District, USACE

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER SOUTH
INDEX POINT F
RISK ANALYSIS INPUTS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

American River North (ARN) IP A			
American River RM 7.83			
	Future Without Project Condition	Fix In Place	Sacramento Bypass Widening
Frequency	Stage, NAVD88		
1yr = .999	23.3	23.3	22.7
2yr = .5	32.4	32.4	30.5
10yr = .1	40.5	40.5	40.6
25yr = .04	46.2	46.2	46.4
50yr = .02	46.2	46.2	46.5
100yr = .01	46.3	46.3	46.6
200yr = .005	51.2	51.2	51.4
500yr = .002	55.9	55.9	55.7
Frequency	Flow		
1yr = .999	1690	1690	1631
2yr = .5	25969	25969	25996
10yr = .1	71653	71653	71654
25yr = .04	114991	114991	114987
50yr = .02	114999	114999	114999
100yr = .01	115000	115000	114999
200yr = .005	159998	159998	159979
500yr = .002	220684	220684	215253

Source: Hydraulic Analysis Section, Sacramento District, USACE

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER NORTH
INDEX POINT A
RISK ANALYSIS INPUTS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

American River North (ARN) IP E			
Arcade Creek RM .95			
	Future Without Project Condition	**Fix In Place**	**Sacramento Bypass Widening**
Frequency	Stage, NAVD88		
1yr = .999	27.0	27.0	26.6
2yr = .5	30.0	30.0	29.4
10yr = .1	33.1	33.1	33.2
25yr = .04	35.4	35.4	34.8
50yr = .02	37.7	37.7	36.1
100yr = .01	39.2	39.2	38.6
200yr = .005	41.4	41.4	40.9
500yr = .002	46.1	46.1	45.2
Frequency	Flow		
1yr = .999	-	-	-
2yr = .5	-	-	-
10yr = .1	-	-	-
25yr = .04	-	-	-
50yr = .02	-	-	-
100yr = .01	-	-	-
200yr = .005	-	-	-
500yr = .002	-	-	-

Source: Hydraulic Analysis Section, Sacramento District, USACE

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER NORTH
INDEX POINT E
RISK ANALYSIS INPUTS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

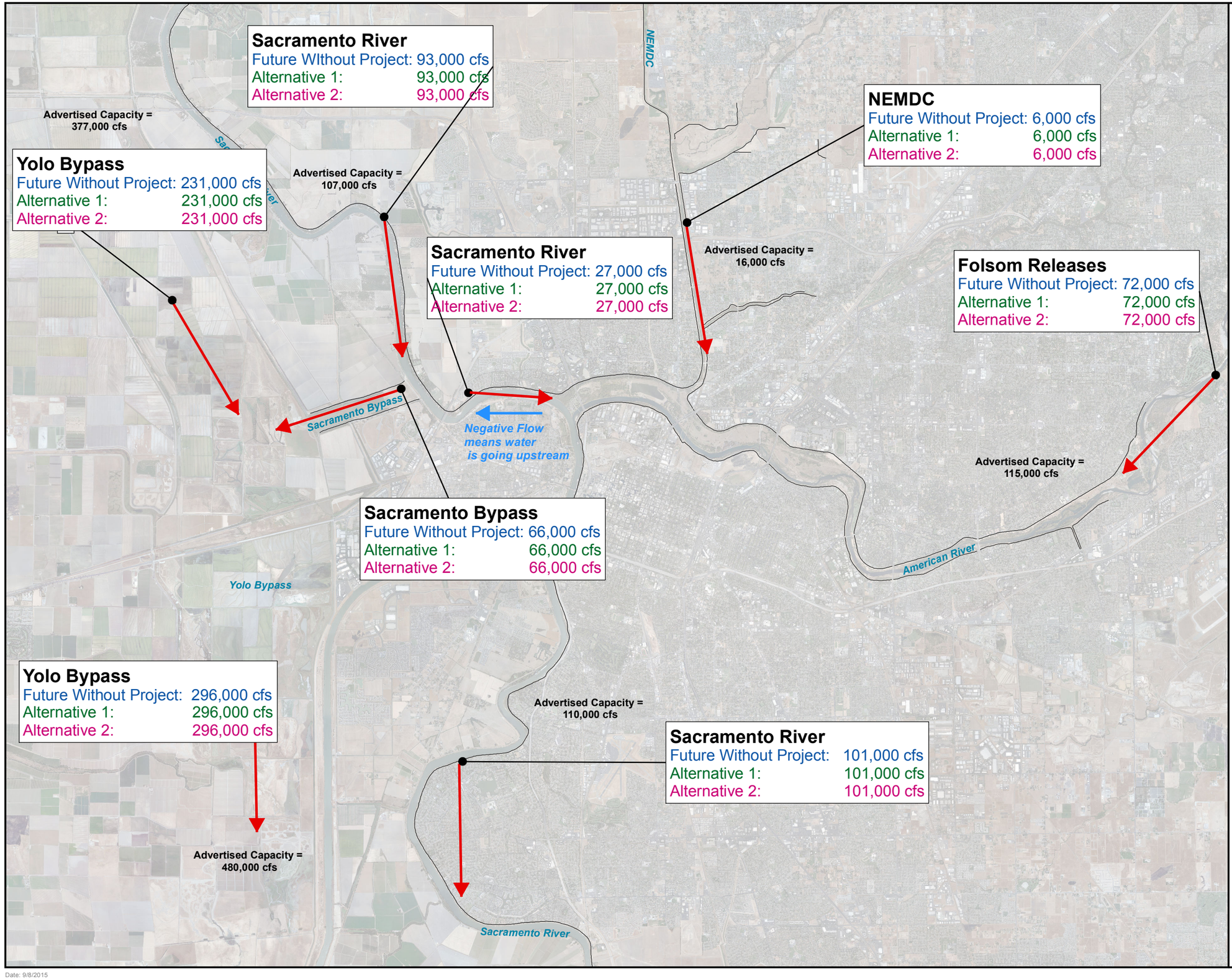
Natomas (NAT) IP D			
Natomas Cross Canal RM 2.71			
	Future Without Project Condition	**Fix In Place**	**Sacramento Bypass Widening**
Frequency	Stage, NAVD88		
1yr = .999	20.6	20.6	20.5
2yr = .5	33.6	33.6	33.5
10yr = .1	39.0	39.0	38.9
25yr = .04	41.5	41.5	41.4
50yr = .02	42.4	42.4	42.3
100yr = .01	43.5	43.5	43.4
200yr = .005	44.6	44.6	44.6
500yr = .002	45.5	45.5	45.5
Frequency	Flow		
1yr = .999	-	-	-
2yr = .5	-	-	-
10yr = .1	-	-	-
25yr = .04	-	-	-
50yr = .02	-	-	-
100yr = .01	-	-	-
200yr = .005	-	-	-
500yr = .002	-	-	-

Source: Hydraulic Analysis Section, Sacramento District, USACE

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

NATOMAS
INDEX POINT D
RISK ANALYSIS INPUTS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



Maximum 10% (1/10) ACE Future Without Project Conditions & With Project Flows

AMERICAN RIVER COMMON FEATURES GRR

Maxiumum Flows are the greatest flow from either the Sacramento or American Storm Centerings.

Sept 2015

Plate 70

Date: 9/8/2015
Path: Q:\AmerRiv\CommonFeaturesGRR\Hydraulics\GIS\TSP_HydraulicReport\Plate_70_ARCF_Flowsplit_10%_08Sept2015.mxd

Sacramento River
Future WIthout Project: 120,000 cfs
Alternative 1: 120,000 cfs
Alternative 2: 120,000 cfs

Advertised Capacity = 377,000 cfs

Yolo Bypass
Future Without Project: 420,000 cfs
Alternative 1: 420,000 cfs
Alternative 2: 420,000 cfs

Advertised Capacity = 107,000 cfs

NEMDC

NEMDC
Future Without Project: 15,000 cfs
Alternative 1: 15,000 cfs
Alternative 2: 15,000 cfs

Advertised Capacity = 16,000 cfs

Sacramento River
Future Without Project: 5,000 cfs
Alternative 1: 5,000 cfs
Alternative 2: 5,000 cfs

Folsom Releases
Future Without Project: 115,000 cfs
Alternative 1: 115,000 cfs
Alternative 2: 115,000 cfs

Sacramento Bypass

Negative Flow means water is going upstream

Advertised Capacity = 115,000 cfs

American River

Sacramento Bypass
Future Without Project: 115,000 cfs
Alternative 1: 115,000 cfs
Alternative 2: 115,000 cfs

Yolo Bypass

Advertised Capacity = 480,000 cfs

Yolo Bypass
Future Without Project: 535,000 cfs
Alternative 1: 535,000 cfs
Alternative 2: 535,000 cfs

Advertised Capacity = 110,000 cfs

Sacramento River
Future Without Project: 122,000 cfs
Alternative 1: 122,000 cfs
Alternative 2: 122,000 cfs

Sacramento River

LEGEND

- Levee Reaches (ARCF)
- Flow Direction
- Backflow

Reach
Future Without Project Condition Flows
Alternative 1 Flows
Alternative 2 Flows

N

0 0.5 1 2 Miles

1:100,000

US Army Corps of Engineers
Sacramento District

Maximum 1% (1/100) ACE Future Without Project Conditions & With Project Flows

AMERICAN RIVER
COMMON FEATURES GRR

Maxiumum Flows are the greatest flow from either the Sacramento or American Storm Centerings.

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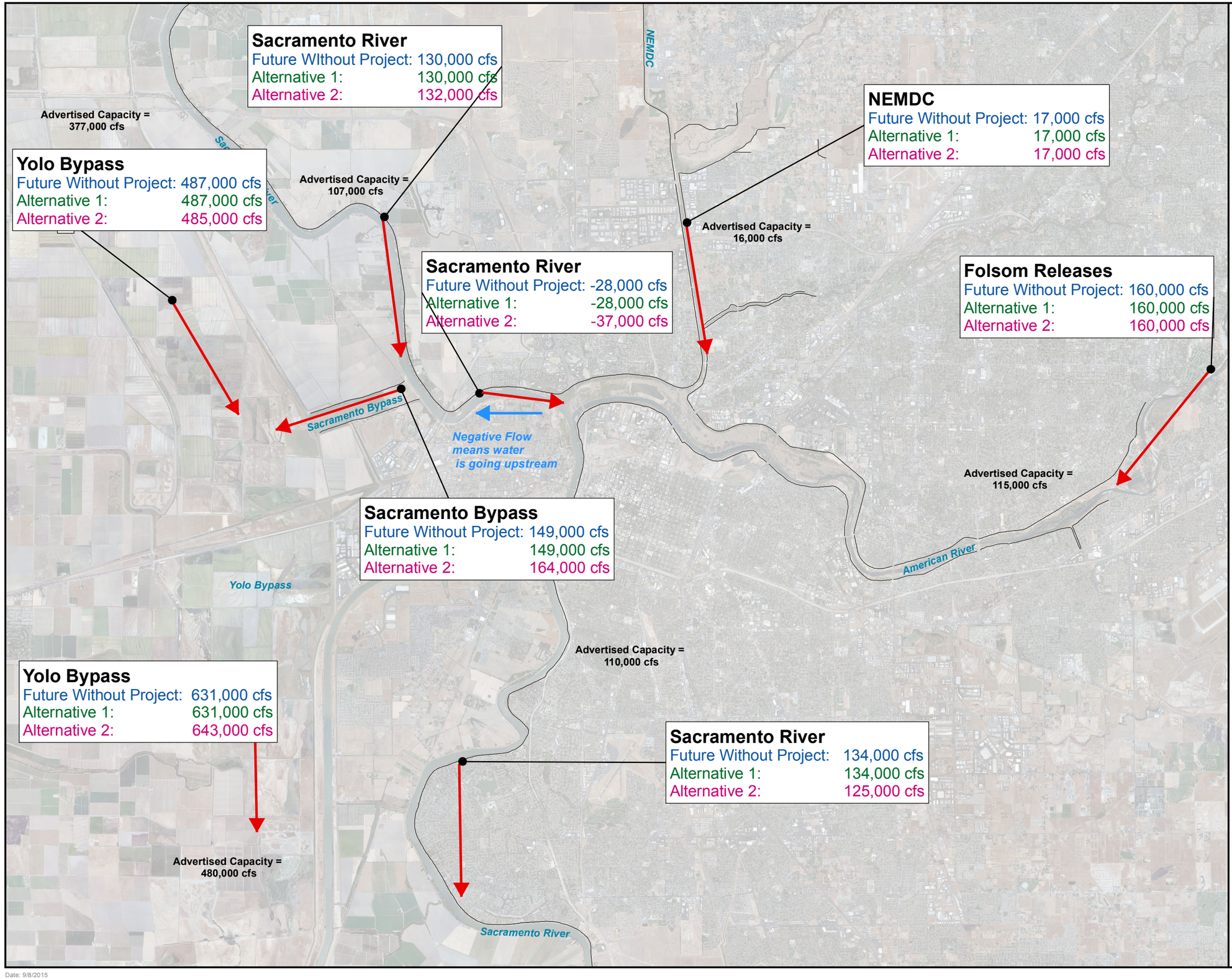
Sept 2015

Plate 71



LEGEND

- Levee Reaches (ARCF)
- Flow Direction
- Backflow

Reach
Future Without Project Condition Flows
Alternative 1 Flows
Alternative 2 Flows

N

0 0.5 1 2 Miles

1:100,000

US Army Corps of Engineers
Sacramento District

Maximum 0.5% (1/200) ACE Future Without Project Conditions & With Project Flows

AMERICAN RIVER
COMMON FEATURES GRR

Maximum Flows are the greatest flow from either the Sacramento or American Storm Centerings.

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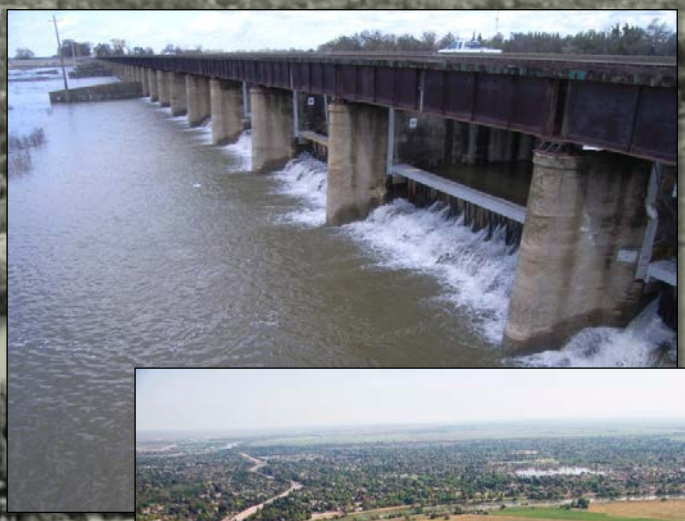
Sept 2015

Plate 72

American River Watershed

Common Features
General Reevaluation Report



Attachment C
Geotechnical Report

December 2015

SAFCA
Sacramento Area Flood Control Agency

CENTRAL VALLEY FLOOD PROTECTION BOARD
PUBLIC SAFETY
WITH FLOOD PROTECTION
STATE OF CALIFORNIA

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:
Sacramento Weir during operation
Sacramento River facing south near the Pocket and Little Pocket neighborhoods
High flows on the American River at the Highway 160 overcrossing
Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Attachment C
Geotechnical Report

U.S. Army Corps of Engineers
Sacramento District

December 2015

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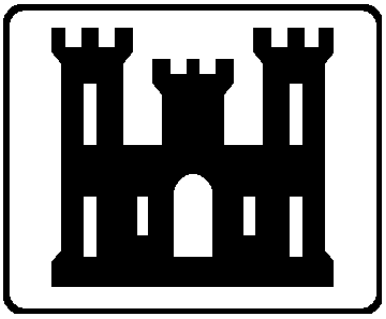
AMERICAN RIVER WATERSHED
COMMON FEATURES PROJECT

GENERAL REEVALUATION REPORT
ATTACHMENT C
GEOTECHNICAL REPORT



US Army Corps of Engineers
Sacramento District

PREPARED BY

GEOTECHNICAL ENGINEERING BRANCH

October 2013

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Enclosure 1 – Analyses Calculation Package
Enclosure 2 – Steady State Seepage and Landside Slope Stability Analyses Results
Enclosure 3 – Probabilistic Analyses and Levee Performance Curves

ABBREVIATIONS

ACN	Arcade Creek North
ACS	Arcade Creek South
ARCF	American River Common Features
ARFCD	American River Flood Control District
ARFCP	American River Flood Control Project
ARN	American River North Basin
ARS	American River South Basin
ASTM	American Society of Testing and Materials
ARWI	American River Watershed Investigation
BGS	Below Ground Surface
BTA	Blanket Theory Analysis
CB	Cement-Bentonite
CFS	Cubic Feet Per Second
CHP	California Highway Patrol
COS	City of Sacramento
CPT	Cone Penetrometer Test
CW	Cutoff Wall
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CY	Cubic Yard(s)
DBH	Diameter at Breast Height
DCN	Dry Creek North
DCS	Dry Creek South
DMM	Deep Mix Method
DSM	Deep Soil Mixing
DWR	Department of Water Resources
DWSC	Deep Water Ship Channel
EFA	Erosion Function Apparatus
EIP	Early Implementation Project
EM	Engineering Manual
ETL	Engineering Technical Letter
EVS	Environmental Visualization System
FEMA	Federal Emergency Management Agency
FOS	Factor(s) Of Safety
FOSM	First Order Second Moment
FT	Foot/Feet
FT/S	Feet Per Second
GER	Geotechnical Engineering Report
GIS	Geographical Information System
GMS	Groundwater Modeling Software
GRR	General Reevaluation Report
H:V	Horizontal To Vertical Ratio
HTRW	Hazardous, Toxic, and Radioactive Waste
HQUSACE	Headquarters U.S. Army Corps Of Engineers
IBC	International Building Code

IWM	In-Stream Woody Material
JET	Jet Erosion Test
K	Coefficient Of Permeability
K_H	Horizontal Hydraulic Conductivity Under Fully Saturated Conditions
K_H/K_V	Ratio Between The Vertical And Horizontal Conductivities; Anisotropic Ratio
K_V	Vertical Hydraulic Conductivity Under Fully Saturated Conditions
Ky	Yield Acceleration
LAR	Lower American River
LiDAR	Light Detection and Ranging
LM	Levee Mile
MA	Maintenance Area
MCDC	Magpie Creek Diversion Canal
MCY	Million Cubic Yards
MSWL	Mean Summer Water Level
MUSYM	Map Unit Symbol
Mw	Moment Magnitude
NAD83	North American Datum of 1983
NAFCI	Natomas Area Flood Control Improvement
NALP	North Area Levee Project
NAT	Natomas Basin
NAVD88	North American Vertical Datum of 1988
NCC	Natomas Cross Canal
NCEER	National Center for Earthquake Engineering Research
NCMWC	Natomas Central Mutual Water Company
NCSS	National Cooperative Soil Survey
NGA	Next Generation Attenuation
NGVD29	National Geodetic Vertical Datum of 1929
NEMDC	Natomas East Main Drainage Canal
NLD	National Levee Database
NLIP	Natomas Levee Improvement Project
NPACR	Natomas Post Authorization Change Report
NRCS	National Resources Conservation Service
NSF	National Science Foundation
NULE	Nonurban Levee Evaluations
OCR	Over-Consolidation Ratio
PACR	Post Authorization Change Report
PDT	Project Delivery Team
PED	Pre-Construction Engineering and Design
PGA	Peak Ground Acceleration
PGCC	Pleasant Grove Creek Canal
PGL	Policy Guidance Letter
Pr(f)	Probability of Failure
PSHA	Probabilistic Seismic Hazard Analysis
P1GDR	Phase 1 Geotechnical Data Report
P1GER	Phase 1 Geotechnical Engineering Report
QA	Quality Assurance

QC	Quality Control
RD	Reclamation District
RM	River Mile
SAFCA	Sacramento Area Flood Control Agency
SB	Soil-Bentonite
SCB	Soil-Cement-Bentonite
SGDR	Supplemental Geotechnical Data Report
SOP	Standard Operating Procedure
SPT	Standard Penetration Test
SRBPP	Sacramento River Bank Protection Project
SRFCP	Sacramento River Flood Control Project
SRN	Sacramento River North
SRS	Sacramento River South
SSURGO	Soil Survey Geographic Database
SUALRP	Sacramento Urban Area Levee Reconstruction Project
SWIF	System-Wide Improvement Framework Policy
TEC	Topographic Engineering Center
TM	Technical Memorandum
TRM	Technical Review Memorandum
ULE	Urban Levee Evaluations
USACE	U.S. Army Corps Of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Society
V:H	Vertical To Horizontal Ratio
$\overline{V}_{S30}$	Velocity Of The Upper 30 Meters
VVR	Vegetation Variance Request
WRDA	Water Resources Development Act
WSAFCA	West Sacramento Area Flood Control Agency
WSE	water surface elevation

1.0 INTRODUCTION

The following briefly outlines pertinent geotechnical information regarding a General Reevaluation Report (GRR) for the American River Common Features (ARCF) Project. This report presents the results of geotechnical analyses and feasibility level geotechnical design recommendations to address levee height, geometry, erosion, access, vegetation, seepage, and slope stability deficiencies within the ARCF GRR study area.

The project area includes portions of the Sacramento and American River Watersheds. The flood plain includes most of the developed portions of the City of Sacramento, the Natomas basin, and portions of Sacramento and Sutter Counties. The study area also includes other flood facilities, including the Fremont and Sacramento Weirs and Yolo Bypass. A Post Authorization Change Report (PACR) for the Natomas portion of the Common Features project and a Chief's Report for the Natomas Post Authorization Change Report (NPACR) were completed in December 2010. The remaining portion of the project, including potential Natomas Basin levee raises, is being addressed in this report.

The ARCF GRR study area, shown in Figure 1-1, has been divided into three basins; Natomas, American River North, and American River South, which were further subdivided into study reaches. This report covers the following areas:

- About 12 miles of the north and south banks of the American River
- About 33 miles of the east bank of the Sacramento River
- About 5 miles of the south bank of the Natomas Cross Canal (NCC)
- About 3 miles of the Pleasant Grove Creek Canal (PGCC)
- About 26 miles of the Natomas East Main Drainage Canal and tributaries (NEMDC)

The ARCF GRR study area has been divided into three basins; Natomas, American River North, and American River South, which were further subdivided into study reaches. For the purposes of the feasibility planning process, the three study area basins were further subdivided into reaches based on common properties (both technical and non technical), such as geographic and geomorphic features. The levees in the American River North Basin have been divided into nine planning reaches; ARN A, B, C, D, E, F, G, H, and I. The levees in the American River South Basin have been divided into seven planning reaches; ARS A, B, C, D, E, F, and G. The levees in the Natomas Basin have been divided into nine planning reaches; NAT A, B, C, D, E, F, G, H, and I.

The ARCF GRR is evaluating federal interest in alternatives to reduce flood risk in the study area. The ARCF GRR has identified several technical deficiencies associated with the flood risk management system protecting the study area. There are various alternatives under consideration to address these deficiencies and the geotechnical components of those alternatives are discussed and or evaluated in this report. The alternatives consist of a combination of structural measures to mitigate seepage, slope stability, erosion protection, and overtopping including the widening and construction of new levees on the Sacramento Bypass and Weir.

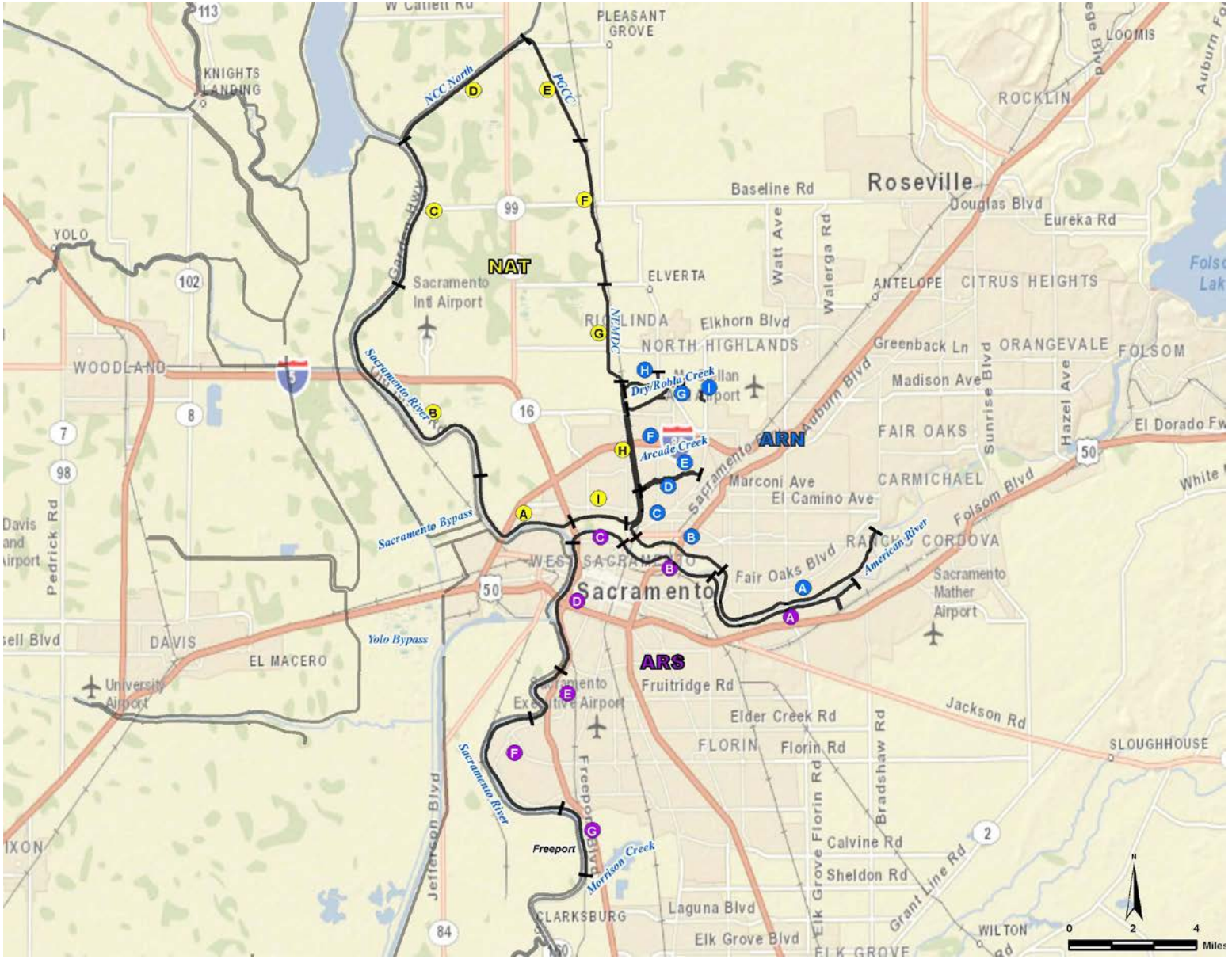

Figure 1-1: Study Area Map of the American River Common Features Project

2.0 GEOLOGY AND GEOMORPHOLOGY

2.1 GEOLOGIC SETTING

The ARCF GRR study area lies in the central portion of the Sacramento Valley which lies in the northern portion of the Great Valley Geomorphic Province of California. The Sacramento Valley lies between the northern Coast Ranges to the west and the northern Sierra Nevada to the east, and has been a depositional basin throughout most of the late Mesozoic and Cenozoic time. A large accumulation of sediments, estimated over two vertical miles in thickness in the Sacramento area, were deposited during cyclic transgressions and regressions of a shallow sea that once inundated the valley. This thick sequence of clastic sedimentary rock units was derived from adjoining easterly highlands erosion during the Late Jurassic period with interspersed Tertiary volcanics. They form bedrock units now buried in mid-basin valley areas. These bedrock units were covered by coalescing alluvial fans during Pliocene-Pleistocene periods by major ancestral west-flowing Sacramento Valley rivers (Feather, Yuba, Bear, and American). These rivers funneled large volumes of sediment into the Sacramento basin. Late Pleistocene and Holocene (Recent) alluvial deposits now cover low-lying areas. These deposits consist largely of reworked fan and stream materials deposited by meandering rivers prior to construction of existing flood control systems.

The Sacramento River is the main drainage feature of the region flowing generally southward from the Klamath Mountains to its discharge point into the Suisun Bay in the San Francisco Bay area. Located in central northern California, the Sacramento River is the largest river system and basin in the state. The 27,000 square mile Sacramento River Basin includes the eastern slopes of the Coast Ranges, Mount Shasta, and the western slopes of the southernmost region of the Cascades and the northern portion of the Sierra Nevada. The Sacramento River, stretching from the Oregon border to the Bay-Delta, carries 31% of the state's total runoff water. Primary tributaries to the Sacramento River include the Pit, McCloud, Feather, and American Rivers. Within the Sacramento area, the Sacramento and American Rivers have been confined by man-made levees since the turn of the century. The confluence with the Sacramento River, only 20 feet above sea level, is subject to tidal fluctuation although more than 100 miles north of the Golden Gate and San Francisco Bay. Within the study area, these levees were generally constructed on Holocene age alluvial and fluvial sediments deposited by the current and historical Sacramento River and its tributaries. Pleistocene deposits underlie the Holocene deposits.

2.2 GEOMORPHOLOGY

Prior to the late Pleistocene (10,000 to 30,000 years ago), the Sacramento River Basin depositional environment was influenced by a lowered base level due to sea levels as low as 400 feet below present (Harden 1998). These lowered global sea levels would have had their greatest influence in present coastal areas such as the San Francisco Bay area, but based on interpretation of the depth to denser, coarser Pleistocene soils it is estimated that average river levels in this area could have been 50 to 60 feet below current levels. The rivers would have been characterized by high energy flow with greater downward erosion rather than deposition, and would have had greater capacity to carry and deposit sand and gravel deposits into the project

area. This older geomorphology is largely covered by the more recent (Holocene) sediments in the project area. The thick zone of materials deposited above the dense, older Pleistocene alluvial deposits are therefore less than 10,000 to 30,000 years old, which is reflected in these deposits consisting of very soft to firm clays and silts and abundant loose to medium dense sands.

The filling of the Sacramento Valley with sediments following the rise in sea level to the current level has significantly reduced the gradient of the rivers flowing down from the Sierra Nevada and Klamath Mountains (including the Sacramento and American Rivers). This gradient reduction has caused the energy of these rivers to transition from erosional to graded. Graded rivers are characterized by downward erosion that is less dominant and more directed toward side-to-side movements than down-cutting. The lateral energy of a graded river causes synchronous erosion and deposition in sweeping bands commonly referred to as meanders. The outside of the meander is a zone of erosion. Material removed by the river at this zone is then deposited downstream as point bars in zones of decreased velocity on the inside of the subsequent meanders. In this way, the river migrates laterally across the flood plain. Often this erosion is slowed where the river encounters more resistant materials in the flood plain. This allows the next closest upstream meander to catch up and gradually erode away the “neck” between the two meanders. Flooding often accelerates this process as the higher energy flows can more easily cut a new thalweg (base of the active channel). The result of the conjoining meanders is the straightening of the river across the opening of the neck and the creation of an abandoned bend in the river, commonly referred to as an oxbow lake.

2.3 HYDRAULIC MINING

Hydraulic mining activity in the Sierra Nevada during the mid- to late-1800s supplied a substantial amount of sediment to many river channels draining the Sierra Nevada, which resulted in aggradation of the channels and flooding due to decrease in channel cross section area. Gold dredging and mining operations have destroyed some fluvial deposits and surfaces, confounding the understanding of the long-term geomorphic history.

This phenomenon, coupled with a disastrous flood in 1862, prompted the channelization of the Sacramento and American Rivers and re-alignment of the American River to its present-day configuration, from the former confluence with the Sacramento River to about two miles upstream. It was hoped that these actions would provide flood control as well as stimulate the flushing of accumulated mining-derived sediment from the channel.

3.0 CONSTRUCTION HISTORY

A mix of Federal, State, and local agencies have been involved in flood control project construction and operation since levees were first constructed in California in the mid-1800's. Since the creation of the State Reclamation Board (now the Central Valley Flood Protection Board or CVFPB) in 1911 and the authorization of the Sacramento River Flood Control Project (SRFCP) in 1917, most levee improvements have been first Federally authorized by Congress, then subsequently authorized by the State Legislature.

The SRFCP was authorized by the Flood Control Act of 1917 (PL 64-367) as modified by the Acts of 1928, 1937, 1941 and 1950. Features of the SRFCP, in the study area, consisted of levees along the lower American River, NEMDC, Arcade and Dry (Linda) Creeks, PGCC, NCC, and Sacramento River improvements, including new and reconstructed levees. The American River Flood Control Project (ARFCP), authorized by the Flood Control Act of 1954 (PL 83-780), consisted of a levee along the north bank of the river, extending from the terminus of the SRFCP project levee near Cal Expo upstream about 8 miles to Carmichael Bluffs. The levee along the American River up to Mayhew Canal was enlarged in 1948. Bank protection was installed along the levee in 1951. The completed flood control system was documented in 1957 in a design memorandum, which included design water surface profiles. To this day, these are the profiles that govern the operation and maintenance requirements of the levee system.

3.1 AMERICAN RIVER LEVEES

The levees along the American River left bank were originally constructed in the late 1800s to early 1900s, likely using clamshell dredges with material sourced from the channel. The levees were then reconstructed on the left bank between 16th Street and Mayhew and on the north bank between NEMDC and Cal Expo with materials sourced from waterside borrow pits using scrapers, dozers, and compactors between 1947 and 1957. Waterside borrow material was used on the right bank of the American River from Carmichael Bluffs downstream to the upper end of the existing flood protection system near Cal Expo under the ARFCP in 1958. Figure 3-1 below represents a typical constructed levee section on the American River in the 1940’s through 1950’s.

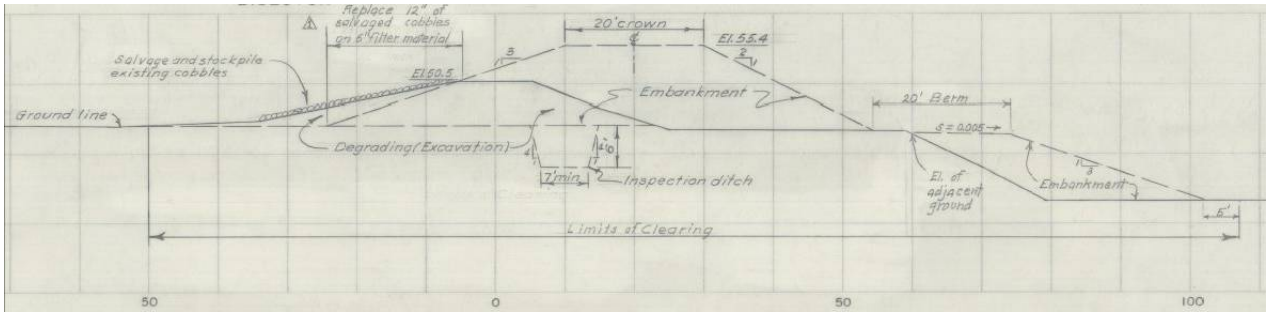

Figure 3-1: American River Typical Section 1940-1960

The ARCF Project was authorized by the WRDA 1996 and 1999 which included, seepage remediation and levee raising. Seepage remediation was completed by constructing a slurry cutoff wall to varying depths along the American River Right Bank Levee and Left Bank Levee

from the Mayhew Drain to the Sacramento River confluence. Due to restrictive site features, such as bridge and utility crossings, the cutoff wall was not constructed contiguously and gaps (windows) were left in the cutoff wall.

3.2 SACRAMENTO RIVER WEST LEVEE (SOUTH OF AMERICAN RIVER)

The levees along the Sacramento River south of the confluence with the American River were constructed by local interests using clamshell dredges excavating material from the Sacramento River in the early 1900's, Figure 3-2. This method of construction usually resulted in loose, sandy fill material that is deepest below the center of the levee. The current materials within the levee embankment are predominantly sands, silty sands, and cohesionless materials. A setback levee at the Edwards Break and riverbank protection was constructed in 1937 and in 1939 the Edwards Break levee slope had been rebuilt. In 1941 the levee was enlarged in the vicinity of Richfield Oil Co. Numerous riverbank and levee waterside slope protection were constructed along the Sacramento east bank levee. Shown below is the Dredge Neptune placing material at RM 57.3 in 1942 during the Sacramento Bank Protection Project.

Figure 3-2: Dredge Neptune at RM 57.3 in 1942

Under the SUALRP levee improvements were constructed along the Sacramento River between the NCC and Freeport. This included slurry cutoff walls constructed in the early 1990s varying in depth from 17 to 30 feet from the levee crest and were intended to address through-seepage. The American River Common Features, Pocket Geotechnical Project constructed a deep cutoff wall using deep soil mixing (DSM) in 2006 varying from 107 to 110 feet from the levee crest which is intended to address under-seepage. The Sacramento River East Bank Levee Under-Seepage Remediation Project, Pocket and Little Pocket Areas constructed a deep-mix method (DMM) cutoff wall in 2005 varying from 91 to 112 feet from the levee crest. This project also constructed an under-seepage cutoff wall using the DMM at the Sump 132 105 feet in depth.

3.3 SACRAMENTO RIVER WEST LEVEE (FROM NCC TO AMERICAN RIVER)

The levees protecting the Natomas Basin were constructed by a private mining and dredging company with the purpose of reclaiming and selling thousands of acres of farmland. The levees were constructed using large "clam shell" dredging machines. The work began in 1912 and was completed by the end of 1915. Based on typical construction schematics shown on basin-wide maps and historical literature, the levees along the Sacramento River were constructed in the following manner:

- A dragline was used to excavate a trench about 6 to 12 feet deep along the centerline of the levee alignment. The trench bottom width ranged from about 12 to 28 feet. The excavated material was deposited along both sides of the trench forming two small containment dikes.
- Hydraulic dredging operations placed material from the adjacent Sacramento River bottom into the excavation area between the dikes. This material consisted predominately of sands.
- The final levee configuration was achieved by covering the dredged sand with the adjacent dike materials. These materials consisted predominately of silt, clay, and fine sand, Figure 3-3.

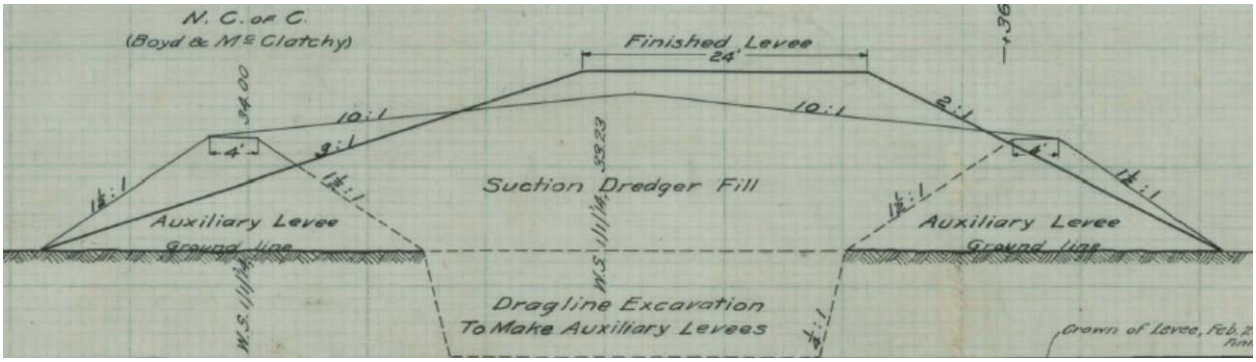

Figure 3-3: Sacramento River Typical Levee Section, 1912-1915

In 1991, between the Sacramento River and NCC confluence to Power Line Road, a drained stability berm was constructed to 10 feet in width extending to approximately half the levee height under the SUALRP. The berm was constructed over a drainage layer that extended as a chimney drain on the levee slope to prevent internal erosion due to seepage through the levee embankment. Filter fabric was placed between the drainage layer and the levee fill to preserve the functionality of the drainage layer. From Power Line Road to the confluence of the Sacramento and American rivers, an SCB cutoff wall was constructed to prevent through-seepage and internal erosion within the levee under SUALRP in 1994. The slurry wall was constructed to depths between 25 and 45 feet below the levee crest. The wall is considered to be hanging, as the tip is not "keyed in" to a lower impervious clay layer of the foundation.

3.4 NATOMAS CROSS CANAL SOUTH LEVEE

Construction on the south levee along the NCC began in 1909. The perimeter levees were constructed encompassing both RD 1000 and RD 1001 areas. In approximately 1912, clamshell dredgers were used to construct the drainage canal of what is now known as NCC between the two levee districts. Work was completed around 1914.

The NCC was excavated across an area that was not a preexisting drainage alignment. The clamshell dredges excavated the alignment of NCC by floating upon the excavated borrow channel located near the waterside levee toe. As the dredgers heaped spoils up from the channel, they were shaped into a levee configuration using small scrapers. The waterside slope was roughly at 3H:1V and the landside slope was about 2H:1V. The crest width was reported as 20 feet. A small core trench near the center of the embankment was also constructed, Figure 3-4.

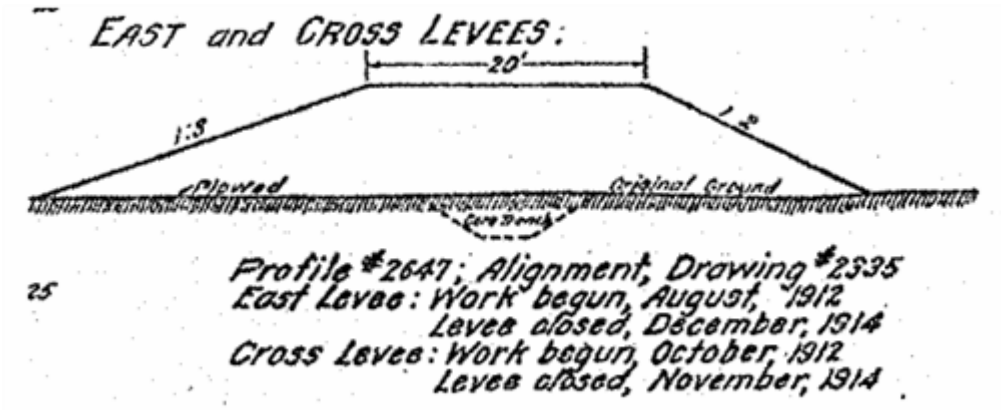

Figure 3-4: Natomas Cross Canal Typical Levee Section, 1912-1914

3.5 NEMDC, PGCC, ARCADE CREEK AND DRY CREEK LEVEES

The Natomas Company of California originally constructed the NEMDC and PGCC west levees from August 1912 to December 1914. A portion of the NEMDC levee was constructed using a clamshell dredge excavating from Steelhead Creek, but the majority of the NEMDC and PGCC west levees were constructed using horse-drawn excavators using material sourced from the channel.

From 1954 through 1958 the USACE completed construction and enlargement (widening and strengthening) portions of the NEMDC, PGCC, Arcade Creek, and Dry Creek levees. Portions of the NEMDC (east and west bank) and PGCC levees were enlarged to between 20 and 12 feet wide at the crest by placing additional material on the waterside levee slope. The NEMDC and PGCC levees were constructed with 3:1 waterside and 2:1 landside embankment slopes. The south bank levee of Arcade Creek was widened to have a 20-foot crest and the north bank levee was constructed (with a 20-foot levee crest). The south levee of Dry (Linda) Creek was constructed (with a 20-foot crest width). The Arcade and Cry Creek levees were constructed with 2:1 waterside and landside embankment slopes. The material was sourced from a waterside borrow trench that paralleled the levee alignment. Figure 3-5 shows a typical section from the 1958 enlargement of the NEMDC east levee.

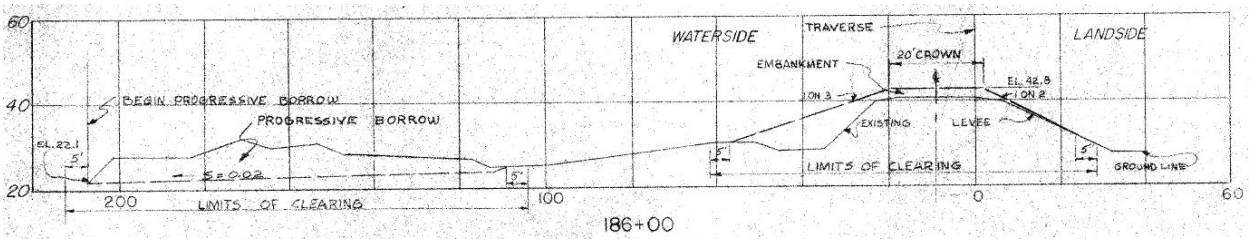

Figure 3-5: NEMDC Typical Levee Section (East Bank), 1958

SAFCA initiated construction of the North Area Local Project (NALP), in 1992 and completed work by 2001. Federal authorization occurred in 1993 under Section 9159 of the Defense Appropriation Act of 1993, as part Phase II of the Natomas Area Flood Control Improvement (NAFCI) Project of 1993, which was authorized by the SAFCA Board of Directors on April 28, 1996. The project consisted of levee embankment and floodwall improvements on the NEMDC east and west levee, Arcade Creek north and south levee, and construction of the Dry Creek north levee (see Figure 3-6).

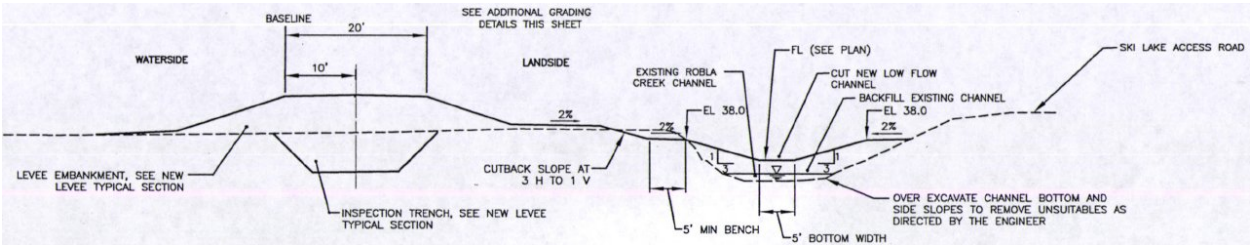

Figure 3-6: Robla Creek Typical Levee Section, 2001

4.0 PAST PERFORMANCE

The study area has experienced several large discharges in recorded history, the earliest was in 1850 when the City of Sacramento was founded and another, larger, flood occurred in January 1862, inundating and substantially damaging Sacramento. These flood events quickly spurred the construction of flood protection levees along many of the banks of the Sacramento River, as well as the cultural re-alignment of the American River in 1868. Additionally, a large flood in 1907 breeched the eastern Sacramento River levee near present day Derick Way (known as the "Edwards Break"), with subsequent flooding of reclamation districts on the eastern side of the river south to the Delta. Additional flood events occurred in 1907, the middle of the century in 1950 and 1955, and more recently in 1986 and 1997, despite the existence of the upstream Folsom Dam. At least eight large floods have occurred in the lower American and Sacramento River basins since Folsom Darn became operational, these occurred in 1955, 1963, 1964, 1969, 1970, 1980, 1982, and 1986. The early floods spurred construction of flood control levees along the lower American River near Sacramento, and the recent floods tested the performance and capacity of the modern levee system.

In February 1986 and January 1997, major storms in Northern California caused record flood flows on the Sacramento and American Rivers. Record high outflows from Folsom Dam and Reservoir, together with high flows in the Sacramento River, resulted in water levels rising above the design freeboard of levees protecting the Sacramento area. It is estimated that major sections of levees along the American and Sacramento rivers would likely have failed if the storms had lasted longer. These events caused undermining of the levee embankment and also washed away portions of the riverbank. Figure 4-1 below shows the erosion distress experienced on the American River as result of the 1986 event. Subsequently flood events in 1997, and late 2005 to early 2006 each caused minor surficial erosion along the American River.

Figure 4-1: 1986 Erosion Distress on the American River South Bank Near I-80

Flood events in 1986, 1997, and 2006 have also caused seepage at or near the landside levee toe as well as at distances of 2,500 to 4,000 feet landward. Seepage distress was experienced throughout the Sacramento River levee reaches. Further documentation including aerial photographs, and reports by landowners, detailed seepage boils as well as eroding and sloughing banks at locations of former channels and oxbows beginning in the late 1930's. Flood fighting (see Figure 4-2) has occurred throughout the Sacramento River reaches in both 1986 and 1997 as a response to seepage and stability concerns.

Figure 4-2: 1997 Flood Fighting on the Sacramento River in Natomas

5.0 GEOTECHNICAL REACH DESCRIPTION

American River North Basin

On the American River north bank (Reaches A and B), there is significant riparian habitat on a typically large waterside bench. In some areas, significant landside vegetation (mostly large trees) exists near the levee toe or on the levee slope. On the landside numerous encroachments include; fences at or near the landside levee toe, parking lots built, and residences. In Reach A the levee embankment is predominantly a silty sand to silt material constructed over a thick silt to silty sand blanket which is underlain by a poorly graded gravel aquifer. While in Reach B the levee embankment is predominantly a lean clay material constructed over a silt and lean clay blanket varying in thickness which is underlain by a silty sand and gravel aquifer. In both Reaches A and B a keyed in cutoff wall was constructed under WRDA 1996/1999 to mitigate underseepage.

On the East Side Tributaries (Reaches C through H), there is sparse vegetation on the levee slopes and adjacent to the embankment. On the landside of the NEMDC (Reaches C and F) levee embankment a railroad embankment is adjacent to the levee. Along approximately half of the Reach E alignment a concrete lined ditch is located at the landside levee toe which is approximately 5 to 10 feet deep. The NEMDC (Reaches C and F) levee embankment varies from clay sand and silt to lean clay and silt material. A lean clay blanket of variable thickness is underlain by a silty sand and poorly graded sand aquifer. On Arcade Creek (Reaches D and E), the levee embankment is predominantly clayey sand, lean clay, and silt constructed over a thin lean clay and silt blanket underlain by a silty sand to poorly graded sand aquifer. The Dry/Robla Creek (Reaches G and H) levee embankment is predominantly a clayey sand and silt constructed over a clayey sand, lean clay, and silt blanket of varying thickness. The blanket is underlain by a silty sand aquifer.

Reach I includes both leveed and non leveed portions of Magpie Creek and the Magpie Creek Diversion Canal (MCDC) between Rose Street, where the Magpie Diversion Canal flows into Robla Creek, to the west and McClellan Air Force Base to the east. The levees associated along Magpie Creek and the MCDC are composed of silty sand and is underlain by predominantly dense to very silty sand and stiff to hard sandy silt with a somewhat prevalent hardpan layer about 4 feet thick, 2 to 6 feet below grade.

American River South Basin

On the American River south bank (Reaches A, B and C), there is significant riparian habitat on a typically large waterside bench. In some areas, significant landside vegetation (mostly large trees) exists near the levee toe or on the levee slope. On the landside numerous encroachments include; fences at or near the landside levee toe, power poles, parking lots, and residences. The Reach A and B levee embankment is predominantly composed of silty sand and sandy silt while the Reach C levee is predominantly poorly graded sand. The levees are underlain by a thick silt to silty sand blanket which is underlain by a sand and gravel aquifer. In both Reaches A and B a

keyed in cutoff wall, and in Reach C a hanging cutoff wall, were constructed under WRDA 1996/1999 to mitigate underseepage.

On the Sacramento River, south of the American River confluence, (Reaches D through G), there is significant waterside and landside vegetation on both the slopes and at the toe of the levee. In all of the reaches, significant urban development has occurred up to the levee toe and/or the landside levee slope. Old Town Sacramento surrounds Reach D, Reaches E and F are residential areas of the Little Pocket and Pocket neighborhoods, and Reach G is the town of Freeport and an adjacent railroad alignment. On the landside numerous encroachments include; fences at or near the landside levee toe and across the levee crest, residences, commercial structures, stairways cut into the landside levee slope, and pools. The levee embankment is predominantly poorly graded sand and silty sand constructed over a lean clay and sandy silt blanket of varying thickness which is underlain by a poorly graded sand aquifer. A through-seepage cutoff wall was constructed which extends to a depth of approximately 18 to 40 feet in portions of Reach D and G and all of E through F. Sections of deep cutoff wall to approximately 110 feet were constructed in portions of Reaches E and F.

Natomas Basin

In the Natomas Basin, on the Sacramento River east bank (Reaches A, B, and C), the there is significant landside and waterside vegetation. On the waterside of the levee crest (levee slope and toe) there exists almost continuous residential structures and related features such as, driveways, out structures, and landscaping. On the landside numerous encroachments are mostly due to agricultural uses (ditches, utilities, and structures) in Reaches B and C and residential in Reach A. The levee embankment was constructed of hydraulically placed sandy core between clay trainer dikes. The trainer dikes were constructed of material obtained by excavating the natural impervious blanket. The levee was constructed over a lean clay and silt blanket underlain by a silty sand and poorly graded sand aquifer. In Reach A and portions of Reach B a shallow through seepage cutoff wall was constructed and in the rest of Reach B and C a landside stability berm. As part of the NPACR and adjacent levee is proposed for construction on the landside of the existing levee with either/or both a deep cutoff wall or landside seepage berm to mitigate levee underseepage.

On the Natomas Cross Canal south bank (Reach D), there is limited vegetation on both the landside and waterside of the levee, which was constructed on the canal bank. The levee embankment is predominantly a silt and clayey sand material constructed on a thin silt blanket which is underlain by poorly graded sand and silty sand aquifer. For a portion of the reach a landside stability berm was constructed to half the existing levee height. As part of the NPACR a cutoff wall is proposed for construction to mitigate levee underseepage.

On the PGCC and NEMDC west bank (Reaches E through H), there is vegetation on the waterside and landside of the levee. Encroachments are sparse for Reaches E through G (mostly agricultural uses) but in Reach H commercial development exists at the landside toe. The levee embankment is predominantly a clayey sand sandy lean clay constructed on a thin lean clay blanket which is underlain by silty sand to poorly graded sand aquifer. As part of the NPACR a

cutoff wall or landside seepage berm is proposed for construction to mitigate levee underseepage.

On the American River north bank (Reach I) there is significant vegetation on both the waterside and landside of the levee; predominantly comprised of trees. Encroachments include primarily commercial buildings near the landside levee toe, and parking lots adjacent to the levee embankment. The levee embankment is predominantly silty sand constructed on a sandy silt blanket which is underlain by silty sand and poorly graded sand aquifer. As part of the NPACR a cutoff wall is proposed for construction to mitigate levee underseepage.

6.0 LEVEE FAILURE MODES AND ANALYSES CRITERIA

For the purposes of problem identification and alternatives analysis, several different failure modes have been evaluated for the without project condition. The failure modes included seepage (under and through), slope stability, erosion, overtopping and seismic.

Steady state seepage analysis considered a maximum allowable vertical exit gradient at the toe of the levee to be less than 0.5 for the water at the design elevation and 0.80 for the water at the top of levee elevation. For landside seepage berms a maximum gradient of 0.8 is allowable at the berm toe. The minimum required factor of safety for the design water surface elevation for the landside steady state slope stability analysis was 1.40 and 1.20 for the top of levee water surface elevation.

The main purpose of seismic vulnerability analyses was to identify the potential seismic performance of a levee. Although seismic remediation generally will not be implemented based on these analysis results, a levee's seismic degradation potential should be considered during selection of a static remediation, or in developing an emergency action plan to be implemented following an earthquake. For the most critical category of levee (e.g., urban levees that are frequently hydraulically loaded) the following displacements are acceptable:

- Any deformation inducing crest displacement of 1 foot or less, unless larger lateral movements comprise the ability of foundation cut-offs or toe drains, etc. to provide for safe retention of high water.
- If more than 1 foot of seismic displacement is predicted, deformation is still acceptable if the levee continues to ensure water retention with 3 feet of freeboard for a 200-year flood event.
- If other safety criteria are met (e.g., cracking that can be repaired in a few days).

The typical USACE levee section, established by EM 1110-2-1913, is nationally considered to have a minimum 10-foot crest with 2:1 (horizontal: vertical) waterside and landside slopes. According to the Sacramento District 1969 "Design Manual for Levee Construction" levees should be constructed with 3:1 waterside and 2:1 landside slopes with either a 20 or 12-foot levee crest width for main stream or tributary levees respectively. The Sacramento District Geotechnical Engineering Branch, SOP-003 *Geotechnical Levee Practice*, suggests a 20-foot crest width with 3:1 waterside and landside slopes except existing levees with good past performance exists where existing 2:1 slopes are acceptable.

Vegetation, encroachment, and access policy includes EM 1110-2-1913, SOP 03, and ETL 1110-2-571 "Guidelines for Landscaping and Vegetation Management at Levees, Floodwalls, Embankments Dams, and Appurtenant Structures". The vegetation-free zone, as established by ETL 1110-2-571, is a three-dimensional corridor surrounding all levees, floodwalls, and critical appurtenant structures in a flood damage reduction system. The vegetation-free zone applies to all vegetation except grass. The minimum height of the corridor is 8 feet, measured vertically from any point on the ground. The minimum width of the corridor is the width of the flood-control structure (Levee toes or floodwall stem), plus 15 feet on each side, measured from the outer edge of the outermost critical structure.

7.0 TYPICAL LEVEE IMPROVEMENT MEASURES

Where levee height, geometry, erosion, access, vegetation, seepage, and slope stability deficiencies were identified (criteria not met) improvement measures consisting of cutoff walls, seepage berms, relief wells, stability berms, geotextile reinforcement, flattened embankment slopes, flood walls, retaining walls, sliver fills, and various other measures could be implemented.

Seepage cutoff walls are vertical walls of low hydraulic conductivity material constructed through the embankment and foundation to cut off potential through seepage and underseepage. In order to be effective for underseepage mitigation, cutoff walls usually tie into an impervious sublayer. The conventional method using a long stick and boom excavator has a maximum depth of 70 to 80 feet. Deeper cutoff walls, up to about 150 feet could be excavated using cable excavation method with crane rigs. Mix-in-place methods of cutoff wall construction include deep mixing method, jet grouting, and cutter soil mixing. Deep Mixing Method uses specialized construction equipment to mix the soil with bentonite and cement in situ and is capable of depths more than 100 feet. Pressure relief wells relieve excess pore pressures that can build up beneath a surficial blanket layer to reduce exit gradient. Relief wells collect seepage and bring it to the surface where it can be discharged freely on the ground surface or collected and drained away from the levee toe. Seepage berms are earth structures built at the landside toe that provide additional weight to prevent blanket layer heave, reduce exit gradients, and can allow safe exit of underseepage. The minimum seepage berm width is typically four times the levee height and the maximum width is generally 300 to 400 feet.

Slope flattening is a mechanical method to repair a slope that may not have stable slopes. Both the waterside and landside slopes can be graded using construction equipment. In most cases, this process requires the removal of all vegetation and encroachments from the levee slope being flattened. Slopes are typically flattened to 3H:1V to 5H:1V. Stability berms are constructed of a random fill material placed over blanket and chimney drainage features to capture seepage through the levee. A thin filter sand layer is placed between the drainage layer and the levee embankment and native soils. Drained stability berms have the benefit of also reducing susceptibility to through seepage. Geotextile is a type of synthetic material that is primarily used for soil reinforcement within an embankment. Geotextile is a woven pervious sheet of fabric constructed of synthetic plastic fibers. Geotextiles only provide reinforcement in tension, thus they are primarily buried within a soil at the tension surface to strengthen the soil.

Floodwalls are an efficient, space-conserving method for containing unusually high water surface elevations. They are primarily constructed from pre-fabricated materials, although they may be cast or constructed in place, and are constructed almost completely upright. Floodwalls are typically located along a levee hinge point to allow vehicular access along the crown. To address deficiencies found in the required levee freeboard various methods of raising the existing levee crown elevation could be implemented. A crown only levee raise assumes that the levee crown is currently wide enough to support the placement of additional embankment material while maintaining the minimum allowable crown width upon the completion of the raise. A full levee raise includes an embankment raise from the waterside crown hinge point upward at a

3H:1V slope, establishing a new crown width, and then down the landside at a new 3H:1V slope).

To protect against waterside erosion in areas where a waterside berm exists, a launchable rock trench may be constructed. This is accomplished by placing rip-rap a certain distance on the waterside slope and excavating a trench at the waterside toe, or where the waterside slope meets the berm. Rip-rap is then placed in the trench and then covered with random fill. As the waterside berm is erodes, it will eventually reach the launchable rock trench. At this point, the undermining action of the erosion event and soils surrounding the trench will allow for the rip-rap contained in the trench to "launch" into the void created adjacent to the trench. In areas that have no or minimal waterside berm, on bank rip-rap is placed on the waterside levee slope to protect against erosion. This entails filling the eroded portion of the bank and installing stone protection along the levee slope from the base of the erosion area to the top of the erosion area. Vegetation would be limited to grass. If there is a natural bank distinct from the levee that requires erosion protection, it would be treated with stone protection.

The purpose of the toe access easement is to allow for necessary maintenance, inspection, and floodfight access. For the ARCF project, the Project Delivery Team (PDT) has determined that a minimum toe access easement of 10 feet is required in association with other levee improvements. The actual toe access may vary depending on site specific constraints. Where vegetation management standards are not met, that levee section must be brought into compliance or a variance may be applied to a levee system or portion of that system to provide for the same levee functionality as intended in ETL 1110-2-571. In consideration for a vegetation variance request (VVR), the VVR will preserve, protect, and enhance the natural resources of the levee system or segment.

8.0 CROSS-SECTION SELECTION

Cross-sections for geotechnical analysis were selected to represent critical surface and subsurface conditions of each reach. The topography of each reach is inherently variable. The existence of access ramps on both landside and waterside of the levee, railroads running perpendicular and parallel to the levee, and/or pump stations or other structures built up adjacent to the levee section create difficulties to discern the typical versus critical cross-section. The sections were selected based on subsurface data, laboratory test results, geomorphology, surface conditions, field reconnaissance, historical performance, and levee geometry. The ground surface elevations used in the cross-sections were based on a LiDAR (light detection and ranging) survey completed in November 2008 for the DWR, ULE project. The natural soil layers were delineated based on boring logs and laboratory test results. Elevation references in this report are in feet and are based on the North American Vertical Datum of 1988 (NAVD88) unless otherwise noted. All horizontal references in this report are in feet and are based on the California State Plane, Zone II, North American Datum of 1983 (NAD83). Plate 1 shows the relationship between LM, RM, and stationing that were used to describe the location of the cross-sections. Table 8-1 and Plate 2 presents the cross-sections where geteochnical analyses were performed, and used in the economic analyses.

Table 8-1: Index Point Locations

Basin	Reach	Channel	Bank	Unit	Levee Mile
ARN	A	American River	North	9	1.32
ARN	E	Arcade Creek	North	7	0.90
ARS	B	American River	South	4	3.90
ARS	F	Sacramento River	East	1	5.92
NAT	D	NCC	South	2	1.17

9.0 HYDRAULIC LOADING CONDITIONS

Water surface profiles for the ARCF GRR study area were obtained from the Hydraulics and Hydrology Branch, Sacramento District. The profiles provide water surface elevations in NAVD 88 by river mile for various flood frequencies. Deterministic seepage and stability analyses were performed for various flood frequencies typically incorporating the 25yr, 50yr, 100yr, 200yr, 500yr, and top of levee. The probabilistic analyses were performed for a range of stages not correlated to flood frequency, but which represented stages from no head (landside toe of levee) to maximum head (top of levee).

During the preparation of this report, the hydraulic model was in the process being revised and updated. Due to the detailed review process required of the hydraulic model update, the decision was made to perform the deterministic analyses using draft hydraulic model water surface profiles for various flood frequencies. Water surface profiles for deterministic seepage and slope stability analyses for the Natomas Basin were based on the previous hydraulic model dated December 2010, for the American River North Basin (ARN) Reaches A and B and American River South Basin (ARS) Reaches A through G were based on a draft update dated July 2011, and for ARN Reaches C through H were based on a draft update dated March 2012. The various different models have a variability of 1 to 3 feet of stage for the same flood frequency. Table 9-1 below summarizes the water surface elevations deterministically analyzed at each index point, by basin.

Table 9-1: Analyses Water Surface Elevations

Index Point	Event	Stage	Head
ARN Reach A U9 LM 1.32	Crest	52.95	9.69
	500yr	55.83	12.57
	200yr	51.1	7.84
	100yr	46.27	3.01
	50yr	46.16	2.9
	25yr	46.08	2.82
ARN Reach E U7 LM 0.90	Crest	43.94	12.25
	500yr	46.12	14.43
	200yr	41.34	9.65
	100yr	39.08	7.39
	50yr	37.68	5.99
	25yr	35.34	3.65
ARS Reach B U4 LM 3.90	Crest	48.83	16.03
	500yr	47.76	14.96
	200yr	41.31	8.51
	100yr	38.13	5.33
	50yr	37.73	4.93
	25yr	37.41	4.61

Index Point	Event	Stage	Head
ARS Reach F U1 LM 5.92	Crest	33.41	17.96
	500yr	33.33	17.88
	200yr	32.05	16.6
	100yr	30.33	14.88
	50yr	29.65	14.2
	25yr	29.03	13.58
NAT Reach D U4 LM 1.17	Crest	44.85	15.3
	500yr	45.16	N/A
	200yr	44.23	14.68
	100yr	42.84	13.29
	50yr	41.88	12.33
	25yr	41.11	11.56

10.0 SEEPAGE AND SLOPE STABILITY ANALYSES

Deterministic steady state seepage analysis was performed using the finite element program SEEP2D within GMS 6.5 (Groundwater Modeling System). Results from the seepage analysis were used to calculate average vertical exit gradients at the landside levee toe and/or at a more critical location near the levee toe if applicable, for example at the invert of the empty drainage ditch. The pore pressures and/or phreatic surfaces were exported to UTEXAS4.0 for use in slope stability analysis.

Boundary conditions along the waterside ground surface from the waterside model limits to the levee slope were assigned as fixed total head conditions corresponding to the analyzed water elevation. On the landside, exit face boundary conditions are applied from the landside crest hinge point to landside extents of the model. All other boundaries not explicitly assigned a condition are assumed by the program to be no flow which include both vertical faces of the model and the bottom nodes. The landside model extents were extended 2,000 feet from the levee centerline and for the waterside model extents to the channel centerline.

Embankment stability against shear failure was analyzed using the UTEXAS4.0 software package for steady state conditions. Analyses to find factors of safety against sliding were conducted using a floating grid automatic circular failure surface search routine to identify the critical failure surfaces with Spencer Procedure within the embankment and/or foundation. The Spencer Procedure satisfies both force and moment equilibrium for each slice. A minimum weight restriction was applied to the slices within the failure surface to eliminate surficial failure surfaces. Where tensile stresses exist on the failure surface, a water filled crack depth was introduced to eliminate the tensile stresses, but not compressive stresses.

Material properties including hydraulic conductivity for seepage analysis and drained (effective) shear strength and unit weight for slope stability analysis were developed based on a review of field and laboratory data that was then generalized into appropriate parameters by material type. The stratigraphy of the existing levee cross-section was divided into unique layers typically consisting of levee embankment fill, foundation or blanket layer, pervious aquifer layers separated by an aquitard, and a deeper fine grained layer. Analysis material parameters were assigned considering saturated conditions.

The results of the without project seepage and slope stability analyses indicate that the levees in ARN Reaches C through F and ARS Reaches D through G did not meet minimum criteria. The analyses showed that the levees did not meet criteria at varying flood frequencies typically between the 25 and 200 year events. In general, the analyses identified underseepage deficiencies and/or underseepage related slope stability deficiencies. Therefore, the with project analyses typically included deep cutoff walls which resulted in the with project levee analyses satisfying criteria.

10.1 ARN REACH A – AMERICAN RIVER NORTH – U9 LM 1.32

The without project conditions analyses includes the WRDA 1996/1999 cutoff wall and met criteria for both seepage gradients and slope stability factors of safety. As no seepage and stability deficiencies exist, no further improvements are recommended. Figure 10-1 displays steady state seepage and landside slope stability results for analyzed flood frequencies.

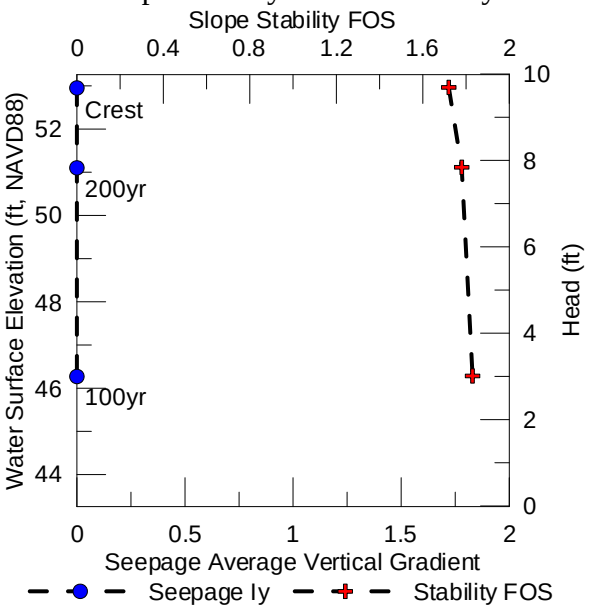

Figure 10-1: ARN Reach A U9 LM 1.32 Without Project Analyses Results

10.2 ARN REACH E – ARCADE CREEK NORTH – U7 LM 0.90

The without project conditions seepage analysis of the Arcade Creek north levee have shown the potential for seepage gradients to exceed criteria beginning at the 100 year flood frequency event due to a thin clay blanket underlain by poorly graded sand layer. Related to the underseepage deficiency, slope stability factors of safety do not meet criteria beginning at the 50 year flood frequency event. The 100 year flood frequency event corresponds to a water surface elevation of 39.08 feet and 7.39 feet of head and the 50 year flood frequency event corresponds to a water surface elevation of 37.68 feet and 5.99 feet of head. Additionally, an open drainage ditch to the landside levee toe from NEMDC to Norwood Avenue amplifies the slope stability deficiency. With project conditions analyses addressed the underseepage and slope stability deficiencies by incorporating a cutoff wall be keyed-in to a low permeability confining layer at elevation –6.0 feet. With the improvement measures described above seepage and stability analyses met criteria. Figure 10-2 displays the without project conditions analyses results and Figure 10-3 displays the with project analyses results for analyzed flood frequencies.

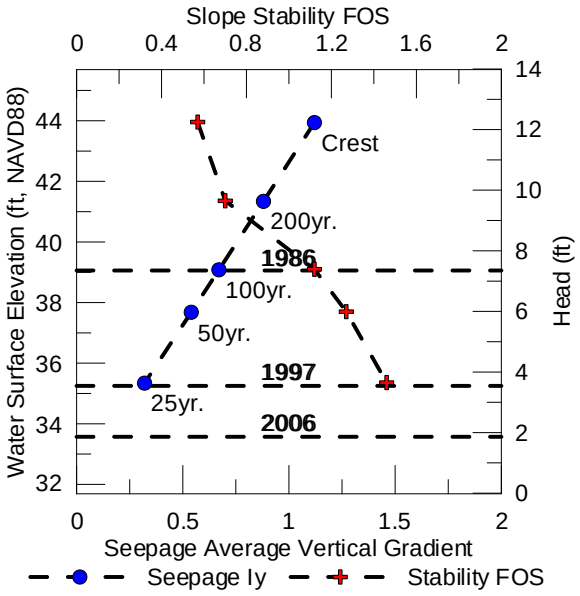

Figure 10-2: ARN Reach D U7 LM 0.90 Without Project Analyses Results

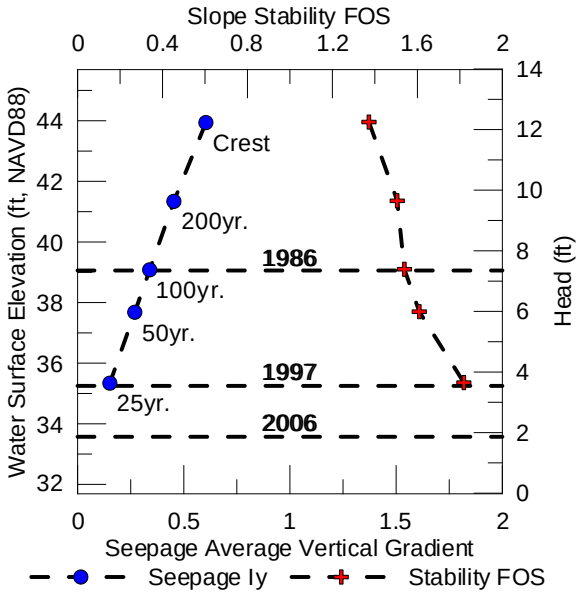

Figure 10-3: ARN Reach D U7 LM 0.90 With Project Analyses Results

10.3 ARS REACH B – AMERICAN RIVER SOUTH – U4 LM 3.90

The without project conditions analyses includes the WRDA 1996/1999 cutoff wall and met criteria for both seepage gradients and slope stability factors of safety. As no seepage and stability deficiencies exist, no further improvements are recommended. Figure 10-4 displays steady state seepage and landside slope stability results for analyzed flood frequencies.

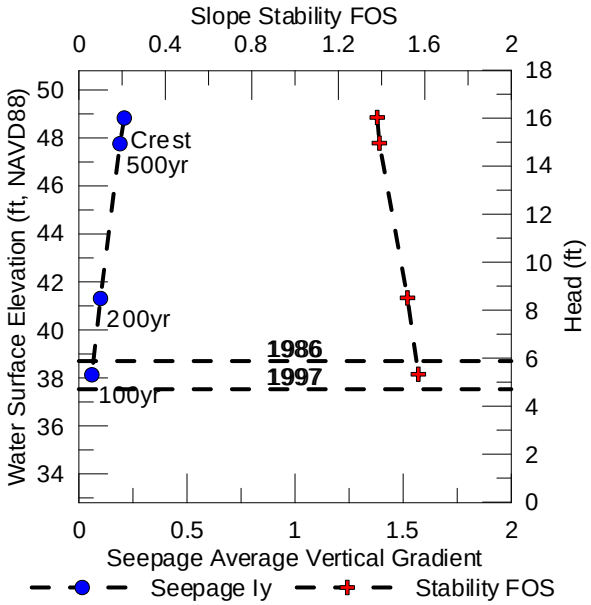

Figure 10-4: ARS Reach B U4 LM 3.90 Without Project Analyses Results

10.4 ARS REACH F – SACRAMENTO RIVER EAST – U1 LM 5.92

The without project conditions analysis on the Sacramento River, at this location, included a through seepage cutoff wall constructed by the SUALRP in the early 1990's. Slope stabilty analysis resulted in factors of safety below criteria beginning at the 25 year flood frequency event, which corresponded to a water surface elevation of 29.03 feet and 13.58 feet of head. Seepage analysis at the 25 year flood frequency event through crest water surface elevation indicated marginal underseepage gradients (0.4 to 0.5). A review of past performance indicated that seepage and boils were observed at numerous locations both before (1995) and after (1998) the construction of the through cutoff wall. Past flood event stages were compared to analyzed flood frequencies and the 1997 event (maximum recorded stage) was comparable to the 25 year flood frequency. The past performance is in agreement with the seepage and stability analyses results. With project conditions analyses addressed the underseepage deficiencies by incorporating a keyed-in cutoff wall to tip elevation -105.0 feet. Figure 10-5 displays the without project conditions analyses results and Figure 10-6 displays the with project analyses results for analyzed flood frequencies.

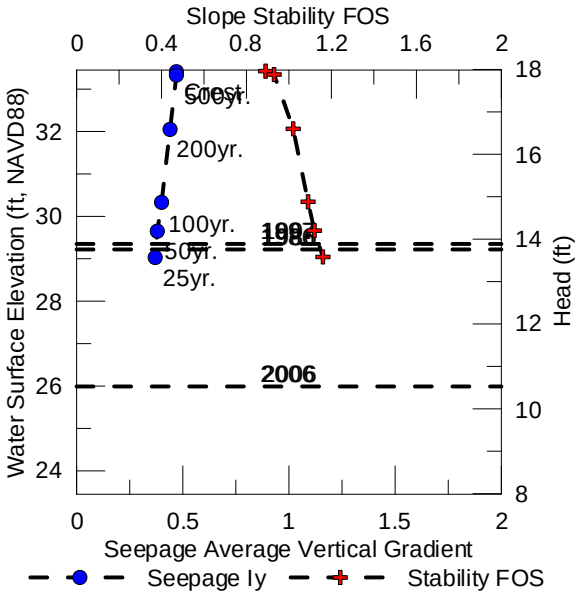

Figure 10-5: ARS Reach F U1 LM 5.92 Without Project Analyses Results

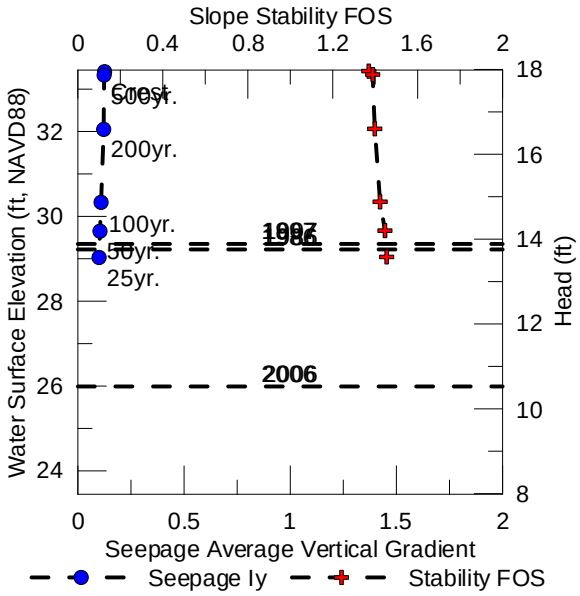

Figure 10-6: ARS Reach F U1 LM 5.92 With Project Analyses Results

10.5 NAT REACH D – NCC SOUTH – U1 LM 1.17

The without project conditions analyses includes the NPACR cutoff wall which satisfies criteria for both seepage gradients and slope stability factors of safety. The ARCF GRR included a levee raise, the NPACR analyses section met top of levee analyses criteria with the raise. Figure 10-7 displays steady state seepage and landside slope stability results for analyzed flood frequencies.

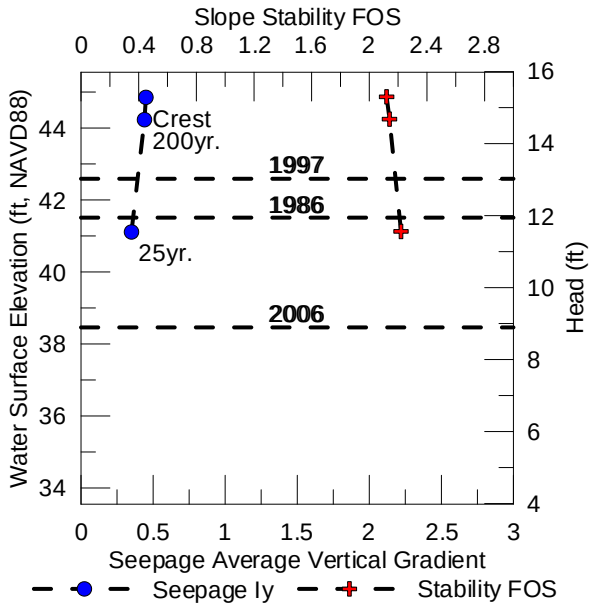

Figure 10-7: NAT Reach D U1 LM 1.17 Without Project Analyses Results

11.0 EROSION ASSESSMENT

The American River levees were originally intended to convey a release from Folsom Dam of 115,000 cfs. During several events since the construction of Folsom Dam, flows have exceeded design capacity and caused significant erosion distress. Additionally, the objective release from Folsom Dam is currently under review as part of the Folsom Dam Reoperations Study and the Joint Federal Project is currently constructing improvements to the dam for a release of 160,000 cfs.

Insufficient geotechnical data were available to adequately support existing and proposed channel stability analyses and potential design recommendations. Specifically the geotechnical and geologic study focused on characterization of soil properties through exploration and testing, geologic mapping, and 3-dimensional modeling of the subsurface stratigraphy. Additional geotechnical data was generated to characterize the material comprising the existing channel bed between the Right and Left bank levees of Lower American River (LAR) between River Mile (RM) 5.0 and 11.0. Specifically, the geotechnical study was directed to investigation the location and properties of a potentially erosionally resistant unit, better represent and organize the existing geotechnical data, and improve upon existing geologic mapping.

Subsurface exploration, soil borings and CPT, and subsequent laboratory testing were performed in support of the various tasks associated with studying erosion on the LAR. Relatively undisturbed samples were collected of the potentially erosionally resistant unit for erosion rate testing to be used in hydraulic modeling and analyses. Additional subsurface investigation consisted performing several geoelectrical surveys of the LAR channel and floodplain between RM 5.5 and RM 11.0 to characterize the extent and thickness of lithologic units that may have differing scour potential. The erosion resistance of the LAR was further assessed by performing Jet Erosion Tests (JET) and Erosion Function Apparatus (EFA) testing on undisturbed samples of cohesive materials located near the bed elevation of the LAR. The test results showed that the erodibility of each sample was related to the geologic unit and that most of the specimens within the Fair Oaks formation (below the erosionally resistant surface) could be categorized as Moderate Resistant to Very Resistant. Similarly, in general, the layer above erosionally resistant surface could be categorized as Very Erodible to Erodible.

Fugro Consultants performed the geologic portion of the erosion study, key findings from their report, *Lower American River Stratigraphic and Geomorphic Mapping Report* (2012), are reproduced below. Two levels of investigation were performed: (1) detailed mapping and analysis of the geologic deposits between the levees from RM 5.0 to 11.0, and (2) development of reconnaissance mapping along the channel corridor between RM 0.0 to 5.5 and RM 11.0 to 22.4. Detailed geologic mapping, as well as petrographic and pedogenic analyses, completed during this study demonstrated the presence of two potentially erosion-resistant units. These were: (1) a moderately cohesive silty and sandy interbed of relatively limited lateral and longitudinal extent within a thicker package of loose Holocene sediments (the “upper” unit); and (2) much thicker, more widespread relatively erosion-resistant deposits associated with the Pleistocene-aged Fair Oaks formation of Shlemon (1967) (the “lower unit”). Figure 11-1 presents a generalized stratigraphic section.

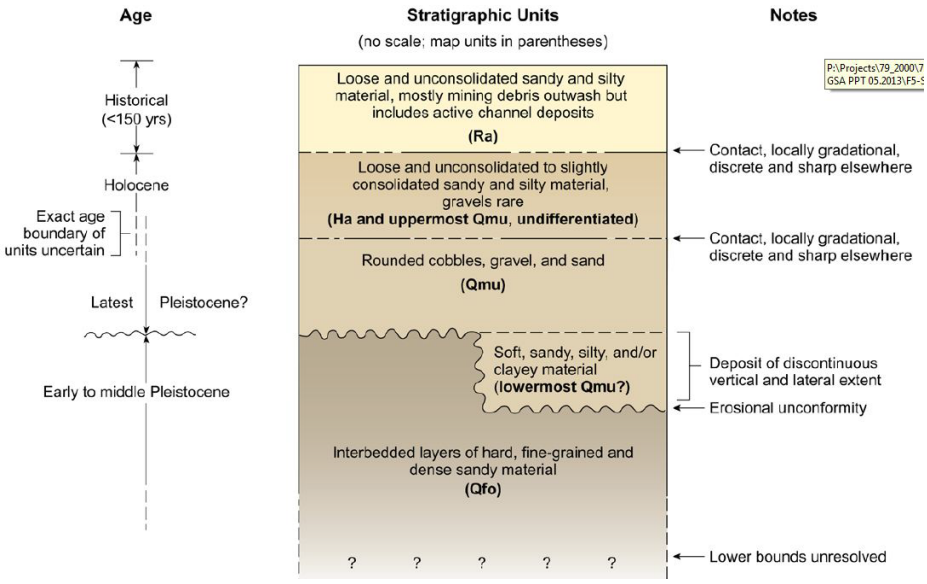

Figure 11-1: Generalized, Composite Stratigraphic Section of the Lower American River

A 3-dimensional (3D) stratigraphic model of the LAR study reach was developed by incorporating both existing and newly collected geotechnical and geologic data. The model described the stratigraphy and subsurface conditions of the study reach and help evaluate the stratigraphic susceptibility of this reach to erosion near the levee banks. Figure 11-2 presents a site specific representation of the generalized section presented in Figure 11-1.

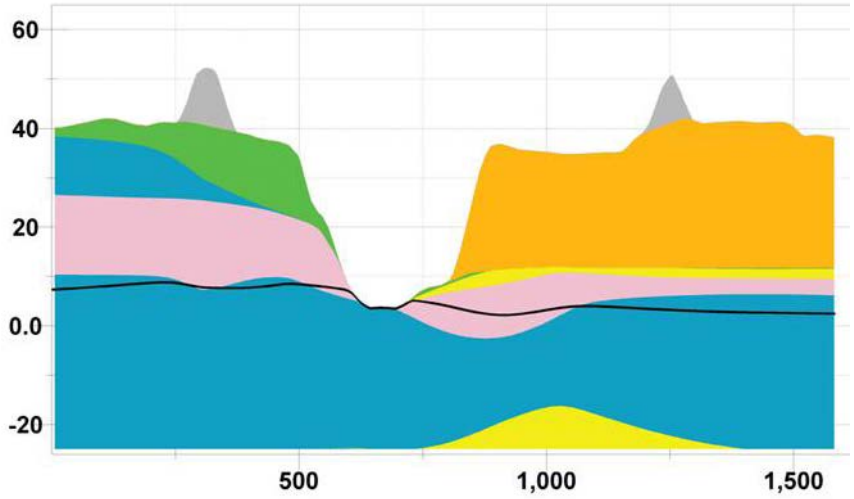

Figure 11-1: 3D Stratigraphic Model Section 11 Near RM 7.2

A review of the applied velocity and shear stresses at different simulated flows was performed on the left and right banks of the study area at several locations. Applied velocity exceeds permissible velocities for most soils by 50,000 cfs on the right bank and between 80,000 and 115,000 on the left bank. Therefore, it is reasonable to assume that, depending on flood event duration, channel and bank geometry, levee geometry, soil type, and vegetation cover, that erosion distress to the American River channel banks and levees has the potential to occur beginning at flows exceeding 30,000 cfs.

12.0 SEISMIC ASSESSMENT

To evaluate the potential to liquefaction resistance of soils, liquefaction triggering analysis was performed based on the procedure from the summary report of the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils, published as part of the Journal of Geotechnical and Geoenvironmental Engineer, dated October 2001 (Youd, Idriss, Andrus, & Arango, October 2001).

The result of the liquefaction triggering analysis and liquefaction-induced post-earthquake deformation based on limit equilibrium analysis indicates that liquefaction potential is highly likely at each critical location for all the reaches for Natomas Basin, Reach A of American River North Basin, and Reaches C to G of American River South Basin. Moreover, at these locations, the analysis indicates that the post-earthquake deformation as the result of liquefaction of the material beneath the embankment is a global or structural failure mode that is very likely to compromise the ability to provide flood protection at these critical locations.

13.0 VEGETATION VARIANCE REQUEST SUPPORTING ANALYSES

The majority of the Sacramento River levee within the study area, require seepage, slope stability, height, and erosion improvements in order to meet USACE criteria. Construction of the levee improvement measures will require complete vegetation removal on the levee from approximately 15 feet landward of the landside toe to approximately 1/3rd the height of the levee on the waterside slope. On the waterside, where construction does not remove vegetation, on the lower 1/3rd of the slope to 15 feet waterward of the waterside levee toe, the vegetation will be left in place and a Vegetation Variance Request (VVR) will be sought by the Sacramento District. To show that the safety, structural integrity, and functionality of the levee would be retained, an evaluation of underseepage and waterside embankment slope stability was completed given that a tree fell resulting in scouring of the root ball area.

The analyses section/index point at LM 5.92 was chosen for the VVR analyses because if was considered to be representative of the most critical channel and levee geometry and the without project analyses showed the section does not meet underseepage and slope stability criteria. The cross-section geometry of the index point incorporated tree fall and scour by using a maximum depth of scour for cottonwoods as approximately 11.0ft; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of Cottonwoods (12.0ft) projected horizontally at a depth of 11.0ft below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets USACE seepage and slope stability criteria considering the seepage and stability improvement measures are in place (“with project” conditions). Therefore, it is a reasonable conclusion that with a VVR to allow vegetation to remain, the safety, structural integrity, and functionality of the Sacramento River levee would be retained.

14.0 GEOTECHNICAL RECOMMENDATIONS FOR LEVEE IMPROVEMENT

The levees protecting the ARCF GRR study area are susceptible to through seepage, underseepage, slope stability, and erosion. In some locations, on the levees along the American River and Natomas Basin, substantial projects have been authorized to address these deficiencies. However, seepage, slope stability, and/or erosion deficiencies still remain on portions of the Sacramento River, on the east bank of NEMDC, on both banks of Arcade Creek, and on both banks of the American River. To address seepage and seepage related slope stability deficiencies the predominant recommendation is cutoff walls. Due to several factors including constraints on expanding the levee footprint; seepage berms, relief, wells, and the vast majority of other seepage improvement measures were considered not feasible. Based on hydraulic modeling, some reaches may require raises to prevent overtopping at certain flood frequencies. Plate 3 shows the locations of those improvements.
On the American River erosion continues to be a potential failure mode that requires additional improvements to convey design flows. To accomplish this, two erosion protection measures have been proposed that could be implemented in combination along the levee alignment depending on factors such as, bank/bench geometry, existing habitat, and existing land use among other considerations. The two measures are a launchable rock trench and on bank rip-rap.

On the Sacramento River east levee (Reaches ARS D through G), the need for further seepage and slope stability improvements has been identified through geotechnical analyses. A combination of conventional open trench and Deep Soil Mixing (DSM) cutoff wall construction methods is anticipated. Levee raises are proposed in some segments of the Sacramento River levee which would be accomplished with a levee embankment raise and retaining wall at the landside levee toe or a flood wall constructed at the levee crest. The levee at Pioneer Reservoir was improved by the Sacramento District with relief wells and a landside seepage berm to meet criteria at the 100 year flood event. At this location, the seepage berm should be thickened to increase the level of protection (200 year flood event). To address a slope stability deficiency in Reach G, a full levee degrade and placement of geotextile within the reconstructed levee embankment is recommended. The Sacramento River levee requires erosion protection, which could be addressed with the measures presented for the American River. The extents of levee seepage and slope stability improvements for the Sacramento River are shown in Table 14-1.

Table 14-1: Sacramento River Reaches D through G Recommended Improvements

Reach	Beginning LM	Ending LM	Tip Elevation (ft)	Depth (ft)	Type	Description
D	0.00	0.18	NA	NA	NA	USACE 2000 CW
	0.18	1.25	NA	NA	NA	High Ground
	1.25	1.97	NA	NA	NA	Pioneer Reservoir
	1.97	3.2	-80	120	DSM	Hanging/Keyed In
	3.2	3.63	-45	80	Open Trench	Keyed In
	3.63	0.59	NA	NA	NA	High Ground
E	0.59	0.9	-95	135	DSM	Partial
	0.9	1.36	NA	NA	NA	SAFCA 2006 CW
	1.36	1.71	-75	115	DSM	Keyed In
	1.71	2.39	-65	105	DSM	Keyed In
E/F	2.39	3.39	-55	95	DSM	Partial
F	3.39	3.67	-75	115	DSM	Hanging
	3.67	3.99	NA	NA	NA	USACE 2006 CW
	3.99	4.57	-75	110	DSM	Keyed In
	4.57	5.01	-45	80	Open Trench	Keyed In
	5.01	6.03	-110	145	DSM	Partial
	6.03	6.11	NA	NA	NA	Sump 132 CW
	6.11	6.28	-85	120	DSM	Keyed In
	6.28	7.36	-65	100	DSM	Keyed In
F/G	7.36	8.32	-60	95	DSM	Hanging
G	8.32	10.64	NA	NA	NA	Geotextile

The NEMDC, Arcade Creek north, Dry Creek, and Robla Creek levees sections were improved in the 1990's to early 2000's by SAFCA and, although they did not include internal seepage improvements, the levees meet geotechnical analyses criteria for seepage and slope stability, except in limited segments. The exception being a portion of NEMDC from its confluence with the American River, both banks of Arcade Creek, and a section of NEMDC where the historic Magpie Creek intersects the levee foundation. To address underseepage and underseepage induced slope stability deficiencies the proposed improvement measure is a cutoff wall constructed with the conventional open trench method. The Arcade Creek south bank proposed cutoff wall is proposed in conjunction with a full levee height degrade and incorporation of geotextile placed within the reconstructed levee embankment. The Arcade Creek north bank a cutoff wall is proposed in conjunction with replacing the existing landside ditch with buried culverts from the confluence of NEMDC upstream to Rio Linda Blvd. Depths and locations of the proposed cutoff wall are shown in Table 14-2 below

Table 14-2: East Side Tributaries Reaches C through F Proposed Cutoff Wall Extents

Reach	Beginning		Ending		Tip Elevation (ft)	Depth (ft)
	Unit	LM	Unit	LM		
C	2	0.00	2	0.48	-45	80
D	1	0.00	1	2.08	-6	45
E	7	0.00	7	1.92	-6	45
F	2	2.01	2	3.24	-45	80

For the levees surrounding the Natomas Basin, the geotechnical recommendations for seepage and slope stability were addressed in the NPACR. The recommended alternative from that report included a combination of seepage berms and cutoff walls combined with either an adjacent levee or fix-in-place improvement to the existing levee. To address levee overtopping concerns, a floodwall at the waterside hinge point or a soil embankment raise is proposed where necessary.

15.0 MAGPIE CREEK

In the early 1990's, the Sacramento District and SAFCA began studying the Magpie Creek and MCDC flood control project after the realization that the system was overtopped during frequent events. In the late 1990's and early 2000's, both the Sacramento District and SAFCA developed varies improvement alternatives for the project. While the alternatives varied slightly, they included similar measures such as, levee raises (either embankment or floodwall), new levee construction, channel improvements (deepening or widening), and construction of detention basins. Levee improvements consisting of either levee embankment raises or flood wall raises were proposed for the left bank of Magpie Creek and the MCDC, while new levee construction was proposed for the right banks. Based on the available existing feasibility and design documents prepared in the 1990's and early 2000's by the Sacramento District and SAFCA, the levee, channel, and detention basin improvement measures appeared to be geotechnically adequate and require no further geotechnical analyses as part of the ARCF GRR.

16.0 SACRAMENTO WEIR AND BYPASS

The existing Sacramento Weir and Bypass, which allows high flows in the Sacramento River to be diverted into the Yolo Bypass, could be expanded to roughly twice their current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass would be degraded and a new levee constructed approximately 1,500 feet in length to the north. The existing Sacramento Weir would be expanded to match the wider bypass.

The new north levee of the Sacramento Bypass would be constructed as per the standard levee section for new construction which includes; Type I Levee Fill, 3H:1V waterside and landside slopes, and a minimum crest width of 20 feet. As both the existing north and south levees have experienced underseepage and slope stability related distress, the new north levee would include a 300-foot wide drained landside seepage berm (5 feet thick at the landside levee toe tapering to 3 feet thick at the berm toe and constructed of random fill with a 1.5-foot thick drainage and filter layer at the base) with a system of relief wells located at least 15 feet landward of the berm toe and spaced at 200-foot intervals. A seepage cutoff wall with tip elevation of 5 feet (35 feet deep) should be constructed beneath the Sacramento Weir.

17.0 PROBABILISTIC ANALYSES

The First-Order-Second-Moment (FOSM) method, as recommended in ETL 1110-2-556, "Risk-Based Analysis in Geotechnical Engineering for Support of Planning Studies" dated 28 May 1999, was followed during the probabilistic evaluation of each index point. In this approach, the uncertainty in performance is taken to be a function of the uncertainty in model parameters. The standard deviations of a performance function were estimated based on the expected values (means) and the standard deviation of the random variable means. The performance functions considered were underseepage, through-seepage, and slope stability.

Potential sources of levee distress or failure considered in the analyses were underseepage through the levee foundation, through-seepage through the levee embankment, and instability of the landside levee slope under steady state conditions. The levees were evaluated against the above mentioned performance modes at five different water surface elevations (loading conditions), which included; levee crest, levee crest minus three feet, half levee height, toe plus three feet, and landside levee toe where the probability of failure was considered to be zero. Using this method of selecting loading conditions the curves should represent probability of poor performance at multiple flood frequencies.

The probability of poor performance was evaluated by assessing the foundation and embankment materials and assigning values for the probability moments of the random variables considered in the analyses. Random variables for underseepage were considered for the ratio of the horizontal permeability of the aquifer to the vertical permeability of the upper less permeable blanket, blanket thickness, and aquifer thickness. Random variables for through-seepage were considered for critical tractive stress, porosity, and intrinsic permeability of the levee embankment material. Random variables for slope stability were considered for effective friction angle, effective cohesion, and total unit weight of the levee embankment, and effective friction angle and cohesion of the foundation material.

A judgment based conditional probability function for each analyzed cross-section was based on existing conditions of the levee such as encroachments on the levee slopes, vegetation on the levee slopes and in the vicinity of the levee toes, existing cracks and holes due to animal burrows, erosion of the waterside levee slopes and riverbank, and considering the past history of sand boils or slope failures. Generally, past experience with poor performance at utility crossing and rodent activity indicates the risk of failure is somewhat significant in the analyzed areas.

The conditional probability of failure as a function of floodwater elevation has been developed by combining the probability of failure functions for all considered failure modes; underseepage, through-seepage, slope instability, and judgment.

The without project levee performance curves indicate that the levees in ARN Reaches C through F and ARS Reaches D through G would perform unsatisfactorily when minimally loaded. In general, the analyses identified underseepage deficiencies and/or underseepage related slope stability deficiencies. Therefore, the with project levee performance curves considered the proposed improvement measures for each failure mode, as necessary, which resulted in significant reduction in probabilities of poor performance.

17.1 ARN REACH A – AMERICAN RIVER NORTH – U9 LM 1.32

Borings chosen to be used in probabilistic analyses resulted in a mean blanket thickness value of 15.0 ft with a coefficient of variation of 96, and a mean aquifer thickness of 24.0 ft with a coefficient of variation of 42. The blanket was comprised of predominantly silty sands. The aquifer was made up of poorly graded sand to silty sand, and silty gravel.

The levee embankment contains an existing cutoff wall which mitigates underseepage, through seepage, and slope stability concerns. The without project judgment based probability portion of the curve was comprised mainly of erosion, and encroachments, accounting for 50.0% and 4.0% respectively at the crest. Past performance has indicated significant amounts of erosion of the riverbank, waterside levee slope and foundation. Overall judgment based contributions account for a Pr(f) of 55.3% of the without project combined curve at the levee crest. Figure 17-1 presents the without project conditions combined curve.

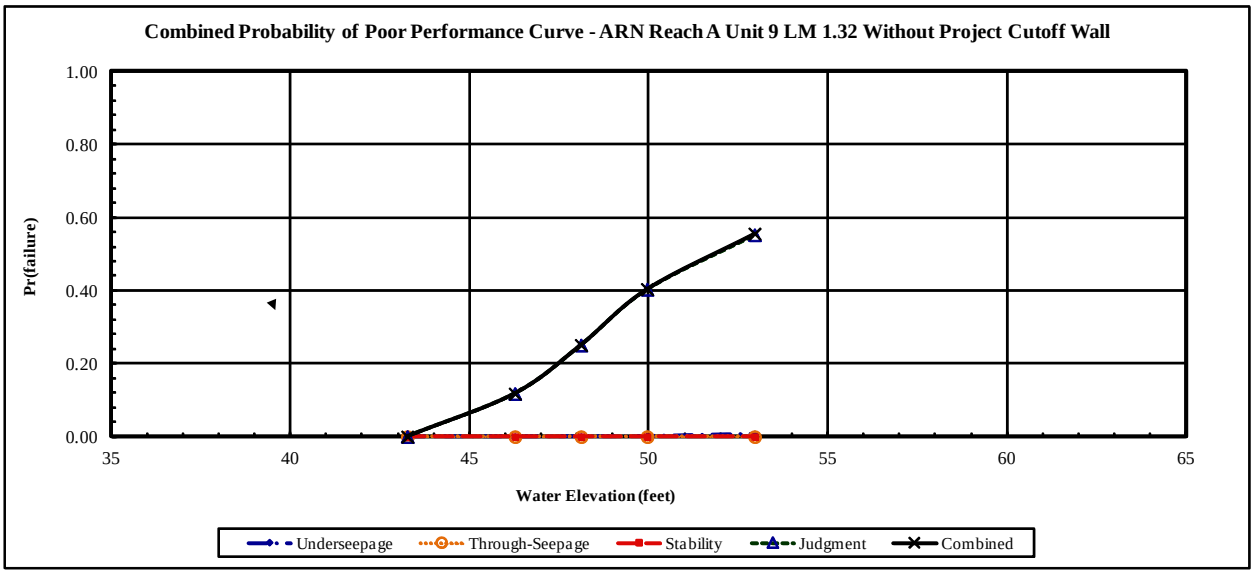

Figure 17-1: Combined Probability of Poor Performance for Without Project Conditions

The remaining probability of failure was primarily attributed to the judgment based failure modes, erosion, which is proposed to be mitigated through the placement riprap erosion protection. With project improvement measures reduce erosion to a Pr(f) of 5.0% at the levee crest. Figure 17-2 presents the with project conditions combined curve.

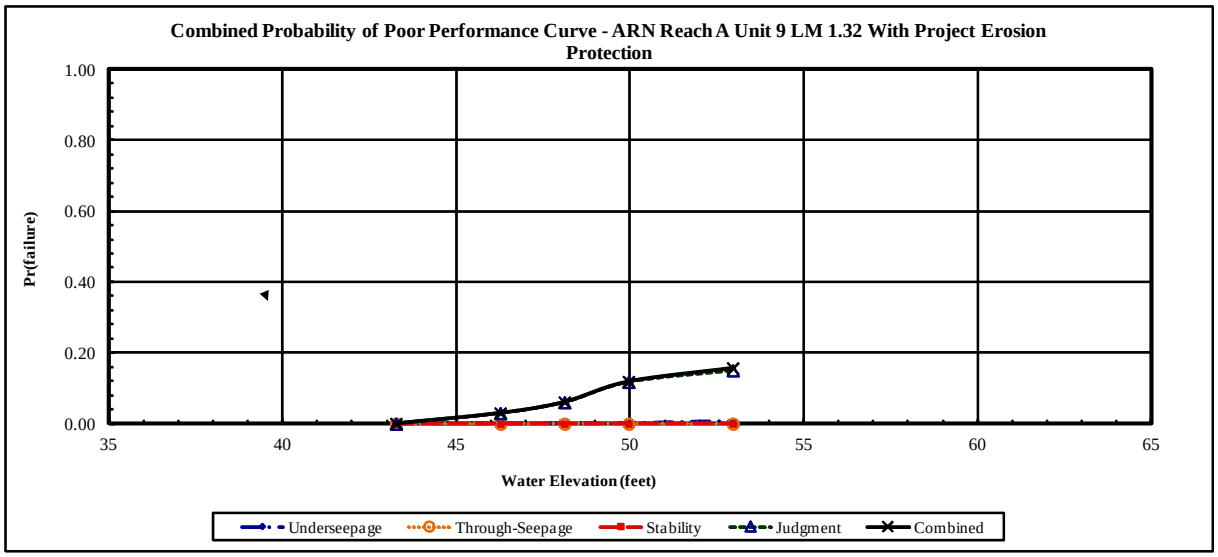

Figure 17-2: Combined Probability of Poor Performance for With Project Conditions

17.2 ARN REACH E – ARCADE CREEK NORTH – U7 LM 0.90

Borings chosen to be used in probabilistic analyses resulted in a mean blanket thickness value of 6.0 ft with a coefficient of variation of 50, and a mean aquifer thickness of 25.0 ft with a coefficient of variation of 36. The blanket was comprised of predominantly lean clay. The aquifer was made up of silty sands, poorly graded sands, and silts.

The without project underseepage analysis resulted in a Pr(f) of 72.4% at the levee crest and landside slope stability analysis resulted in a Pr(f) of 68.1% at the crest. The without project judgment based probability portion of the curve was comprised mainly of utilities and animal burrows both of which account for a Pr(f) of 6.0% at the crest. Overall judgment based contributions account for a Pr(f) of 17.7% of the without project combined curve at the levee crest. Figure 17-3 presents the without project conditions combined curve.

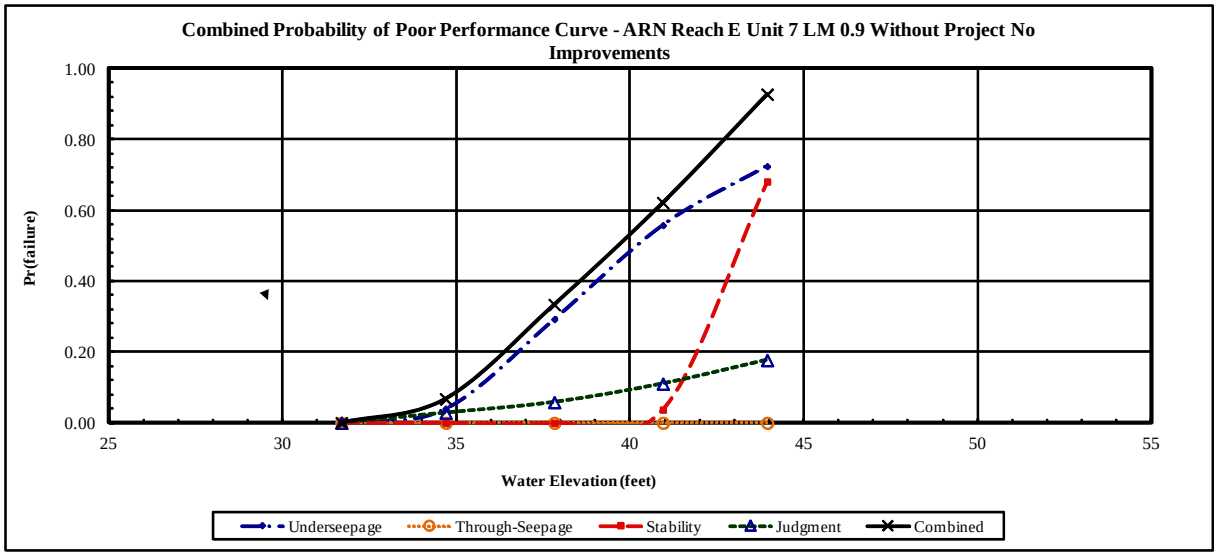

Figure 17-3: Combined Probability of Poor Performance for Without Project Conditions

With project conditions analyses were completed with the incorporation of an underseepage cutoff wall. This improvement mitigates underseepage and landside slope stability concerns. With project conditions did not provide a reduction to judgment based probabilities of failure. As such the Pr(f) for both utilities and animal burrows remained at 6.0% at the levee crest. Figure 17-4 presents the with project conditions combined curve.

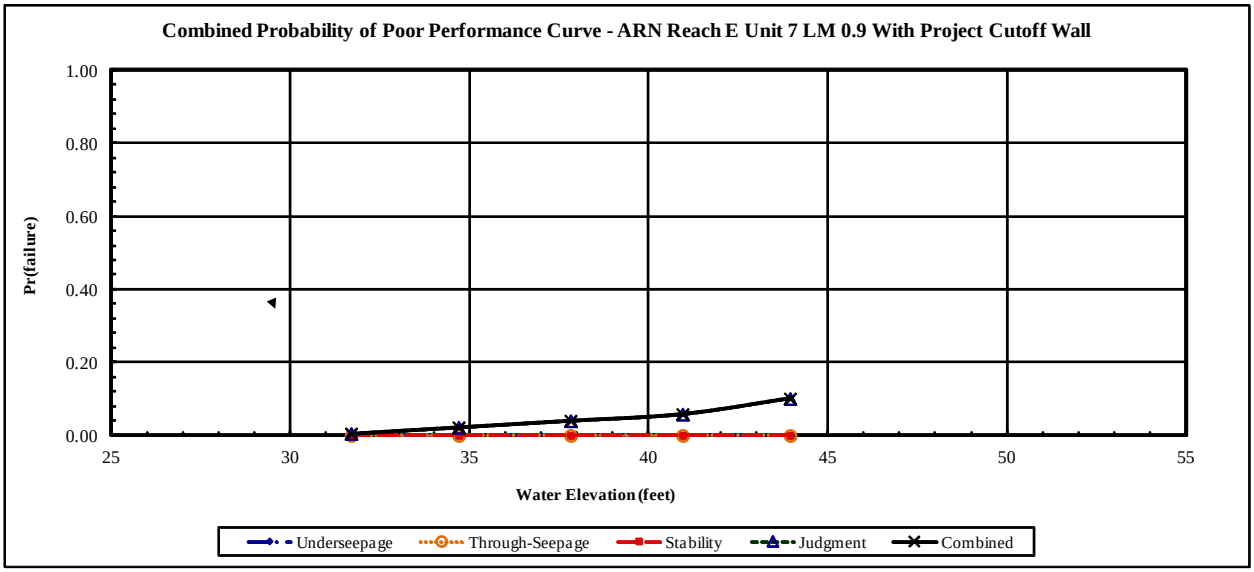

Figure 17-4: Combined Probability of Poor Performance for With Project Conditions

17.3 ARS REACH B – AMERICAN RIVER SOUTH – U4 LM 3.90

Borings chosen to be used in probabilistic analyses resulted in a mean blanket thickness value of 10.0 ft with a coefficient of variation of 30, and a mean aquifer thickness of 41.0 ft with a coefficient of variation of 24. The blanket was comprised of predominantly silts and lean clays. The aquifer was made up of silty sands and poorly graded sands.

The levee embankment contains an existing cutoff wall which mitigates both underseepage, through seepage, and slope stability concerns. The without project judgment based probability portion of the curve was comprised mainly of erosion, and encroachments, which accounted for 60.0% and 4.0% respectively at the crest. Past performance has indicated significant amounts of erosion of the riverbank, waterside levee slope and foundation. The combined without project levee performance curve resulted in a Pr(f) of 65.0% at the levee crest. Figure 17-5 presents the without project conditions combined curve.

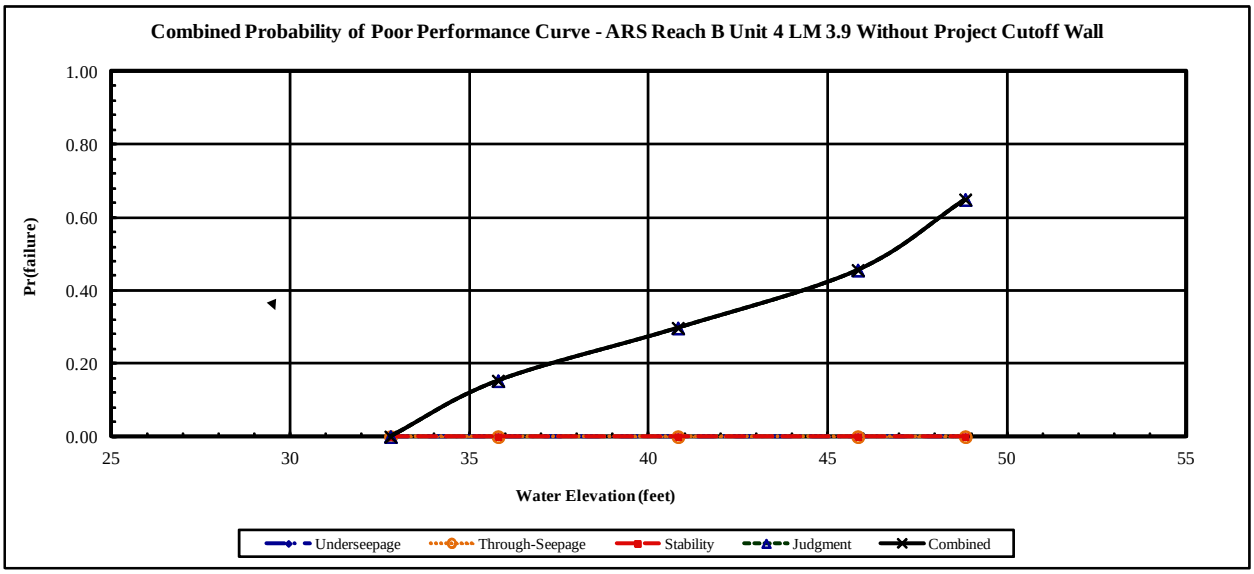

Figure 17-5: Combined Probability of Poor Performance for Without Project Conditions

The high probability of failure was primarily attributed to the erosion portion of the judgment based failure modes, which is proposed to be mitigated through the placement of riprap erosion protection. With project improvement measures reduce erosion to a Pr(f) of 5.0%. Figure 17-6 presents the with project conditions combined curve.

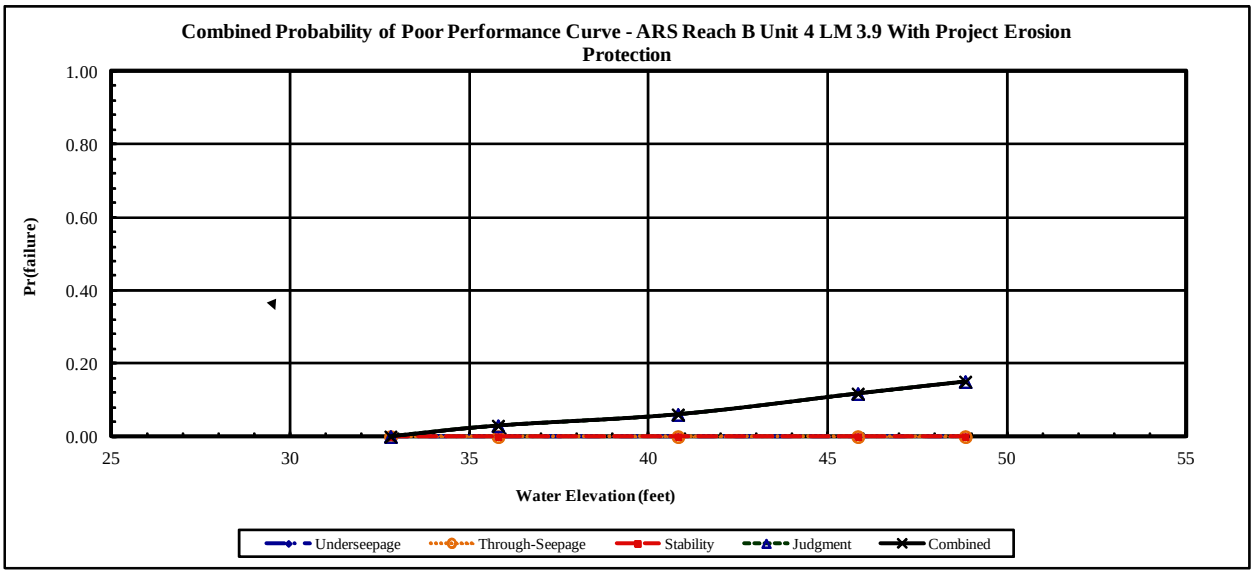

Figure 17-6: Combined Probability of Poor Performance for With Project Conditions

17.4 ARS REACH F – SACRAMENTO RIVER EAST –U1 LM 5.92

Borings chosen to be used in probabilistic analyses resulted in a mean blanket thickness value of 19.0 ft with a coefficient of variation of 47, and a mean aquifer thickness of 83.0 ft with a coefficient of variation of 19. The blanket was comprised of predominantly silts, and lean clays. The aquifer was made up of mainly silty sands, and poorly graded sands.

The without project underseepage analysis resulted in a Pr(f) of 25.8% at the levee crest and landside slope stability analysis resulted in a Pr(f) of 1.9% at the crest. The levee embankment contains an existing shallow cutoff wall which mitigates through seepage concerns. The without project judgment based probability portion of the curve was comprised mainly of erosion, and encroachments, which accounted for 16.0% and 6.0% respectively at the crest. Overall contributions account for a Pr(f) of 28.7% of the without project combined curve at the levee crest. Figure 17-7 presents the without project conditions combined curve.

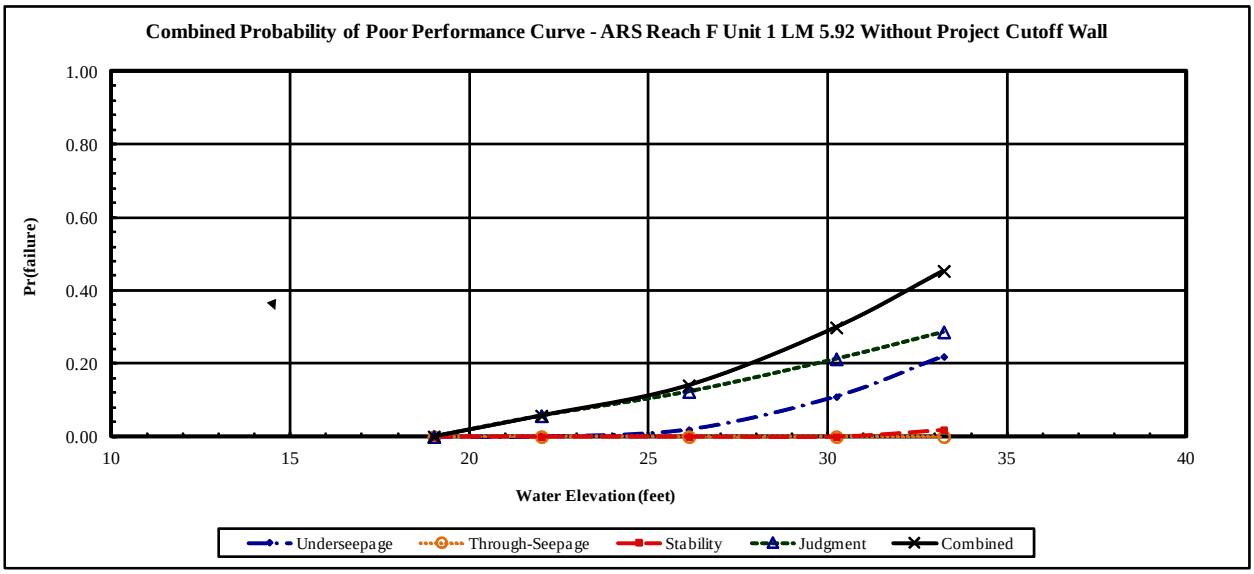

Figure 17-7: Combined Probability of Poor Performance for Without Project Conditions

With project conditions analyses were completed with the incorporation of an underseepage cutoff wall and waterside erosion protection. These improvements mitigated underseepage, landside slope stability, and erosion concerns. With project conditions analysis reduce erosion, encroachments, and utilities to a Pr(f) of 2.0%, 3.5%, and 1.0% as during construction, a portion of existing encroachments and utilities will be removed or relocated to allow for proper inspection and maintenance. Figure 17-8 presents the with project conditions combined curve.

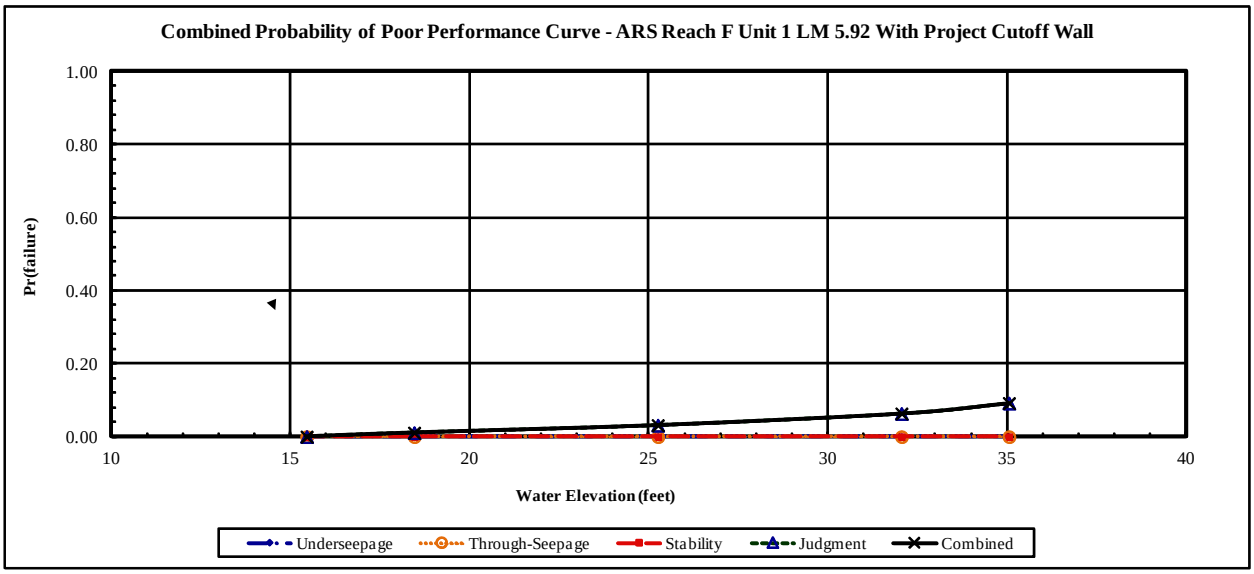

Figure 17-8: Combined Probability of Poor Performance for With Project Conditions

17.5 NAT REACH D – NCC SOUTH –U1 LM 1.30

The NPACR recommended a cutoff wall constructed through the existing levee section for Reach D of Natomas which mitigated underseepage and landside slope stability concerns. The change in Pr(f) for seepage was 4.2% from the design water surface elevation to the top of levee water surface elevation, given the inclusion of the cutoff wall. The judgment based probabilities also added a Pr(f) of 9.3%, comprised mainly of animal burrows and encroachments, which contributed a Pr(f) of 7.0% and 5.0% respectively. Figure 17-9 presents the with project levee performance curve from the NPACR which included a levee raise component. It is also the with project conditions levee performance curve for the ARCF GRR.

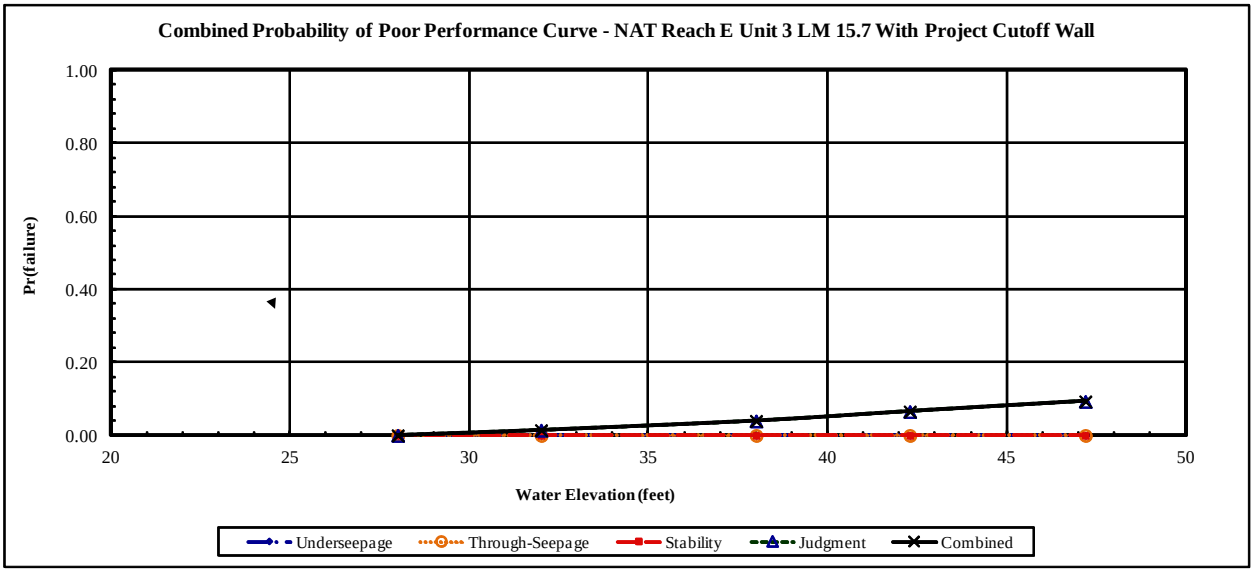

Figure 17-9: Combined Probability of Poor Performance for With Project Conditions

18.0 MATERIAL REQUIREMENTS AND BORROW SITES

It is anticipated that significant quantities of material will be required for construction of the proposed project. Several different improvement measures such as seepage berms, cutoff walls, embankment construction/reconstruction, and erosion protection are proposed. The SOP-03 established the requirements of engineered fill to be used for the construction of the levee embankments.

The material is expected to be sourced from several sites including; newly identified borrow sites within approximately 25 miles of the study area, existing borrow sites identified for the Natomas Basin by SAFCA, the DWSC dredge disposal area, the existing levees, and existing commercial sources. A desktop regional borrow study was performed to identify potential borrow sites, within 25 miles of the study area, where enough soil could be sourced to satisfy the project needs. Plates 4 and 5 show the high confidence and low confidence areas of potential borrow sites. Test pits and laboratory testing on materials collected from test pits were provided by SAFCA as part of the NLIP for borrow sites established for the Natomas Basin. Additionally, the Sacramento District has studied the DWSC spoil areas as a borrow source several time in the past, and a discussion of that borrow source is included below. Typically projects constructed by the Sacramento District utilize commercial borrow sites near the project area.

19.0 CONCLUSIONS

This report presented the results of geotechnical analyses and feasibility level geotechnical design recommendations associated with the various alternatives under consideration to address technical deficiencies in the flood risk management system protecting the study area. The alternatives consisted of a combination of structural measures to mitigate deficiencies with levee height, geometry, erosion, access, vegetation, seepage, and slope stability. They also included, the widening and construction of new levees on the Sacramento Bypass and Weir.

The results of the without project seepage and slope stability analyses indicated that the levees in ARN Reaches C through F and ARS Reaches D through G did not meet minimum criteria. The analyses showed that the levees did not meet criteria at varying flood frequencies typically between the 25 and 200 year events. The with project analyses typically included deep cutoff walls which resulted in the with project levee analyses satisfying criteria.

Two potentially erosion-resistant units were identified in the stratigraphy of the American River: (1) a moderately cohesive silty and sandy interbed of relatively limited lateral and longitudinal extent within a thicker package of loose Holocene sediments (the “upper” unit); and (2) much thicker, more widespread relatively erosion-resistant deposits associated with the Pleistocene-aged Fair Oaks formation (the “lower unit”). Erosion rate testing confirmed that erodibility was related to the geologic unit and that most of the specimens within the Fair Oaks formation could be categorized as Moderate Resistant to Very Resistant and similarly, the layers above erosionally resistant surface could be categorized as Very Erodible to Erodible.

The results of the liquefaction triggering analysis and liquefaction-induced post-earthquake deformation based on limit equilibrium analysis indicated that liquefaction potential is highly

likely at each critical location for all the reaches for Natomas Basin, Reach A of American River North Basin, and Reaches C to G of American River South Basin. Moreover, at these locations, the analysis indicates that the post-earthquake deformation as the result of liquefaction of the material beneath the embankment is a global or structural failure mode that is very likely to compromise the ability to provide flood protection at these critical locations.

Based on analyses at LM 5.92 that incorporated tree fall and scour it was shown that the tree fall and scour did not significantly affect levee performance and that the levee meets USACE seepage and slope stability criteria. Therefore, it was a reasonable conclusion that with a VVR to allow vegetation to remain, the safety, structural integrity, and functionality of the Sacramento River levee would be retained.

The without project levee performance curves indicate that the levees in ARN Reaches C through F and ARS Reaches D through G would perform unsatisfactorily when minimally loaded. In general, the analyses identified underseepage deficiencies and/or underseepage related slope stability deficiencies. Therefore, the with project levee performance curves typically included deep cutoff walls which resulted in significant reduction in probabilities of poor performance.

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NATOMAS CROSS CANAL SOUTH LEVEE

PLEASANT GROVE CREEK CANAL LEVEES

SACRAMENTO RIVER EAST LEVEE - NORTH (RD 1000)

NATOMAS EAST MAIN DRAINAGE CANAL (NEMDC) - WEST LEVEE

NATOMAS EAST MAIN DRAINAGE CANAL (NEMDC) - EAST LEVEE AND TRIBUTARIES

SACRAMENTO RIVER EAST LEVEE - SOUTH (COS AND MA09)

AMERICAN RIVER NORTH LEVEE

AMERICAN RIVER SOUTH LEVEE

MAYHEW DRAIN LEVEES

RD1001 RD1600 RD1000 RD0827 RD0785 RD0537 RD2035 RD0141 RD0900 RD0673 RD0999 RD0765 RD0307 RD2022

MA4 MA9

ARFCD

COS

LEGEND

- Levee mile marker
- River mile marker
- SAFCA Natomas stationing
- Levee alignment with DWR Urban stationing
- City of Sacramento (COS)
- Maintenance Area
- Reclamation District
- American River Flood Control District (ARFCD)

US Army Corps of Engineers.
SACRAMENTO DISTRICT

PLATE 1 - ARCF GRR LEVEE MILE AND STATIONING MAP
ATTACHMENT C - GEOTECHNICAL REPORT

AMERICAN RIVER COMMON FEATURES GENERAL REEVALUATION REPORT

5,000 2,500 0 5,000 Feet
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NAT Reach D - Unit 2 Levee Mile 1.17

NCC North

PGCC

NAT

NEMDC

Sacramento River

Dry/Robla Creek

ARN

ARN Reach E - Unit 7 Levee Mile 0.9

Arcade Creek

Sacramento Bypass

ARN Reach A - Unit 9 Levee Mile 1.32

American River

ARS Reach B - Unit 4 Levee Mile 3.9

Yolo Bypass

ARS

ARS Reach F - Unit 1 Levee Mile 5.92

Sacramento River

Morrison Creek

LEGEND

ARCF GRR Geotechnical Analyses Locations

ARCF GRR Study Area Levee Centerlines

Non Study Area Levee Centerlines

US Army Corps of Engineers.
SACRAMENTO DISTRICT

PLATE 2 - ANALYSES SECTION AND INDEX POINT LOCATION MAP
ATTACHMENT C - GEOTECHNICAL REPORT

AMERICAN RIVER COMMON FEATURES GENERAL REEVALUATION REPORT

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NCC North
PGCC
NEMDC
NAT
Sacramento River
Dry/Robla Creek
ARN
Arcade Creek
Sacramento Bypass
American River
Yolo Bypass
ARS
Sacramento River
Morrison Creek

LEGEND
- ARCF GRR Study Area Levee Centerlines
- Non Study Area Levee Centerlines
- Seepage Cutoff Wall
- Geotextile Reinforced Embankment
- Seepage Berm

US Army Corps of Engineers
SACRAMENTO DISTRICT

PLATE 3 - GEOTECHNICAL IMPROVEMENTS MAP
ATTACHMENT C - GEOTECHNICAL REPORT

AMERICAN RIVER COMMON FEATURES GENERAL REEVALUATION REPORT

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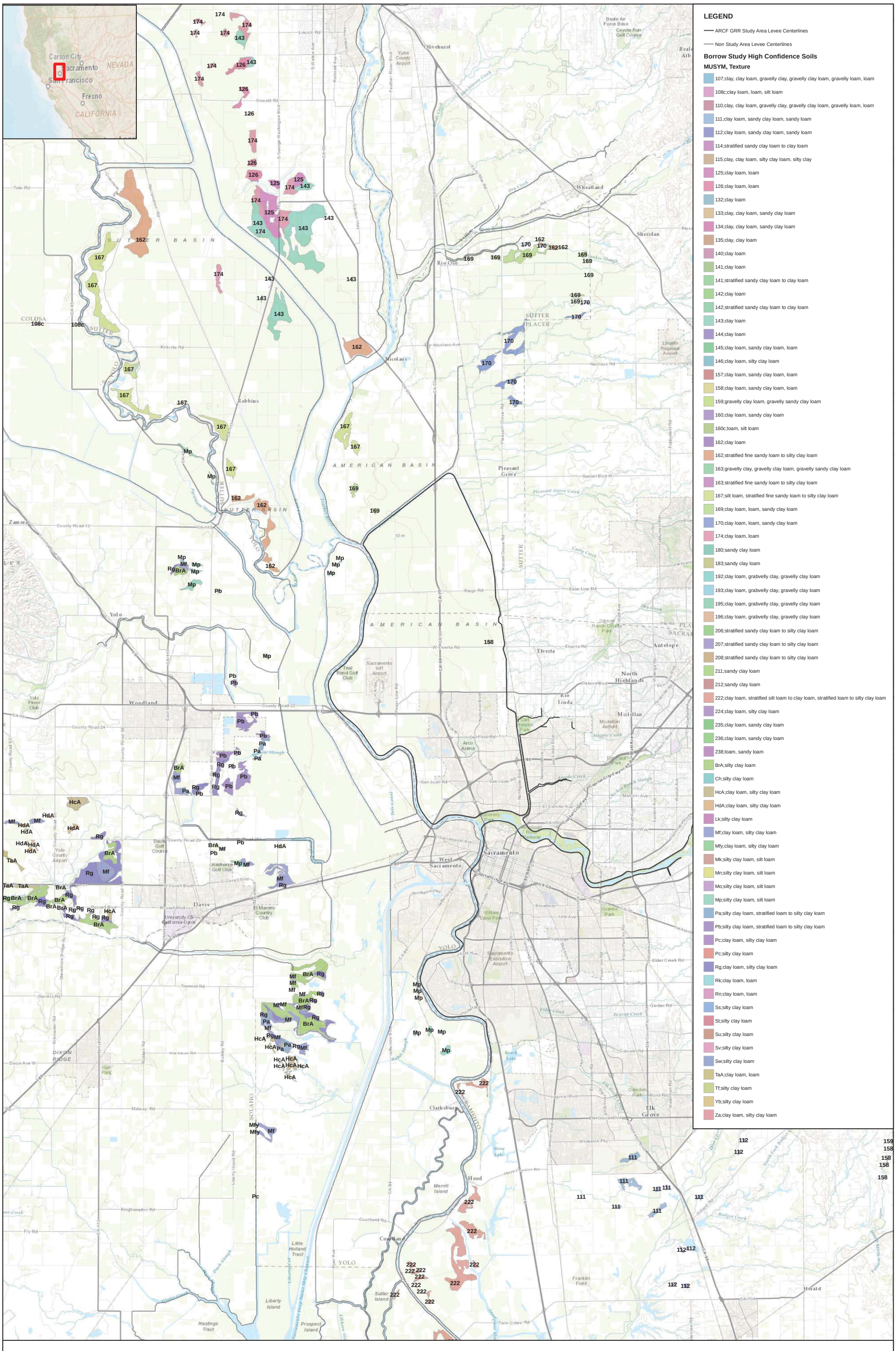

PLATE 4 - DESKTOP BORROW STUDY HIGH CONFIDENCE LOCATION MAP
ATTACHMENT C - GEOTECHNICAL REPORT

US Army Corps of Engineers.
SACRAMENTO DISTRICT

AMERICAN RIVER COMMON FEATURES GENERAL REEVALUATION REPORT

12,000 6,000 0 12,000 Feet
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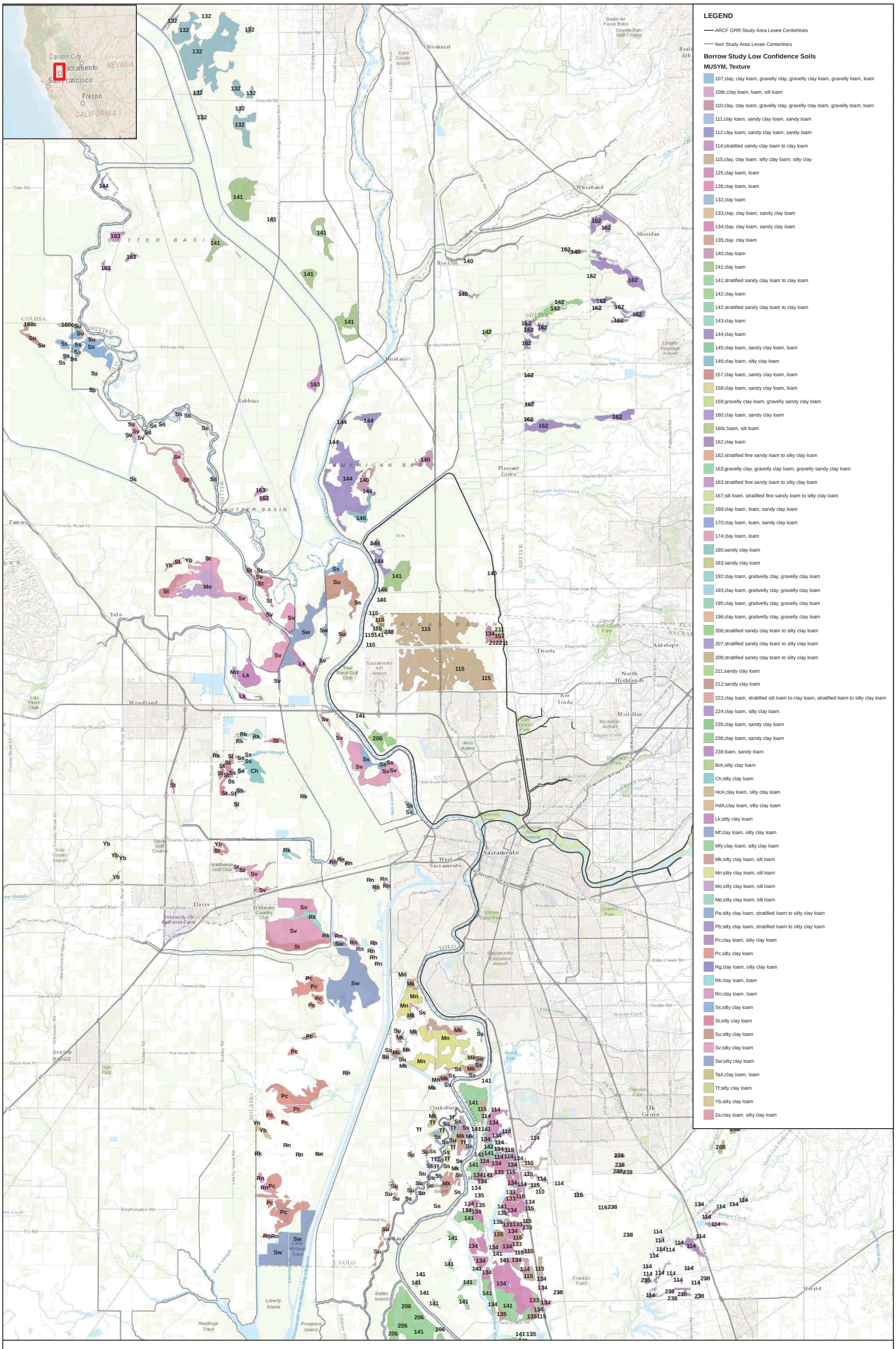
LEGEND
ARCF GRR Study Area Levee Centerlines
Non Study Area Levee Centerlines
Borrow Study Low Confidence Soils
MUSYM, Texture
107;clay, clay loam, gravelly clay, gravelly clay loam, gravelly loam, loam
108c;clay loam, loam, silt loam
110;clay, clay loam, gravelly clay, gravelly clay loam, gravelly loam, loam
111;clay loam, sandy clay loam, sandy loam
112;clay loam, sandy clay loam, sandy loam
114;stratified sandy clay loam to clay loam
115;clay, clay loam, silty clay loam, silty clay
125;clay loam, loam
126;clay loam, loam
132;clay loam
133;clay, clay loam, sandy clay loam
134;clay, clay loam, sandy clay loam
135;clay, clay loam
140;clay loam
141;clay loam
141;stratified sandy clay loam to clay loam
142;clay loam
142;stratified sandy clay loam to clay loam
143;clay loam
144;clay loam
145;clay loam, sandy clay loam, loam
146;clay loam, silty clay loam
157;clay loam, sandy clay loam, loam
158;clay loam, sandy clay loam, loam
159;gravelly clay loam, gravelly sandy clay loam
160;clay loam, sandy clay loam
160c;loam, silt loam
162;clay loam
162;stratified fine sandy loam to silty clay loam
163;gravelly clay, gravelly clay loam, gravelly sandy clay loam
163;stratified fine sandy loam to silty clay loam
167;silt loam, stratified fine sandy loam to silty clay loam
169;clay loam, loam, sandy clay loam
170;clay loam, loam, sandy clay loam
174;clay loam, loam
180;sandy clay loam
183;sandy clay loam
192;clay loam, grabvelly clay, gravelly clay loam
193;clay loam, grabvelly clay, gravelly clay loam
195;clay loam, grabvelly clay, gravelly clay loam
196;clay loam, grabvelly clay, gravelly clay loam
206;stratified sandy clay loam to silty clay loam
207;stratified sandy clay loam to silty clay loam
208;stratified sandy clay loam to silty clay loam
211;sandy clay loam
212;sandy clay loam
222;clay loam, stratified silt loam to clay loam, stratified loam to silty clay loam
224;clay loam, silty clay loam
235;clay loam, sandy clay loam
236;clay loam, sandy clay loam
238;loam, sandy loam
BrA;silty clay loam
Ch;silty clay loam
HcA;clay loam, silty clay loam
HdA;clay loam, silty clay loam
Lk;silty clay loam
Mf;clay loam, silty clay loam
Mfy;clay loam, silty clay loam
Mk;silty clay loam, silt loam
Mn;silty clay loam, silt loam
Mo;silty clay loam, silt loam
Mp;silty clay loam, silt loam
Pa;silty clay loam, stratified loam to silty clay loam
Pb;silty clay loam, stratified loam to silty clay loam
Pc;clay loam, silty clay loam
Pc;silty clay loam
Rg;clay loam, silty clay loam
Rk;clay loam, loam
Rn;clay loam, loam
Ss;silty clay loam
St;silty clay loam
Su;silty clay loam
Sv;silty clay loam
Sw;silty clay loam
TaA;clay loam, loam
Tf;silty clay loam
Yb;silty clay loam
Za;clay loam, silty clay loam
Carson City
Sacramento
San Francisco
Fresno
NEVADA
CALIFORNIA
SUTTER BASIN
AMERICAN BASIN
Olivehurst
Wheatland
Sheridan
Rio Oso
Nicolaus
Pleasant Grove
Robbins
Zamora
Yolo
Woodland
Davis
West Sacramento
Sacramento
Elverta
Antelope
North Highlands
Rio Linda
Arden-Arcade
Clarksburg
Elk Grove
Herald
Franklin Field
Liberty Island
Prospect Island
Hastings Tract
Sutter Island
Courtland
DIXON RIDGE
COLUSA
Beale Air Force Base
Coyote Run Golf Course
Yuba County Airport
Lincoln Regional Airport
Sacramento Executive Airport
Sacramento Int'l Airport
Arco Arena
Teal Bend Golf Club
Wildhorse Golf Club
El Macero Country Club
University Of California-Davis
Yolo County Airport
Mcclellan Airfield
Gibson Ranch County Park
Camden Park
Beach Lake
William Land Park
Granite Park
Discovery Park
Del Paso Park
Pleasant Grove Creek
Dry Creek
Curry Creek
Willow Slough
Cache Creek
Putah Creek
Feather River Blvd
S Walton Ave
Railroad Ave
Garden Hwy
S George Washington Blvd
Power Line Rd
Natomas Blvd
Northgate Blvd
Norwood Ave
Walerga Rd
Watt Ave
Fruitridge Rd
Elkhorn Blvd
Elverta Rd
W Elverta Rd
Base Line Rd
Rego Rd
Pleasant Grove Rd
Lincoln Rd
Oswald Rd
Tule Rd
Kirkville Rd
Nicolaus Ave
Nicolaus Rd
Wheatland Rd
Lincoln Hwy
Sunset Blvd W
Laguna Blvd
Elk Grove Blvd
Whitelock Pky
Bond Rd
Calvine Rd
Elder Creek Rd
Gerber Rd
Florin Rd
Fruitridge Rd
Broadway
14th Ave
Folsom South Canal
Sacramento River
Feather River
Yolo Bypass
Sacramento Ave
Capitol City Fwy
US-50
CA-160
CA-99
CA-70
CA-65
CA-113
CA-16
CA-45
CA-104
Pleasant Grove
Sutter
Yolo
Solano
Sacramento
Placer
Sutter Basin
American Basin
Yolo Basin
Liberty Island
Prospect Island
Hastings Tract
Sutter Island
Courtland
Clarksburg
Elk Grove
Herald
Franklin Field
Woodland
Davis
West Sacramento
Sacramento
Elverta
Antelope
North Highlands
Rio Linda
Arden-Arcade
Olivehurst
Wheatland
Sheridan
Rio Oso
Nicolaus
Pleasant Grove
Robbins
Zamora
Yolo
PLATE 5 - DESKTOP BORROW STUDY LOW CONFIDENCE LOCATION MAP
ATTACHMENT C - GEOTECHNICAL REPORT
AMERICAN RIVER COMMON FEATURES
GENERAL REEVALUATION REPORT
US Army Corps of Engineers.
SACRAMENTO DISTRICT
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Feet
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05 Feb 2013
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AMERICAN RIVER WATERSHED

COMMON FEATURES PROJECT

GENERAL REEVALUATION REPORT

ATTACHMENT C – GEOTECHNICAL REPORT

ENCLOSURE 1

ANALYSES CALCULATION PACKAGE

AMERICAN RIVER NORTH BASIN

ARN REACH A – AMERICAN RIVER NORTH – U9 LM 1.32

STRATIGRAPHY INPUT

BORING LOGS

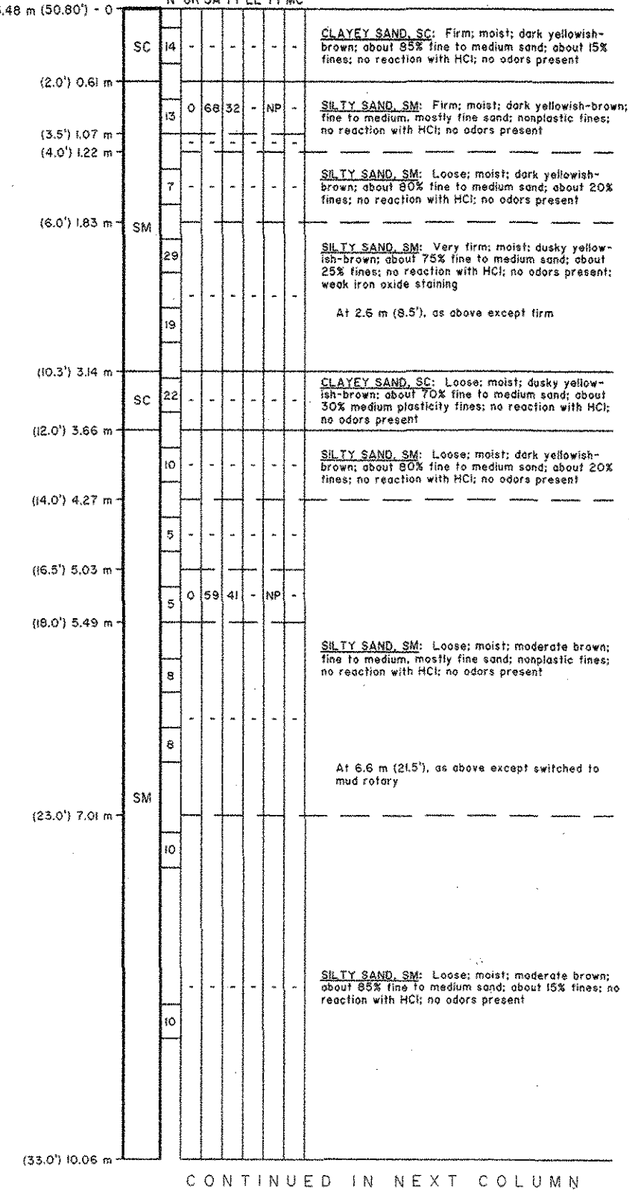
LABORATORY TESTING

AMERICAN RIVER WATERSHED - COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT - GEOTECHNICAL ANALYSIS
AMERICAN RIVER NORTH RA U9 LM 1.32
Table F-2-1: Permeability and Strength Selection for Analysis

Boring Number	Top of Boring Elevation (ft, NAVD 88)	Layer ID	Soil Description	USCS Soil Classification	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Elevation of Top of Layer (ft, NAVD 88)	Elevation of Bottom of Layer (ft, NAVD 88)	Layer Thickness (ft)	Average Depth to Groundwater During Drilling	Laboratory and Field Data										Comments
											Average % Fines	Average Field N (blows/ft)	Average N_{60} (blows/ft)[1]	Average Normalized Blow Count, $N_{1,60}$ (blows/ft)[2]	Torvane (tsf)	Pocket Penetrometer (tsf)	Average Unit Weight (pcf)	PI	LL	LI	
WNCBAR_003B, 2F-97-6, DH-7, DH-7A	53.01	1	Silty Sand (SM) with Silt (ML) Levee	SM	0.00	8.61	53.01	44.40	8.61		45	16	30								
		2	Silty Sand (SM) with Silty (ML)	ML	8.61	37.11	44.40	15.90	28.50		33	9	21								
		3	Poorly Graded Gravel (GP) with Lean Clay (CL)	GP	37.11	53.61	15.90	-0.60	16.50			76	89								
		4	Poorly Graded Sand with Silty Sand (SP-SM)	SP-SM	53.61	61.87	-0.60	-8.86	8.26		13	48	69								
		5	Lean Clay (CL) with Silt (ML)	CL	61.87	86.41	-8.86	-33.40	24.54			73	64								
		6	Impervious Clay Cap (CL)	CL																	
		7	Cutoff Wall	SB WALL														8	25	17.00	
					Total Depth (ft.)	**86.41**															

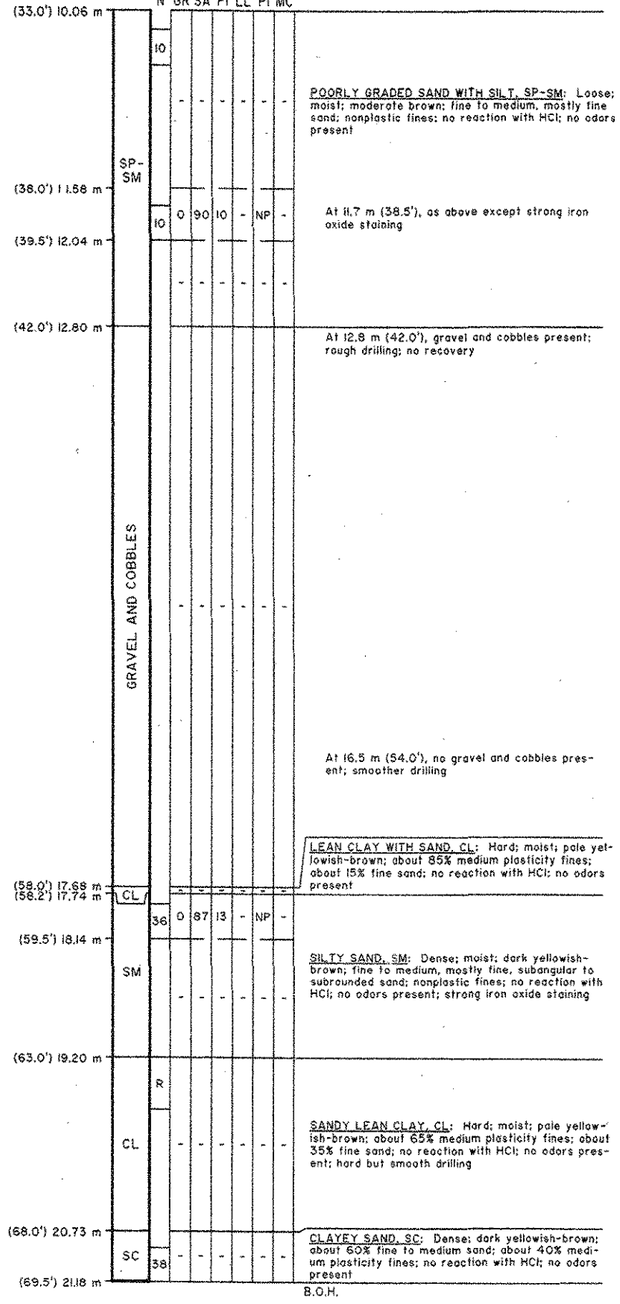
Layer ID	Recommended Hydraulic Conductivity					Strenth Coorelations								Strength from Lab Test Data						Recommended Strength Parameters			Comments
	Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Total Overburden Pressure at Mid Layer During Drilling (psf)	Effective Overburden Stress at Mid Layer During Drilling (psf)	OCR from N_{60}[3]	OCR from LI[3]	Su from N (psf)[4]	Su/σ'$_o$ from PI (psf)[4]	Calculated Maximum Past Pressure (psf)[5]	Drained Friction Angle[7]	OCR	σ'$_p$ (psf)	Su (psf)	Su/σ'$_o$	Φ'	C' (psf)	Φ'	C' (psf)	γ (pcf)	
1	5.00E-04	4.00	1.25E-04	1.418	0.354	0	-269													33	0	125	
2	2.00E-04	4.00	5.00E-05	0.567	0.142	0	-1426													33	0	125	
3	2.00E-01	4.00	5.00E-02	567.000	141.750	0	-2830													35	0	135	
4	1.00E-03	4.00	2.50E-04	2.835	0.709	0	-3603													33	0	125	
5	1.00E-05	4.00	2.50E-06	0.028	0.007	0	-4626	#VALUE!		9269		#NUM!								28	50	115	
6	1.00E-05	4.00	2.50E-06	0.028	0.007	0	0	#VALUE!	#VALUE!											28	50	115	
7	1.00E-06	4.00	2.50E-07	0.003	0.001															0	50	85	

2F-97-6
STA. 14+65



CONTINUED IN NEXT COLUMN

2F-97-6
CONTINUED FROM PREVIOUS COLUMN



GRAPHIC SCALE

SCALE 1 : 25 — 0 0.5 1 1.5 2 2.5 METERS

NOTES:

1. THE LEGENDS AND NOTES FOR THE 2F-97-# EXPLORATIONS ARE SHOWN ON SHEET B-11.
2. ADDITIONAL LOGS OF EXPLORATIONS ARE SHOWN ON SHEET NOS. B-1 THROUGH B-12 AND B-14 THROUGH B-49.

US Army Corps of Engineers
Sacramento District

Symbol	Description	Date Approved	Symbol	Description	Date Approved

Designed by: R. IWASA
Drn by: R. IWASA
Csd by: SCANDRONE
Reviewed by: M. RAMSBOTHAM
Submitted by: Chief, Design Section
Date: 8 FEB 1999
Design file no: AMT - 4 - 783
SPEC. No: 9995
File name: AR-LOGLDWG
Plot date: 8 FEB 1999
Plot scale: 1 : 1
Rev: REV. 4

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

AMERICAN RIVER
AMERICAN RIVER WATERSHED PROJECT
LOWER AMERICAN RIVER
RIGHT (NORTH) BANK LEVEE STRENGTHENING
CALIFORNIA

LOG OF EXPLORATION
2F-97-6

Sheet reference number:
B-13
SEQ. 24

Hole No. DH-7

DRILLING LOG | DIVISION | INSTALLATION | SHEET 1 OF 2 SHEETS

1. PROJECT: American River FCD, Maint. Areas 10 & 11
2. LOCATION (Coordinates or Station): American River, East Levee, site #7
3. DRILLING AGENCY: D.C. Exploration
4. HOLE NO. (As shown on drawing title and file number): DH-7
5. NAME OF DRILLER: Mike Moore
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: NA
8. DEPTH DRILLED INTO ROCK: NA
9. TOTAL DEPTH OF HOLE: 30.0
10. SIZE AND TYPE OF BIT: 8" Hollow stem augers
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Mobile B-53
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: NA
15. ~~ELEVATION~~ GROUND WATER
16. DATE HOLE: STARTED 4-22-57; COMPLETED 4-22-57
17. ELEVATION TOP OF HOLE: NA
18. TOTAL CORE RECOVERY FOR BORING: N/L %
19. SIGNATURE OF INSPECTOR: Paul F. Schmidt (WA)

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% ~~CORE~~ RECOVERY & PR	~~BOX OR~~ SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0	ML	LEVEE 0.0-0.5 Gravel + dirt 0.5-11.2 SANDY SILT: Dk. yel brn (10YR 4/2), ~40-70% Fines; non to slight plastic, quick dilatancy, no toughness; ~30-60% sand, very fine-grained, poorly graded, mica flakes; slight charcoal, organic lns; high pervious ness; F. m to stiff; moist. 7.8-9.2 gray silty Sand medium dense	4/5 0.8/10 1.5 4 1.5/5 1.5/7 4 1.5/5 1.5/6 1.5 5 1.5/6 1.5/6 8/9 1.2/14 1.5 7/8 1.3/8 1.5 5 1.5/7 1.5/7 4 1.4/2 1.5/3 3 1.5/3 1.5/3 2 1.5/3 1.5/3 1 1.5/2 1.5/3 3 1.4/2 1.5/4 3	B-1 B-2 B-3 B-4 B-5	Sampling with a 2.0" (OD) split-spoon sampler, driven by a 140 lb. wire-line hammer, free-falling 30.0 in. per blow. Drilling is easy
	11.2	SP	FOUNDATION 11.2-12.6 SAND: Salt & pepper; <5% fines; >95% fine-grained sand, mica and qtz; loose, dry.			
	12.6	ML	12.6-30.0 SANDY SILT: as 0.5-11.2' No changes			
	30.0					

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PROJECT | HOLE NO.

Hole No. DH-7

DRILLING LOG	DIVISION	INSTALLATION	SHEET 2 OF 2 SHEETS

1. PROJECT		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING	%
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20.0	ML	12.6 - 30.0 SANDY SILT: (cont.)	3 1.5 / 5 1.5	B-5 (cont.)	Drilling continues easy.
				3 / 2 1.2 / 1.5 / 3		21.0
	22.0		22 8 - 23.5 more sandy lens	3 / 2 1.2 / 1.5 / 2		22.5
	24.0		24.0 color getting reddish.	3 / 4 1.5 / 5 1.5		24.0
	26.0			3 1.5 / 3 1.5 / 4	B-6	25
				4 1.5 / 4 1.5 / 4		27.0
	28.0		28.0 - 30.0 slightly more sandy	5 1.5 / 5 1.5 / 4		28.5
	30.0		Bottom Hole 30.0'			30.0

Terminated boring at 30.0' (required depth) and back-filled hole with cuttings.

DATA ON THIS LOG ARE AN APPROXIMATION OF THE GEOLOGIC AND SUBSURFACE CONDITIONS BECAUSE THE INFORMATION WAS OBTAINED FROM INDIRECT, DISCONTINUOUS, AND POSSIBLY DISTURBED SAMPLING NECESSITATED BY USE OF SMALL-DIAMETER HOLES. ROTARY AND WASH BORING HOLES HAVE FURTHER COMPLICATIONS IN THIS REGARD BECAUSE OF THE NEED TO USE DRILLING FLUID AND/OR CASING IN ADVANCING HOLES.

THIS LOG INDICATES CONDITIONS IN THIS HOLE ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

THIS HOLE WAS LOGGED IN SUCH A WAY AS TO PROVIDE DATA PRIMARILY FOR DESIGN PURPOSES AND NOT NECESSARILY FOR THE PURPOSES OF SPECIFIC CONTRACTORS.

THE STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES, AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM

Hole No. DH-7A

DRILLING LOG | DIVISION | INSTALLATION | SHEET 1 OF 1 SHEETS

1. PROJECT: American River F.C.D., Maint. Area 10 & 11
2. LOCATION (Coordinates or Station): American River East levee, site #7 (toe)
3. DRILLING AGENCY: U.C. Exploration
4. HOLE NO. (As shown on drawing title and file number): DH-7A
5. NAME OF DRILLER: Mike Moore
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: NA
8. DEPTH DRILLED INTO ROCK: NA
9. TOTAL DEPTH OF HOLE: 20.0
10. SIZE AND TYPE OF BIT: 5.0" Hollow stem augers
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Mobile B-53
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 2; UNDISTURBED 6
14. TOTAL NUMBER CORE BOXES: NA
15. ~~ELEVATION~~ GROUND WATER
16. DATE HOLE: STARTED 4-22-87; COMPLETED 4-22-97
17. ELEVATION TOP OF HOLE: NA
18. TOTAL CORE RECOVERY FOR BORING: NA %
19. SIGNATURE OF INSPECTOR: Paul F. Schmidt (WA)

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% ~~CORE~~ RECOVERY & PR e	~~BOX~~ OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0	ML	FOUNDATION 0.0 - 20.0 SANDY SILT: dk yel brn (10YR 4/2) to mod brn (5YR 3/4), ~40-70% Fines, non to slight plastic, no toughness, ~30-60% sand, very fine- to fine-grained, poorly graded, mica flakes; high perviousness; soft to firm; moist 2.0 - 2.4 sand lens, clean 3.2 - 3.5 sand lens 6.9 - 7.5 sandy lens 8.5 - 9.0' sand lens 10.5 - 11.1 sandy lens 12.0 - 12.3 sandy lens 17.0 - 17.3 sandy lens 18.5 - 20.0 more sandy Bottom at 20.0	3/1/1 1.4/1.5 1/2/2 1.4/1.5 2/2/2 1.5/1.5 2/2/3 1.5/1.5 3/3/3 1.5/1.5 3/3/4 1.4/1.5 3/2/3 1.3/1.5 3/3/3 1.2/1.5 3/2/3 1.3/1.5 3/4/4 1.5/1.5 3/4/2 1.3/1.5 2/2/1 1.5/1.3	B-1 B-2	Sampling with a 2.0" (OD) split spoon sampler, driven by a 140 lb. wire-line hammer free-falling 30.0" per blow. Drilling is very easy Terminated boring at 20.0' (required depth) and backfilled hole with cuttings

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PROJECT | HOLE NO.

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION DATUM	TOTAL DEPTH OF BORING
5/22/08	5/22/08	52.95 ft	NAVD 88	75.0 ft

DRILLING CONTRACTOR	DRILLER'S NAME	HELPER'S NAME	TOTAL DEPTH OF FILL
Gregg Drilling & Testing, Inc.	E. Santellan	R. Ryon	9.8 ft

DRILLING METHOD	DRILL RIG MAKE AND MODEL	CONSULTANT COMPANY
0 - 3 ft: HA, 3 - 10 ft: HSA, 10 - 75 ft: Rotary Wash	MARL M-10 (Gregg Rig No. D-44)	GEI Consultants, Inc.

DRILL BIT SIZE AND TYPE (HOLE DIAMETER)	DRILLING ROD TYPE AND DIAMETER	FIELD LOGGER
5-inch drag bit	6" HSA, 94mm	M. Horse
☒ VERTICAL ☐ INCLINED	CASING TYPE, DIAMETER, INSTALLATION DEPTH: Surface, 6-in., 10 ft	FIELD LOG REVIEWER: G. Bradner
SAMPLER TYPE(S): Bag, DCore(2.5"), PCore(2.5"), Shelby(2.37"), SPT(1.375")	HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP: Marl, automatic, 140 lbs / 30-inch drop	HAMMER EFFICIENCY: 83%
BOREHOLE BACKFILL OR COMPLETION: 5% bentonite grout	GROUNDWATER READING: DURING DRILLING / AFTER DRILLING (DATE-TIME): N/A due to rotary wash drilling method	

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	0		Gravel Road Base.												
	1		[LEVEE FILL] LEAN CLAY with Sand (CL); yellowish brown (10YR 5/8); moist; 80% medium plasticity, medium dry strength, medium toughness fines; 20% fine sand; 0% gravel.		1										S01A_001_002B
	2				2										S02A_002_003B
50	3		[LEVEE FILL] SILT with Sand (ML); dark brown (10YR 3/3); moist; 85% low plasticity, medium dry strength, rapid dilatancy, low toughness fines; 15% fine sand; 0% gravel.		3	100									S03A_003_005T Pushed Shelby tube at 400 psi
	4														
	5		[LEVEE FILL] SANDY SILT (ML); medium dense; dark brown (10YR 3/3); moist; 52% medium dry strength, rapid dilatancy, low toughness fines; 48% fine sand; 0% gravel.		4	56	10 10 12 [22]	30	1.25P	16	NP	NP			S04A_005_007S
	6														
	7				5	100			1.5P				52	HD	Box 1 Representative S05A_007_008P
45	8														
FILL	9														
	10		[Approximate bottom of Levee Fill at 9.8'].												
	11		4-inch thick Silty Sand (SM) lense; 85% fine sand; 15% fines.		6	44	8 11 9 [20]	28	0.75P						S06B_010_012S S06A_011_012S
	12		SILTY SAND (SM); medium dense; very dark brown (10YR 2/2); wet; 58% fine sand; 42% no plasticity fines; 0% gravel; portion of fines are clay-sized.		7	57									S07A_012_013P
40	13														
	14														
	15				8	50	4 6 6 [12]	17					42	HD	S08A_015_017S
	16														
	17		As above except 70% sand; 30% fines; portion of fines are clay-sized.		9	86				20				SG	S09A_017_018P
35	18														
	19														
	20														

Draft 4 After Final Markups 11/5/2009

Borehole Location: North Bank Crest **County:** Sacramento
Coordinates: Northing: 1,967,149.09 **Easting:** 6,731,673.44
Latitude: 38.56228 **Longitude:** -121.40544
Levee Station or Milepost: 3306+35 **Levee Mile:** 1.31
Levee Segment
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: American River

LOG OF BORING
WCNBAR_003B
Sheet 1 of 4

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

DWR LEVEE U/NU SOIL LOG REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/5/09

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	LABORATORY DATA: Other Lab Tests	REMARKS
	20		SILTY SAND (SM); as above.		10	50	5 6 6 [12]	17					30	HD	S10A_020_022S
	21														
	22		As above except increasing sand; decreasing fines.												S11_022_023P
30	23				11	36									
	24														
	25		SANDY SILT (ML); medium dense; very dark brown (10YR 2/2); moist; 57% low plasticity fines; 43% fine sand; 0% gravel.		12	50	4 5 8 [13]	18	0.5P				57	HD	S12A_025_027S
	26														
	27		As above except decreasing sand; increasing fines.												S13C_027_027P S13B_027_028P S13A_028_029P
			SILTY SAND (SM); medium dense; very dark brown (10YR 2/2); moist; 60% fine sand; 40% low plasticity fines; 0% gravel.												
25	28				13	50									
	29														
	30		As above except 80% sand; 20% no plasticity fines.		14	39	7 8 9 [17]	24							S14A_030_032S
	31														
	32		11-inch Sandy Silt (ML) lense; 30% fine sand; 70% no plasticity fines.												S15B_032_033P S15A_033_034P
20	33		As above except dark yellowish brown (10YR 3/4); 70% sand; 30% fines; portion of fines are clay-sized.		15	60									
	34														
	35														
	36				16	44	7 7 8 [15]	21					30	HD	S16A_035_037S
	37														S17A_037_037P
15	38		As above except 80% fine to medium sand; 20% fines.		17	95									
	39														
	40														
	41		SILTY GRAVEL with Sand (GM); very dense; dark yellowish brown (10YR 3/6); moist; 50% fine to coarse, subrounded to rounded gravel, max. 1 in.; 35% fine to medium sand; 15% low plasticity fines.		18	39	23 23 20 [43]	59							S18A_040_042S 40' to 48': Rig chatter
	42		Gravel, max. 2.5 in.												No Recovery Gravels present in sampler
10	43				19	0									
	44														
	45														

Draft 4 After Final Markups 11/5/2009

Borehole Location: North Bank Crest **County:** Sacramento
Coordinates: Northing: 1,967,149.09 **Easting:** 6,731,673.44
Latitude: 38.56228 **Longitude:** -121.40544
Levee Station or Milepost: 3306+35 **Levee Mile:** 1.31
Levee Segment
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: American River

LOG OF BORING
WCNBAR_003B
Sheet 2 of 4

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

DWR LEVEE U/NU SOIL LOG REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/5/09

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	LABORATORY DATA: Other Lab Tests	REMARKS
	45		Gravel; as above.		20	0									No Recovery Gravel fragments in mud cuttings
	46														
	47														S21A_051_051P
5	48		LEAN CLAY (CL); very stiff; olive brown (2.5Y 4/4); moist; 95% medium plasticity, medium toughness fines; 5% fine sand; 0% gravel.		21	19									
	49														
	50		6-inch thick gravel lense.		22	0	50/4"								No Recovery Driller notes gravel S22A_051_051P Driller notes rock in hole; pushing rock
	51		Gravel.						>3.0P						
	52														
0	53				22	16									Rig Chatter
	54														
	55		LEAN CLAY (CL); hard; yellowish brown (10YR 5/8); 90% low plasticity fines; 10% fine sand; 0% gravel; Iron oxide staining.		23	61	17 47 39 [86]	119	>4.5P						S23A_055_057S
	56														
	57		6-inch thick Silt (ML) lense; 10% fine sand; 90% low plasticity fines.												S24C_057_057P S24B_058_058P S24A_059_060P
-5	58		SILTY SAND (SM); dark yellowish brown (10YR 4/6); 60% fine to medium sand; 40% low plasticity fines; 0% gravel.		24	71									
	59		Poorly Graded SAND (SP); dark olive brown (2.5Y 3/3); moist; 95% fine to medium sand; 5% fines; 0% gravel.												
	60														S25B_060_061S S25A_061_062S
	61		1-foot thick Silty Sand (SM) lense; very dense; 60% fine to medium sand; 40% low plasticity fines.		25	50	21 29 31 [60]	83							
	62		Poorly Graded SAND (SP); dark olive brown (2.5Y 3/3); moist; 95% fine to medium sand; 5% low plasticity, slow dilatancy fines; 0% gravel.												Box 2 Representative S26A_062_062P
-10	63				26	43									
	64														
	65		8-inch thick Lean Clay (CL) lense; 5% fine sand; 95% medium plasticity fines.												S27B_065_067S S27A_065_067S
	66		SILT with Sand (ML); very dense; olive brown (2.5Y 4/4); moist; 85% low plasticity, slow dilatancy fines; 15% fine sand; 0% gravel.		27	50	13 19 21 [40]	55							
	67														S28B_067_067P S28A_070_070P
-15	68		LEAN CLAY (CL); hard; olive (5Y 5/4); moist; 95% medium toughness fines; 5% sand; 0% gravel.		28	100									
	69								>4.5P						
	70														

Draft 4 After Final Markups 11/5/2009

DWR LEVEE U/NU SOIL LOG REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/5/09

Borehole Location: North Bank Crest **County:** Sacramento
Coordinates: Northing: 1,967,149.09 **Easting:** 6,731,673.44
Latitude: 38.56228 **Longitude:** -121.40544
Levee Station or Milepost: 3306+35 **Levee Mile:** 1.31
Levee Segment
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: American River

LOG OF BORING
WCNBAR_003B
Sheet 3 of 4

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	LABORATORY DATA: Other Lab Tests	REMARKS
	70		LEAN CLAY (CL); as above except very stiff.		29	61	19 21 25 [46]	64	>3.3P	19	25	8			S29A_070_072P
	71														
	72		As above except dark yellowish brown (10YR 4/6); 10% fine sand; 90% fines.												S30A_072_072P
-20	73				30	26									
	74														
	75														
	76		Borehole terminated at 75 feet. Backfilled with 5% bentonite grout.												
	77														
-25	78														
	79														
	80														
	81														
	82														
-30	83														
	84														
	85														
	86														
	87														
-35	88														
	89														
	90														
	91														
	92														
-40	93														
	94														
	95														

Draft 4 After Final Markups 11/5/2009

Borehole Location: North Bank Crest **County:** Sacramento
Coordinates: Northing: 1,967,149.09 **Easting:** 6,731,673.44
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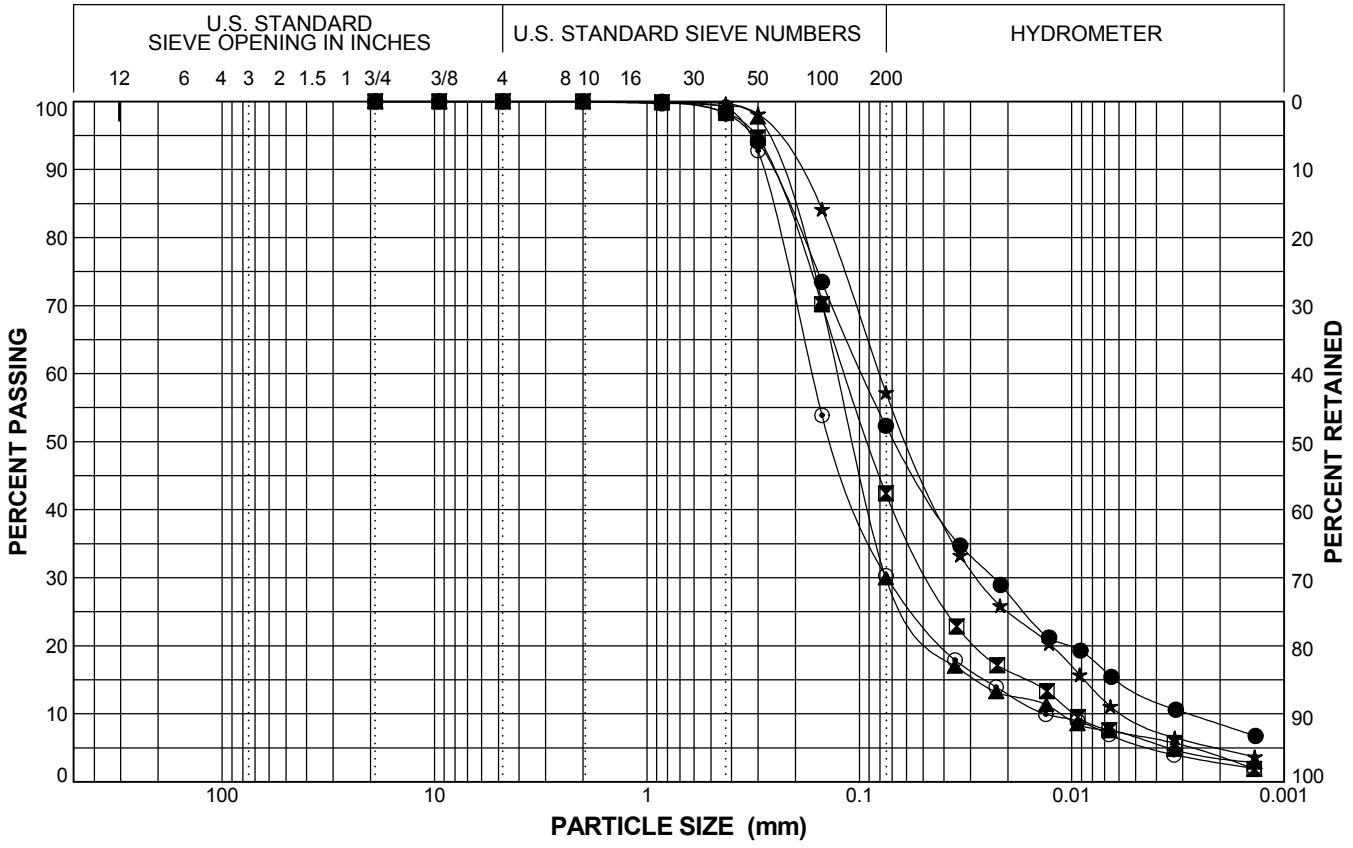
LOG OF BORING
WCNBAR_003B
Sheet 4 of 4

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

DWR LEVEE U/NU SOIL LOG REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/5/09

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	



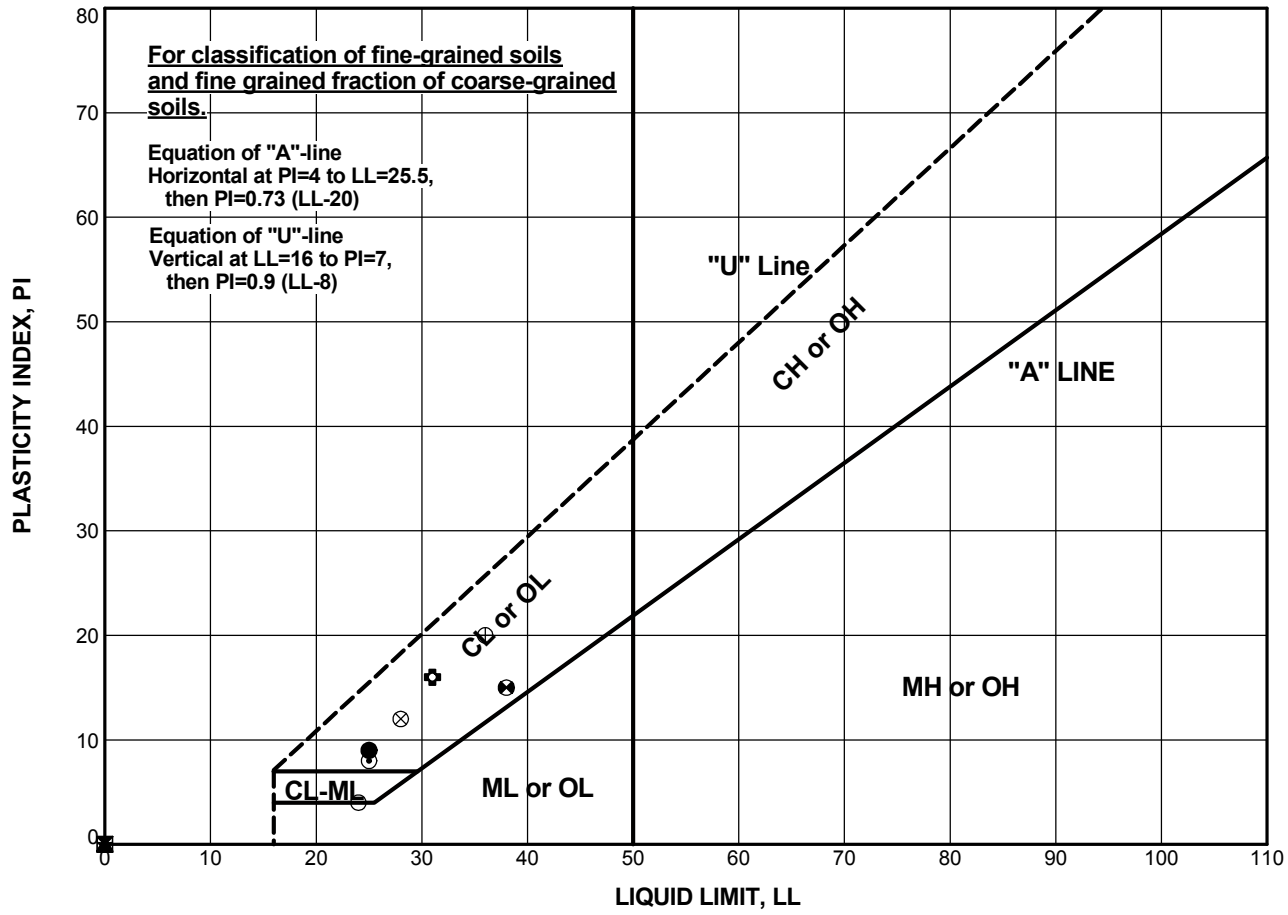
Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
WCNBAR_003B	S05A_007_008P	7	●	0.0	47.7	52.3	SANDY SILT (ML)
WCNBAR_003B	S08A_015_017S	15	⊠	0.0	57.6	42.4	SILTY SAND (SM)
WCNBAR_003B	S10A_020_022S	20	▲	0.0	70.1	29.9	SILTY SAND (SM)
WCNBAR_003B	S12A_025_027S	25	★	0.0	42.8	57.2	SANDY SILT (ML)
WCNBAR_003B	S16A_035_037S	35	⊙	0.0	69.7	30.3	SILTY SAND (SM)

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

American River

PARTICLE SIZE DISTRIBUTION CURVES

DWR LEVEE U/NU SIEVE CURVES #200 REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 2/3/10



Boring Number	Sample Number	Depth (feet)	Test Symbol	WC (%)	LL	PL	PI	Classification
WCNBAR_001B	S06A_015_017S	15	●	13.7	25	16	9	CLAYEY SAND (SC)
WCNBAR_002B	S04A_005_007S	5	⧓	17.5	NP	NP	NP	SANDY SILT (ML)
WCNBAR_002B	S08A_015_017S	15	▲		NP	NP	NP	SILTY SAND (SM)
WCNBAR_003B	S04A_005_007S	5	★	15.6	NP	NP	NP	SANDY SILT (ML)
WCNBAR_003B	S29A_070_072S	70	⊙	18.5	25	17	8	LEAN CLAY (CL)
WCNBAR_004B	S02A_002_003B	2	✿	15.9	31	15	16	LEAN CLAY (CL)
WCNBAR_004B	S08A_014_014P	13.5	○	17.6	24	20	4	SANDY SILTY CLAY (CL-ML)
WCNBAR_005B	S08A_010_012S	10	△	10.4	NP	NP	NP	SILTY SAND (SM)
WCNBAR_005B	S16A_036_036S	35	⊗	17.8	28	16	12	LEAN CLAY with Sand (CL)
WCNBAR_005B	S18A_041_042S	40	⊕	16.3	36	16	20	LEAN CLAY with Sand (CL)
WCNBAR_005B	S22A_050_052S	50	□	17.7	NP	NP	NP	SILTY SAND (SM)
WCSBAR_001B	S02A_002_003B	2	⊠	16.8	38	23	15	LEAN CLAY with Sand (CL)

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

American River

PLASTICITY CHART

DWR LEVEE U/NU ATT. PLOT (U LINE) REV1; AMERICAN RIVER LEVEE BORINGS 11-3-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/3/09

ARN REACH E – ARCADE CREEK NORTH – U7 LM 0.90

STRATIGRAPHY INPUT

BORING LOGS

LABORATORY TESTING

AMERICAN RIVER WATERSHED - COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT - GEOTECHNICAL ANALYSIS
ARCADE CREEK NORTH RN U7 LM 0.90
Table F-2-5: Permeability and Strength Selection for Analysis

Boring Number	Top of Boring Elevation (ft, NAVD88)	Layer ID	Material Type	USCS Soil Classification	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Elevation of Top of Layer (ft, NAVD 88)	Elevation of Bottom of Layer (ft, NAVD 88)	Layer Thickness (ft)	Average Depth to Groundwater During Drilling	Laboratory and Field Data						Recommended Hydraulic Conductivity					Recommended Strength Parameters		
											Average % Fines	Average Field N (blows/ft)	Average N_{60} (blows/ft)[1]	Average Normalized Blow Count, $N_{1,60}$ (blows/ft)[2]	PI	LL	Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WRARFC_003B	44.48	1	Sandy Lean Clay Levee	CL	0.00	12.79	44.48	31.69	12.79	12.89	61	10	9	16	14	27	1.00E-05	4.00	2.50E-06	0.028	0.007	24	50	115
		2	Sandy Lean Clay Blanket	CL	12.79	21.64	31.69	22.84	8.85		55	11	12	12	16 12	27 26	1.00E-05	1.00	1.00E-05	0.028	0.028	28	50	115
		3	Poorly Graded Sand	SP	21.64	40.14	22.84	4.34	18.50		12	35	51	38	19	47	5.00E-03	4.00	1.25E-03	14.175	3.544	35	0	130
		4	Silty Sand	SM	40.14	45.64	4.34	-1.16	5.50		22	82	121	82	7	33	1.00E-03	4.00	2.50E-04	2.835	0.709	33	0	125
		5	Sandy Silt	ML	45.64	55.64	-1.16	-11.16	10.00		94	50	74	48			2.00E-04	4.00	5.00E-05	0.567	0.142	30	0	120
		6	Silty Sand	SM	55.64	76.50	-11.16	-32.02	20.86		23	52	76	40	12 5 10 26	41 24 35 49	1.00E-03	4.00	2.50E-04	2.835	0.709	35	0	125
					Total Depth (ft.)	**76.50**																		

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION BASIS	TOTAL DEPTH OF BORING
5/22/07	**5/23/07**	**44.48 ft**	**Survey crew**	**76.5 ft**

DRILLING CONTRACTOR	DRILLER'S NAME	HELPER'S NAME	TOTAL DEPTH OF FILL
Westex	**K. Jensen**	**T. Seaver/M. Daniels**	**21.5 ft**

DRILLING METHOD	DRILL RIG MAKE AND MODEL	CONSULTANT COMPANY
0 - 21.5 ft: Hollow-Stem Auger, 21.5 - 76.5 ft: Rotary Wash	**Mobile B61 HDX (Rig 103)**	**Geomatrix**

DRILL BIT SIZE AND TYPE (HOLE DIAMETER)	DRILLING ROD TYPE AND DIAMETER	FIELD LOGGER
10" HSA, 4-3/8" Core Bit	**NWJ 67 mm, HQ Core 94 mm**	**A. Behan**

☒ VERTICAL ☐ INCLINED	CASING TYPE, DIAMETER, INSTALLATION DEPTH	FIELD LOG REVIEWER
	10" HSA to 20'	**Y. Ma**

SAMPLER TYPE(S)	HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP	HAMMER EFFICIENCY
Mod Cal (2"), Punch Core (2.25"), Shelby (1.87"), SPT (1.4")	**Mobile, self compensating auto, 140 lbs/30-inch drop**	**77%**

BOREHOLE BACKFILL OR COMPLETION	GROUNDWATER READING: DURING DRILLING	AFTER DRILLING (DATE-TIME)
See Termination Notes	**N/A due to rotary wash drilling method**	

Elevation, feet	Depth, feet	Material Graphics	FIELD CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in.	Blows per Foot	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	REMARKS
	0		SANDY LEAN CLAY (CL); dark yellowish brown (10YR 4/6) mottled with light brownish gray (10YR 6/2) and very dark grayish brown (10YR 3/2); dry; 61% low plasticity, high dry strength, no dilatancy, medium toughness fines; 39% fine to medium sand; trace coarse sand; (FILL).													
	1														
	2														
	3				1	78	5 8 14	22			15				S01B_003_004M S01A_004_004M
	4														
40	5		Color changes to very dark brown (10YR 2/2) mottled with dark yellowish brown (10YR 4/6), fine sand, slow dilatancy fines at 4.5'.												
	6				2	89	4 4 5	9			15	27	14		S02B_006_006M S02A_006_007M
	7														
	8		6" clayey sand lens at 8'.		3	78	2 3 3	6	8						S03B_008_008S S03A_008_009S
	9														
35	10		Fine to medium sand; fines content varies throughout layer with zones of clayey sand interbedded throughout at 9.5'. 4" silty sand lens at 10.3'. 1" silty sand lens at 10.9'. 1" silty sand lens at 11.2'.		4	89	1 1 2	3	4						S04A_010_012S
	11														
	12														
	13		3" silty sand lense at 12.8'.		5	100	2 3 5	8	10						S05A_013_014S
	14														
30	15														
	16				6	100					16	27	16	61	S06A_015_017T 300 psi
	17														
	18		Color changes to dark brown (10YR 3/3); moist at 17.3'. CLAYEY SAND (SC); dark yellowish brown (10YR 3/6); moist; 52% fine sand; 48% fines; (FILL).		7	89	1 3 4	7	9		15	26	12	48	S07B_018_018S S07A_018_019S
	19		SANDY LEAN CLAY (CL); dark brown (10YR 3/3) mottled with dark yellowish brown (10YR 3/6); moist; 57% low plasticity, high dry strength, slow dilatancy, medium toughness fines; 43% sand; (FILL).												
25	20														

Draft 4 After Final Markups 5/21/2008

Borehole Location: Crest of the Levee
Coordinates: North 1,990,149.70 East 6,717,833.03
Levee Station or Milepost: STA: 5048+89 OFFSET: 2.4 Left
GPS: Latitude 38.62567 Longitude -121.45337
Channel / River Name / Feature: Arcade Creek
County: Sacramento

LOG OF BORING
WRARFC_003B
Sheet 1 of 4

Engineering Support Services
Urban Levee Geotechnical Evaluations

Elevation, feet	Depth, feet	Material Graphics	FIELD CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in.	Blows per Foot	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	REMARKS
	20														
	21		(BASE OF FILL).		8	78	5 7 8	15			22			57	S08B_021_021M S08A_021_022M
	22		SILTY SAND (SM); brown (7.5YR 4/4); dry; 80% fine sand; 20% fines; (NATIVE).												S09A_022_023P Switched to rotary wash at 21.5'
	23				9	21									
	24		Poorly Graded SAND (SP); medium dense; dark yellowish brown (10YR 4/4); wet; 95% fine to medium sand; 5% fines; no cementation.												
20	25														
	26				10	78	1 4 6	10	13					5	S10A_025_027S
	27														
	28				NR	0									
	29														
15	30														
	31		SANDY SILT (ML); olive brown (2.5Y 4/4); moist; 51% low dry strength, no to slow dilatancy, low toughness fines; 49% fine sand; few concretions.		11	56	6 21 38	59	76		28	47	19	51	S11B_030_031S S11A_031_031S
	32		Poorly Graded SAND with Silt (SP-SM); dense; olive brown (2.5Y 4/4); moist; 88% sand (mostly fine sand, little medium sand, few coarse sand); 12% fines; with few clayey interbeds; few fine gravel; micaceous.												
	33				NR	0									
	34														
10	35		Color changes to light brownish gray (2.5Y 6/2) at 35'.												
	36				12	39	7 13 17	30	39					12	S12A_035_037S
	37														
	38				13	2									
	39														
5	40		2" sandy silt lens at 39.8'.												S13A_040_040P
	41		SILTY SAND (SM); dense to very dense; olive brown (2.5Y 4/4); moist; 72% fine sand; 28% fines; mostly fine sand, little medium sand, few coarse sand; with few clayey interbeds; few fine gravel; micaceous.		14	33	3 17 22	39	50					28	S14A_040_041S
	42														DN: Thickening mud at 41.5' to get better recovery
	43		LEAN CLAY with Sand (CL); olive brown (2.5Y 4/4); moist; 80% medium plasticity, medium dry strength, slow dilatancy, medium toughness fines; 20% fine sand; with concretions.		15	67					31	33	7	88	S15A_043_044P
	44		SILT (ML); olive brown (2.5Y 4/4); moist; 88% low dry strength, rapid dilatancy, low toughness fines; 12% fine sand.												
0	45		SILTY SAND (SM); very dense; light yellowish brown												

Draft 4 After Final Markups 5/21/2008

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County: Sacramento

LOG OF BORING
WRARFC_003B
Sheet 2 of 4

Engineering Support Services
Urban Levee Geotechnical Evaluations

Elevation, feet	Depth, feet	Material Graphics	FIELD CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in.	Blows per Foot	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	REMARKS
	45		(2.5Y 6/3) to grayish brown (2.5Y 5/2); moist; 84% fine sand; 16% fines; weak cementation.		16	60	10 32 50/3"	82/ 9"						16	S16B_045_046S S16A_046_046S
	46		SILT (ML); very dense; olive brown (2.5Y 4/4); moist; 91% low plasticity, low dry strength, rapid dilatancy, low toughness fines; 9% sand.												
	47													91	S17A_047_048P
	48		SILT with Sand (ML); very dense; olive brown (2.5Y 4/4); moist; 73% no dry strength, rapid dilatancy, low toughness fines; 27% fine sand.		17	27									
-5	49														
	50				18	100	23 50/6"	50/ 6"			24	NP	NP	73	S18B_050_051S S18A_051_051S
	51		SILT (ML); very dense; olive brown (2.5Y 4/4); moist; 95% low dry strength, rapid dilatancy, low toughness fines; 5% sand.												
	52		SILTY SAND (SM); olive brown (2.5Y 4/4); moist; 60% fine sand; 40% fines.												S19B_052_053P
	53		SANDY SILT (ML); olive brown (2.5Y 4/4); moist; 60% low plasticity, low dry strength, rapid dilatancy, low toughness fines; 40% fine sand.		19	63									
	54		SILT (ML); very dense; olive brown (2.5Y 4/4); moist; 95% low plasticity, low dry strength, rapid dilatancy, low toughness fines; 5% sand; grades sandy with depth.												S19A_054_054P
-10	55				20	100	22 50/6"	50/ 6"							S20B_055_056S
	56		SILTY SAND (SM); very dense; olive brown (2.5Y 4/4); moist; 70% fine sand; 30% fines.												S20A_056_056S
	57														
	58				NR	0									DN: Thinks low recovery is due to material type and not to drilling fluid thickness
	59														
-15	60				21	75	35 50/6"	50/ 6"							S21A_060_061S
	61		Wet; fine to medium sand at 61'.												
	62														
	63				22	50									
	64		74% sand, 26% fines at 64'.											26	S22B_064_065P S22A_065_065P
-20	65														
	66		55% sand, 45% fines, strong cementation, with numerous fine to coarse sand-sized and fine gravel-sized concretions, with oxide staining at 65'.		23	58	22 50/6"	50/ 6"			27	41	12	45	S23A_065_066S
	67		SANDY SILTY CLAY (CL-ML); olive brown (2.5Y 4/4) mottled with dark yellowish brown (10YR 4/6); wet; 51% low to medium dry strength, slow to rapid dilatancy, low toughness fines; 49% fine sand; with oxide staining.								27	24	5	51	S24C_067_067P
	68		SILTY SAND (SM); olive brown (2.5Y 4/4); moist; 70% fine sand; 30% fines.		24	88									S24B_068_068P
	69		CLAYEY SAND (SC); olive brown (2.5Y 4/4) mottled with dark yellowish brown (10YR 4/6); wet; 85% fine sand; 15% fines; with oxide staining.								36	35	10	58	S24A_069_070P
-25	70		SANDY SILT (ML); very dense; olive brown (2.5Y 4/4);												

Draft 4 After Final Markups 5/21/2008

DEPARTMENT OF WATER RESOURCES — STATE OF CALIFORNIA

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GPS: Latitude 38.62567 Longitude -121.45337

Channel / River Name / Feature: Arcade Creek

County: Sacramento

LOG OF BORING
WRARFC_003B

Engineering Support Services
Urban Levee Geotechnical Evaluations

Elevation, feet	Depth, feet	Material Graphics	FIELD CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in.	Blows per Foot	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	REMARKS
	70		moist; 58% low plasticity, low to medium dry strength, slow dilatancy, low toughness fines; 42% fine sand; with concretions; grades sandier with depth.		25	64	27 50/5"	50/ 5"							S25B_070_071S S25A_071_071S
	71		SILTY SAND (SM); very dense; olive brown (2.5Y 4/4); moist; 85% fine sand; 15% fines.												
	72														
	73				26	49									
	74		70% sand, 30% fines at 74'.											30	S26A_074_075P
-30	75		LEAN CLAY (CL); light olive brown (2.5Y 5/3); dry; 87% high to very high dry strength, no dilatancy, medium to high toughness fines; 13% fine sand; strong cementation.		27	56	5 26 30	56	72		26	49	26	87	S27A_075_076S
	76														
	77		Borehole terminated at 76.5 feet. Backfilled with 5% bentonite grout.												
	78														
	79														
-35	80														
	81														
	82														
	83														
	84														
-40	85														
	86														
	87														
	88														
	89														
-45	90														
	91														
	92														
	93														
	94														
-50	95														

Draft 4 After Final Markups 5/21/2008

DEPARTMENT OF WATER RESOURCES — STATE OF CALIFORNIA

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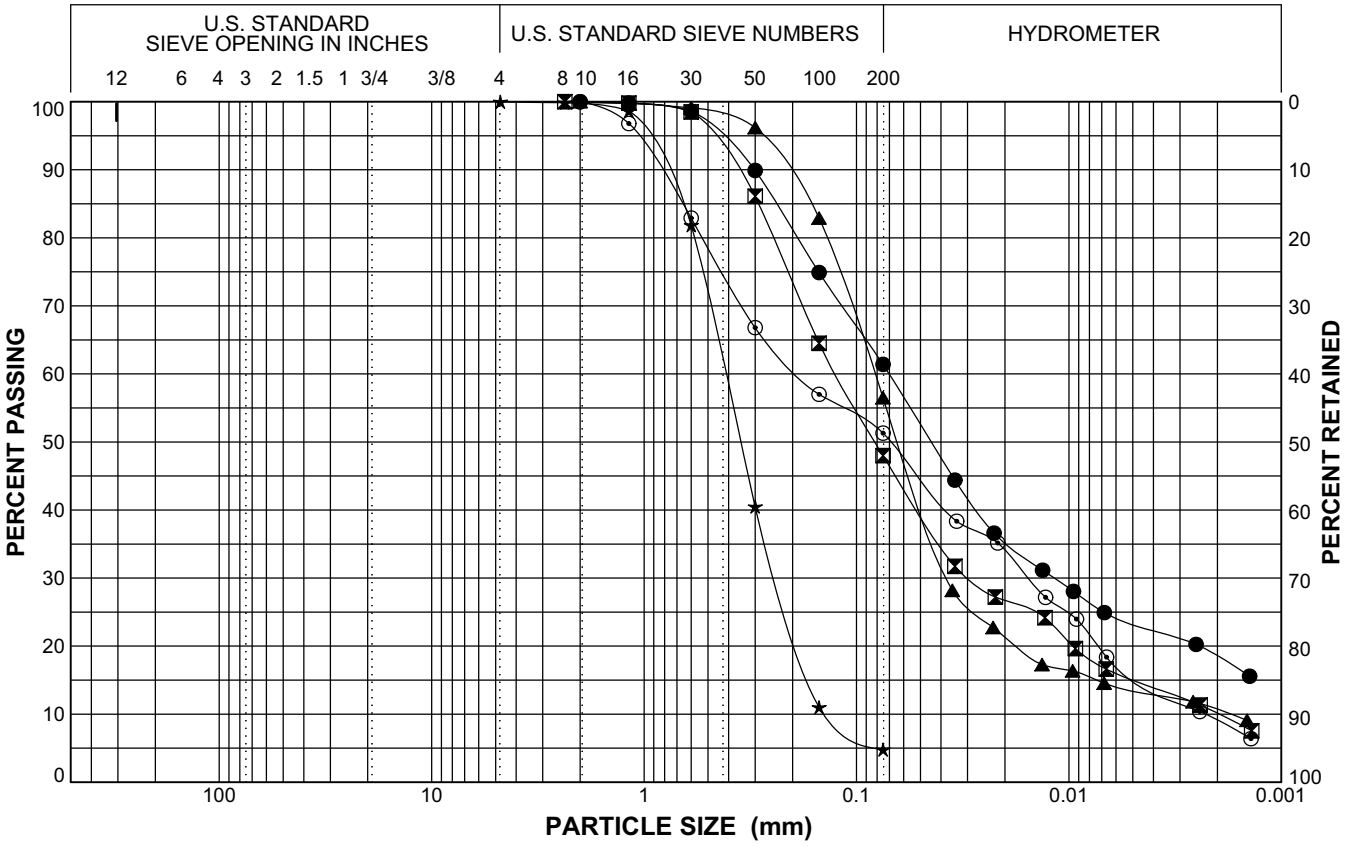
LOG OF BORING
WRARFC_003B
Sheet 4 of 4

Engineering Support Services
Urban Levee Geotechnical Evaluations

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
WRARFC_003B	6A	15	●	0	39	61	SANDY LEAN CLAY CL
WRARFC_003B	7A	17.8	⊠	0	52	48	CLAYEY SAND SC
WRARFC_003B	8A	21	▲	0	44	57	SANDY LEAN CLAY CL
WRARFC_003B	10A	25	★	0	95	5	Poorly Graded SAND SP
WRARFC_003B	11B	30	⊙	0	49	51	SANDY SILT ML

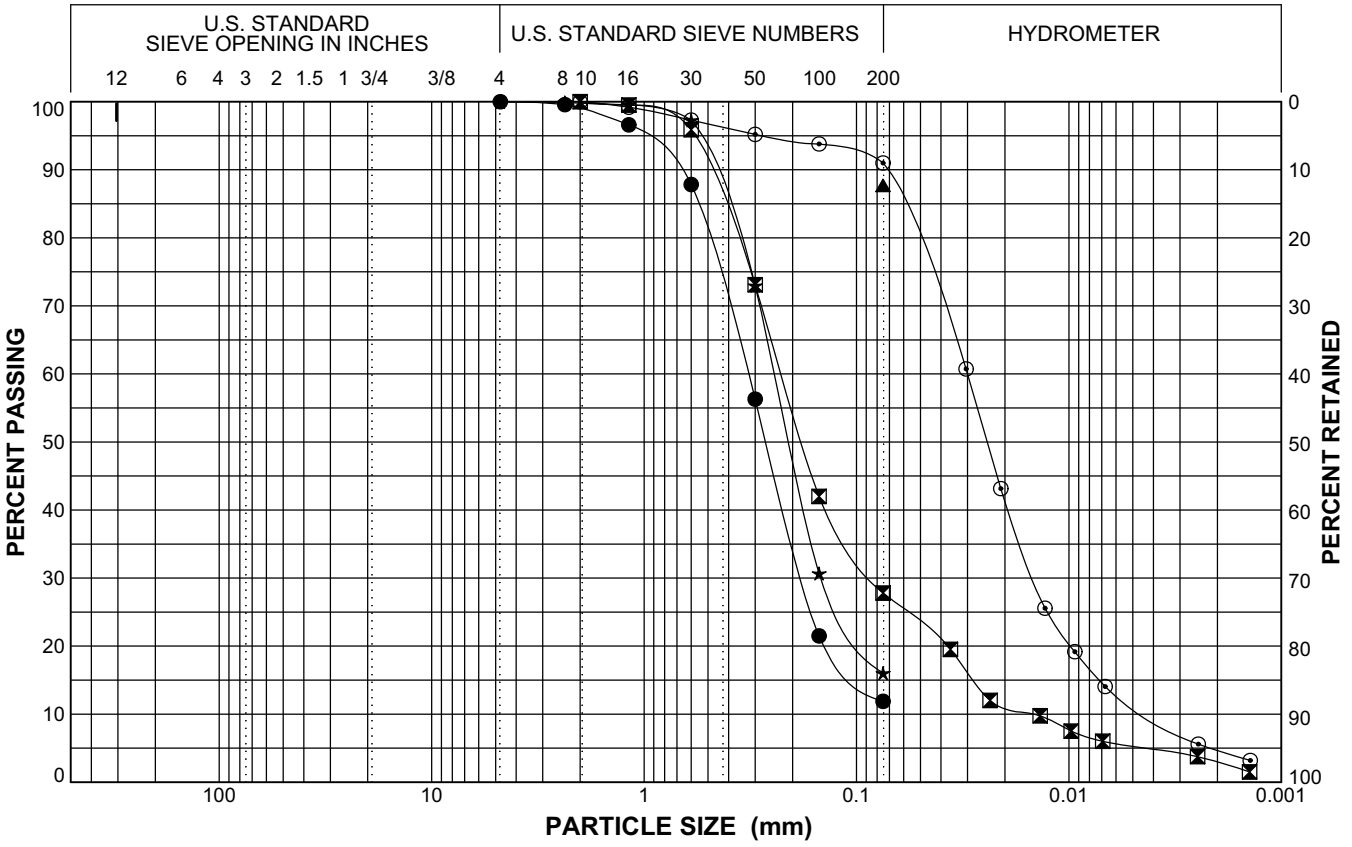
DWR SIEVE CURVES ALL EXPLORATIONS REV10.GPJ DWR_TEST 81507.GDT 5/27/08

Engineering Support Services
Urban Levee Geotechnical Evaluations

Natomas East Main Drainage Canal

PARTICLE SIZE DISTRIBUTION CURVES

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
WRARFC_003B	12A	35	●	0	88	12	SILTY SAND SM
WRARFC_003B	14A	40	⊠	0	72	28	SILTY SAND SM
WRARFC_003B	15A	43	▲	0	0	88	SILT ML
WRARFC_003B	16B	45	★	0	84	16	SILTY SAND SM
WRARFC_003B	17A	46.5	⊙	0	9	91	SILT ML

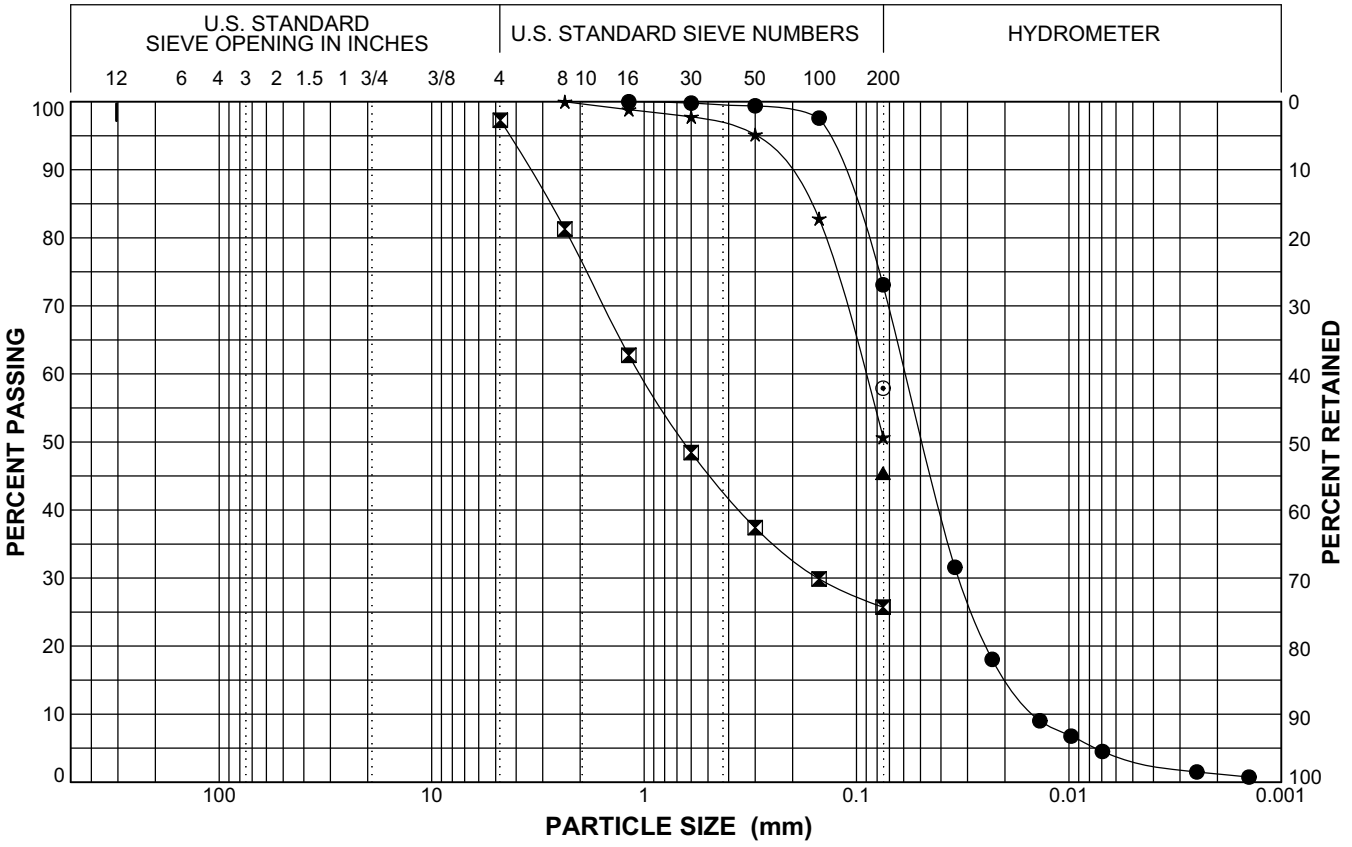
DWR SIEVE CURVES ALL EXPLORATIONS REV10.GPJ DWR_TEST 81507.GDT 5/27/08

Engineering Support Services
Urban Levee Geotechnical Evaluations

Natomas East Main Drainage Canal

PARTICLE SIZE DISTRIBUTION CURVES

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
WRARFC_003B	18B	50	●	0	27	73	SILT with Sand ML
WRARFC_003B	22A	64	⊠	0	72	26	SILTY SAND SM
WRARFC_003B	23A	65	▲	0	0	45	SILTY SAND SM
WRARFC_003B	24C	66.5	★	0	49	51	SANDY SILTY CLAY CL-ML
WRARFC_003B	24A	69	⊙	0	0	58	SANDY SILT ML

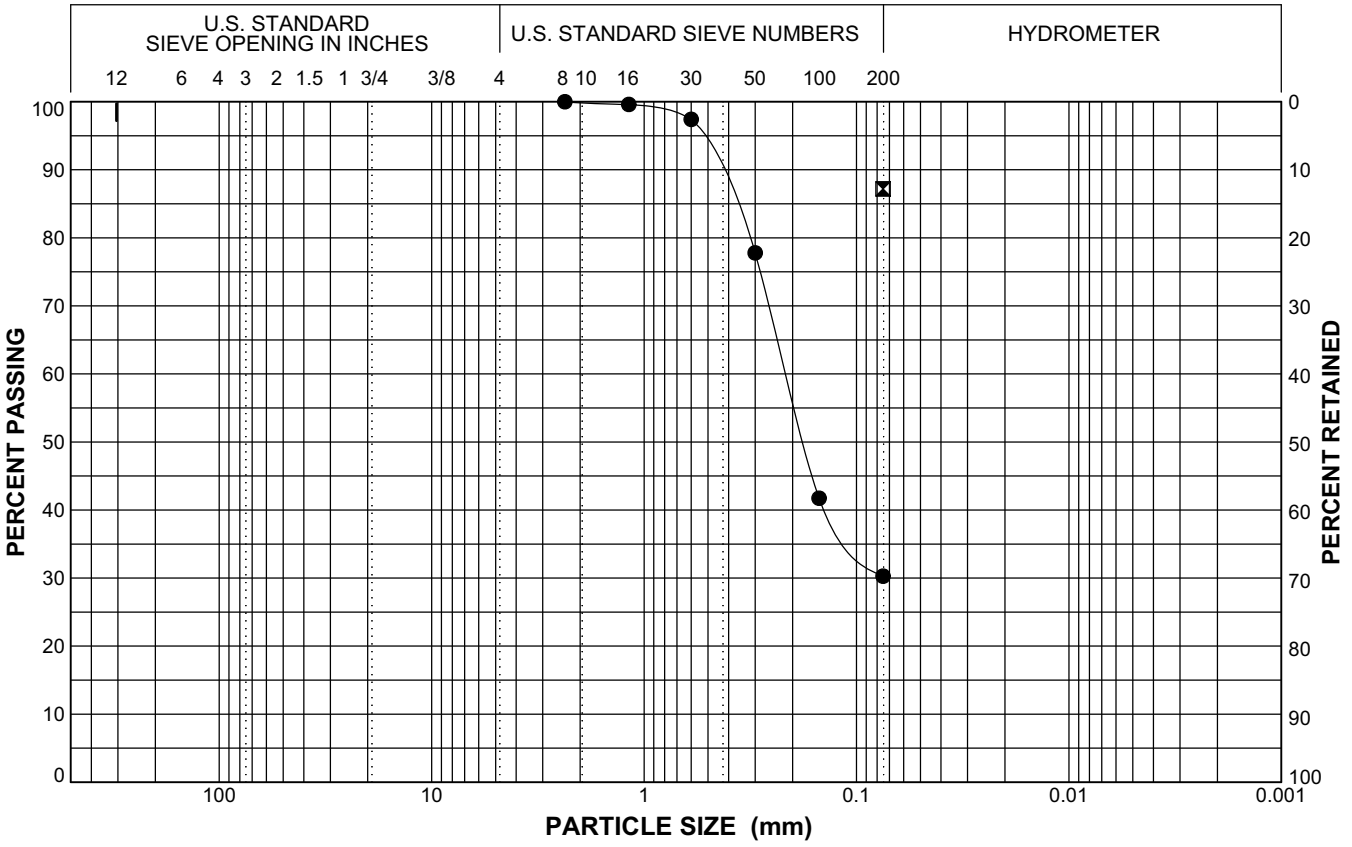
DWR SIEVE CURVES ALL EXPLORATIONS REV10.GPJ DWR_TEST 81507.GDT 5/27/08

Engineering Support Services
Urban Levee Geotechnical Evaluations

Natomas East Main Drainage Canal

PARTICLE SIZE DISTRIBUTION CURVES

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
WRARFC_003B	26A	74	●	0	70	30	SILTY SAND SM
WRARFC_003B	27A	75	⊠	0	0	87	LEAN CLAY CL

DWR SIEVE CURVES ALL EXPLORATIONS REV10.GPJ DWR_TEST 81507.GDT 5/27/08

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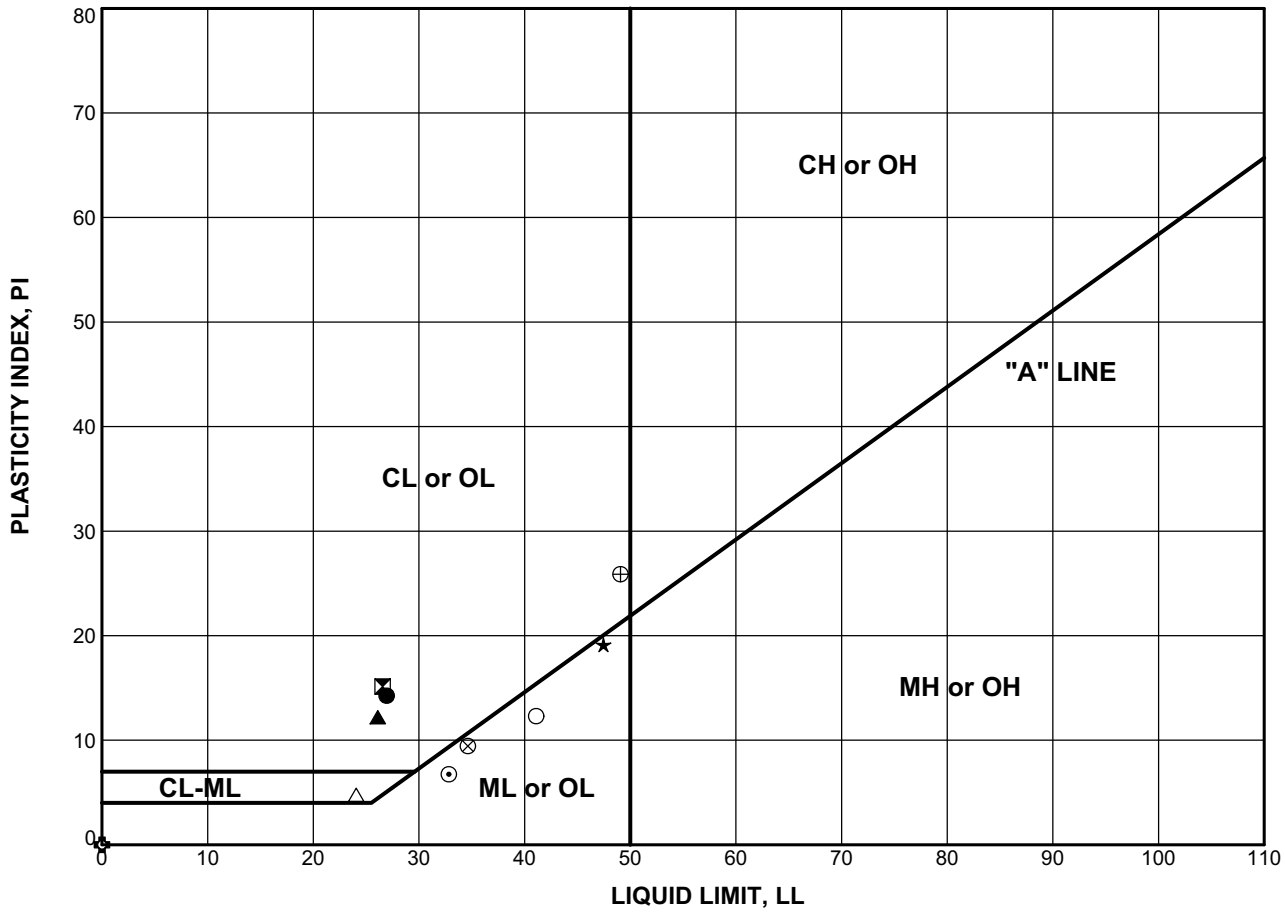
Natomas East Main Drainage Canal

PARTICLE SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Test Symbol	WC (%)	LL	PL	PI	Classification
WRARFC_003B	2A	6	●	14.8	27	13	14	SANDY LEAN CLAY CL
WRARFC_003B	6A	15	⊠	15.7	27	11	16	SANDY LEAN CLAY CL
WRARFC_003B	7A	17.8	▲	15.1	26	14	12	CLAYEY SAND SC
WRARFC_003B	11B	30	★	27.5	47	28	19	SANDY SILT ML
WRARFC_003B	15A	43	⊙	31.0	33	26	7	SILT ML
WRARFC_003B	18B	50	✿	24.4	NP	NP	NP	SILT with Sand ML
WRARFC_003B	23A	65	○	26.5	41	29	12	SILTY SAND SM
WRARFC_003B	24C	66.5	△	27.3	24	19	5	SANDY SILTY CLAY CL-ML
WRARFC_003B	24A	69	⊗	35.7	35	25	10	SANDY SILT ML
WRARFC_003B	27A	75	⊕	25.5	49	23	26	LEAN CLAY CL

DWR ATTERBERG PLOT ALL EXPLORATIONS REV10.GPJ DWR_LEVEES 111507.GDT 5/27/08

Engineering Support Services
Urban Levee Geotechnical Evaluations

Natomas East Main Drainage Canal

PLASTICITY CHART

AMERICAN RIVER SOUTH BASIN

ARS REACH B – AMERICAN RIVER SOUTH – U4 LM 3.90

STRATIGRAPHY INPUT

BORING LOGS

LABORATORY TESTING

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AMERICAN RIVER SOUTH RB U4 LM 3.90
Table F-2-10: Permeability and Strength Selection for Analysis

Boring Number	Top of Boring Elevation (ft, NAVD 88)	Layer ID	Soil Description	USCS Soil Classification	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Elevation of Top of Layer (ft, NAVD 88)	Elevation of Bottom of Layer (ft, NAVD 88)	Layer Thickness (ft)	Average Depth to Groundwater During Drilling	Laboratory and Field Data										Comments
											Average % Fines	Average Field N (blows/ft)	Average N_{60} (blows/ft)[1]	Average Normalized Blow Count, $N_{1,60}$ (blows/ft)[2]	Torvane (tsf)	Pocket Penetrometer (tsf)	Average Unit Weight (pcf)	PI	LL	LI	
2F-96-29, 2F-00-9W, 2F-00-114, WCSBAR_003B, 2F-99-17, 2F-97-23	49.70	1	Poorly Graded Sand to Silty Sand (SP-SM)	SP-SM	0.00	22.10	49.70	27.60	22.10	13.30	19	12									
		2	Levee Foundation Silt (ML)	ML	22.10	32.10	27.60	17.60	10.00		54	6									
		3	Poorly Graded Silty Sand (SP-SM) with Clay &	SP-SM	32.10	54.60	17.60	-4.90	22.50		10	13									
		4	Poorly Graded Gravel & Cobbles (GP)	GP	54.60	70.70	-4.90	-21.00	16.10		47	49									
		5	Silt and Clay (CL-ML)	ML	70.70	82.80	-21.00	-33.10	12.10		71	73									
		6	Cut-off Wall	SCB WALL																	
		7	Impervious Clay Cap	CL																	
					Total Depth (ft.)	**82.80**															

Layer ID	Recommended Hydraulic Conductivity					Strenth Coorelations							Strength from Lab Test Data						Recommended Strength Parameters			Comments
	Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Total Overburden Pressure at Mid Layer During Drilling (psf)	Effective Overburden Stress at Mid Layer During Drilling (psf)	OCR from N_{60}[3]	OCR from LI[3]	Su from N (psf)[4]	Su/σ'$_o$ from PI (psf)[4]	Calculated Maximum Past Pressure (psf)[5]	Drained Friction Angle[7]	OCR	σ'$_p$ (psf)	Su (psf)	Su/σ'$_o$	Φ'	C' (psf)	Φ'	C' (psf)	γ (pcf)	
1	1.00E-03	4.00	2.50E-04	2.835	0.709	0	0													33	0	125	
2	2.00E-04	4.00	5.00E-05	0.567	0.142	0	-861													30	0	120	
3	5.00E-03	4.00	1.25E-03	14.175	3.544	0	-1875													33	0	125	
4	1.20E-02	4.00	3.00E-03	34.020	8.505	0	-3079													35	0	135	
5	2.00E-04	4.00	5.00E-05	0.567	0.142	0	-3959													30	0	120	
6	1.00E-06	1.00	1.00E-06	0.003	0.003	0	0													0	50	85	
7	1.00E-05	1.00	1.00E-05	0.028	0.028	0	0	#VALUE!	#VALUE!											28	50	115	

2 F – 00 – 9W
STA. 6+920

DEPTH		N	GR	SA	FI	LL	PI	MC	
EL.10.40 m (34.12')	0								
									SM — SILTY SAND, SM: Firm; moist; light brown; fine sand; trace gravel and organics
(5.0')	1.52 m	11	11	52	37	–	–	–	
(6.5')	1.98 m								
		14							
		10							At 4.57 m (15.0') as above except loose
(17.5')	5.33 m								
		10	1	45	54	–	–	–	ML — SANDY SILT, ML: Stiff; moist, dark brown; trace gravel and organics
(20.0')	6.10 m								
(21.5')	6.55 m								
(22.0')	7.01 m								
		6							SM — SILTY SAND, SM: Loose; moist to wet; brown
(29.0')	8.84 m ▽								
(30.0')	9.14 m								At 9.14 m (30.0'), as above except very light gray brown with brown and red; fine sand
		10	0	86	14	–	–	–	
(31.5')	9.60 m								
(33.0')	10.06 m								Switch from auger to mud rotary drilling procedure at 10.06 m (33.0')
(34.5')	10.52 m								
		26	0	90	10	–	–	–	SP–SM — POORLY GRADED SAND WITH SILT, SP–SM: Very firm; wet; light gray
(36.0')	10.97 m								
(37.5')	11.43 m								

CONTINUED IN NEXT COLUMN

2 F – 00 – 9W

CONTINUED FROM PREVIOUS COLUMN

DEPTH		N	GR	SA	FI	LL	PI	MC	
(37.5')	11.43 m								
									SP–SM
		21							
(41.5')	12.65 m								Hard drilling at 12.65 m (41.5')
									GRAVEL AND COBBLES — GRAVEL AND COBBLES, GW: Very dense; wet; sandy gravel with cobbles. Soil classification was based on drill response, drill cuttings and slow drilling rate
(52.0')	15.85 m								
(53.0')	16.15 m	R	7	66	27	–	–		
(53.5')	16.31 m								SC — CLAYEY SAND, SC: Very dense; wet; gray; fine to medium sand
(58.0')	17.07 m								
									CL — SANDY LEAN CLAY, CL: Very dense; wet; light gray; fine sand
(60.0')	18.29 m	R	0	49	59	33	9	33	
(61.5')	18.75 m								

B.O.H.

NOTES:

1. SEE FIGURE B–1 FOR LEGEND AND NOTES.

GRAPHIC SCALE

SCALE 1 : 25 (0, 0.5, 1, 1.5, 2, 2.5 METERS)

AMERICAN RIVER WATERSHED PROJECT (COMMON FEATURES), CALIFORNIA LEFT (SOUTH) BANK LEVEE STRENGTHENING CONTRACT 2	DEPARTMENT OF THE ARMY CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA **URS Greiner Woodward Clyde** OAKLAND, CALIFORNIA	DEEP CUTOFF WALL FIELD INVESTIGATION PIEZOMETER INSTALLATION PROGRAM LOG OF EXPLORATION 2F–00–9W	FIGURE B–7

2F-00-114

STA. 6+500

DEPTH		N	GR	SA	FI	LL	PI	MC	
EL. 14.0m (45.9') 0									
	MH	25	–	–	–	–	–	–	SANDY ELASTIC SILT, MH: Dense; moist; brown; about 60% low plasticity fines; about 40% fine sand; trace of organic matter; easy drilling
(3.0') 0.91m									
	SM	10	–	–	–	–	–	–	SILTY SAND, SM: Firm; moist; brown; about 70% fine to medium sand; about 30% low plasticity fines; trace of organic matter (roots); easy drilling
(6.0') 1.83m									
		8	2	85	13	–	–	–	SILTY SAND, SM: Firm; dry; grayish–brown; fine to medium sand; low plasticity fines; trace of hard, coarse, subrounded, sand; easy drilling
(9.0') 2.74m									
		8	–	–	–	–	–	–	SILTY SAND, SM: Firm; moist; brown; about 70% fine to medium sand; about 30% low plasticity fines; trace of organic matter; easy drilling
		13							
(15.0') 4.57m									
		9	0	70	30	–	–	–	SILTY SAND, SM: Firm; moist; olive–gray; mostly fine sand; low plasticity fines; trace of organic matter; easy drilling
▽ (18.0') 5.49m 1:35pm 5/2/00									SILTY SAND, SM: Firm; moist; dark grayish–brown; about 70% fine sand; about 30% low plasticity fines; perched water; easy drilling
(19.2') 5.85m		13							POORLY GRADED SAND WITH SILT, SP–SM: Firm; moist; dark gray; about 90% fine to medium sand; about 10% low plasticity fines; easy drilling
(21.0') 6.40m	SP–SM								
	CL	7	–	–	–	–	–	–	LEAN CLAY WITH SAND, CL: Stiff; very moist to almost wet; very dark grayish–brown; about 85% medium plasticity fines; about 15% fine sand; trace of organic matter; easy drilling
(24.0') 7.32m									
	ML	10	0	47	53	–	–	11	SANDY SILT, ML: Firm; moist; very dark grayish–brown; low plasticity fines; fine sand; easy drilling
▽ (27.0') 8.23m 8:55am 5/2/00									
	CL	11	–	–	–	–	–	–	LEAN CLAY WITH SAND, CL: Stiff; very moist to almost wet; olive–gray; about 75% medium plasticity fines; about 25% fine sand; perched water; easy drilling
(30.0') 9.14m									
	ML	8	0	39	61	–	NP	21	SANDY SILT, ML: Stiff; moist; black; non–plastic fines; fine sand; trace of organic matter; easy drilling From 9.5m (31.3') to 9.6m (31.4'), contains sand lens
(33.0') 10.06m									
	SC	14	–	–	–	–	–	–	CLAYEY SAND, SC: Firm; moist; very dark gray; about 80% fine to medium sand; about 20% medium plasticity fines
(36.0') 10.97 m									
		14	–	–	–	–	–	–	SILTY SAND, SM: Firm; very moist; very dark gray; about 80% fine sand; about 20% low plasticity fines
▽ (39.0') 11.90m 10:20am 7/21/00	SM								At 11.9m (39.0'), as above except wet; flowing sands
		11							
(42.0') 12.80m									

(Continued in Next Column)

2F-00-114

(Continued from Previous Column)

DEPTH		N	GR	SA	FI	LL	PI	MC	
(42.0') 12.80m									
	SP–SM	11	0	92	8	–	NP	–	POORLY GRADED SAND WITH SILT, SP–SM: Firm; wet; very dark gray; hard, fine to coarse, subrounded sand; nonplastic fines; flowing sands; switched to mud rotary
(44.0') 13.41m									
	SP	12	–	–	–	–	–	–	POORLY GRADED SAND, SP: Firm; wet; very dark gray; about 95% fine to medium sand; about 5% nonplastic fines
(47.0') 14.33m									
	SM	12	0	87	13	–	NP	–	SILTY SAND, SM: Firm; wet; very dark gray; fine to medium sand; nonplastic fines
(50.0') 15.2m									
	SP–SM	12	–	–	–	–	–	–	POORLY GRADED SAND WITH SILT, SP–SM: Firm; wet; very dark gray; about 90% fine to medium sand; 10% nonplastic fines
(53.0') 16.16m									
		55	16	77	7	–	NP	–	POORLY GRADED SAND WITH SILT AND GRAVEL SP–SM: Very dense; wet; dark gray; hard, fine to coarse, subrounded sand; hard, sub–rounded gravel maximum particle size >38mm (1–1/2"); nonplastic fines; very rough, hard and slow drilling; encountered cobbles
(56.0') 17.07m									
									At 18.6m (61.0'), flowing sand with clear water
									At 19.5m (64.0'), gravel and cobbles with abundant water
									At 21.3m (70.0'), lost circulation, 5 batches of mud mixed and placed down hole
									At 22.9m (75.0'), bringing up gravel and fine sand, abundant water; flowing sands
									At 24.4m (80.0'), very fast, easy drilling through fine sand; abundant water and flowing sands
(83.0') 25.30m	GRAVEL & COBBLES								

(Continued in Next Column)

2F-00-114

(Continued from Previous Column)

DEPTH		N	GR	SA	FI	LL	PI	MC	
(83.0') 25.30m	GRAVEL & COBBLES								At 26.2m (86.0') bringing up clayey material; no appreciable amount of water; switched to CalMod sampler
(87.5') 26.67m	SM	73	6	52	42	–	NP	32	SILTY SAND, SM: Very dense; moist; dark grayish–brown; mostly fine sand; nonplastic fines; gravel maximum particle size 76mm (3")
(89.0') 27.13m	ML	74	1	36	63	–	NP	29	SANDY SILT, ML: Very dense; moist; dark grayish–brown; nonplastic fines; mostly fine sand; gravel maximum particle size 76mm (3")
(90.4') 27.55m									B.O.H.

STANDARD PENETROMETER DESCRIPTIVE DATA

COHESIONLESS		COHESIVE	
BLOWS*	RELATIVE DENSITY	BLOWS*	CONSISTENCY
0–4	VERY LOOSE	0–1	VERY SOFT
5–10	LOOSE	2–4	SOFT
11–20	FIRM	5–8	FIRM
21–30	VERY FIRM	9–15	STIFF
31–50	DENSE	16–30	VERY STIFF
51+	VERY DENSE	31+	HARD

*BLOWS PER 0.3 m OF PENETRATION OF A 51 mm O.D. AND 35 mm I.D. SAMPLER DRIVEN BY A 63.5 kg HAMMER, WITH A 0.76 m FREEFALL.

LEGEND:

N	NUMBER OF BLOWS WITH THE STANDARD PENETROMETER
GR	GRAVEL, PERCENT BY WEIGHT PASSING THE 76mm (3–INCH) SIEVE AND RETAINED ON THE NO. 4 SIEVE
SA	SAND, PERCENT BY WEIGHT PASSING THE NO. 4 SIEVE AND RETAINED ON THE NO. 200 SIEVE
FI	FINES, PERCENT BY WEIGHT PASSING THE NO. 200 SIEVE
LL	LIQUID LIMIT
PI	PLASTICITY INDEX (LIQUID LIMIT MINUS PLASTIC LIMIT)
MC	LABORATORY DETERMINED MOISTURE CONTENT IN PERCENT OF DRY WEIGHT
NP	NONPLASTIC
SM	COMBINED FIELD VISUAL IDENTIFICATION AND/OR LABORATORY CLASSIFICATION
B.O.H.	BOTTOM OF HOLE
R	REFUSAL WITH THE STANDARD PENETROMETER (SEE NOTE 10)
A	ATTEMPT WITH THE STANDARD PENETROMETER (SEE NOTE 11)
▽	WATER LEVEL
GRAVEL & COBBLES	COBBLES WITH MATRIX MATERIAL (GRAVEL, SAND AND FINES) MATRIX MATERIAL IS CLASSIFIED IN ACCORDANCE WITH ASTM STANDARDS

NOTES:

1. THIS DRAWING IS TO BE USED ONLY FOR APPROXIMATE DESCRIPTIONS OF SUBSURFACE CONDITIONS.
2. SOIL CLASSIFICATIONS AND DESCRIPTIONS ARE BASED ON FIELD LOG DESCRIPTIONS IN ACCORDANCE WITH ASTM D 2488 (DESCRIPTION AND IDENTIFICATION OF SOILS, VISUAL–MANUAL PROCEDURE) AND/OR LABORATORY TEST RESULTS IN ACCORDANCE WITH ASTM D 2487 (CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES).
3. ALL COLORS SHOWN ARE IN ACCORDANCE WITH THE MUNSELL SOIL COLOR CHART.
4. ALL SIEVE SIZES SHOWN ARE METRIC WITH U.S. STANDARD IN PARENTHESES.
5. BORING 2F–00–114 WAS DRILLED BETWEEN 2 MAY AND 21 JULY, 2000 USING AN INGERSALL RAND A–400 DRILL RIG UTILIZING A 152mm (6") O.D. AND A 203mm (8") HOLLOW STEM FLIGHT AUGER.
6. WHERE COBBLES WERE ENCOUNTERED, LABORATORY GRADATION DATA REPRESENTS MATERIAL PASSING THE 76mm (3–INCH) SIEVE. PARTICLES LARGER THAN THE INSIDE DIAMETER OF SAMPLER WERE NOT RECOVERED. HENCE, ALL GRAVEL AND COBBLE LAYERS REFERENCED IN SOIL BORINGS CONTAINED LARGER PARTICLES OF GRAVEL AND COBBLES THAT ARE NOT REFLECTED IN THE LABORATORY GRADATION TEST RESULTS SHOWN IN THE SOIL BORING LOGS.
7. STANDARD PENETROMETER DATA WERE OBTAINED IN ACCORDANCE WITH ASTM D 1586 UTILIZING A 610mm LONG STANDARD 51mm O.D. BY 35mm I.D. SPLIT BARREL SAMPLER. THE SPLIT–SPOON PENETROMETER WAS DRIVEN USING AN AUTOMATIC–TRIP, 63.5 KG SAFETY HAMMER. ALL SPT "N" VALUES ARE "FIELD", I.E. UNCORRECTED FOR DEPTH.
8. GROUNDWATER WAS ENCOUNTERED AT THE TIME OF EXPLORATIONS; GROUNDWATER LEVELS CAN BE EXPECTED TO FLUCTUATE IN RESPONSE TO RAINFALL VARIATIONS, PARTICULARLY IN THE VICINITY OF SITE DRAINAGE FEATURES.
9. DEPENDING ON THE SOIL MOISTURE AT THE TIME OF CONSTRUCTION, THE SOIL ENCOUNTERED MAY BE UNSTABLE OR POTENTIALLY UNSTABLE. THE PROBABILITY OF UNSTABLE CONDITIONS IS HIGHEST WHEN THE SOIL MOISTURE IS GREATEST.
10. REFUSAL WITH THE STANDARD PENETROMETER IS DEFINED AS ONE OF THE FOLLOWING:
    - A. 10 BLOWS FOR NO APPARENT ADVANCEMENT OF THE SAMPLER; OR
    - B. 50 BLOWS FOR LESS THAN 152mm (6") ADVANCEMENT OF THE SAMPLER; OR
    - C. 100 BLOWS FOR 152mm (6") TO 457mm (18") ADVANCEMENT OF THE SAMPLER.
11. ATTEMPT WITH THE STANDARD PENETROMETER IS DEFINED AS REFUSAL WITHIN THE FIRST 152mm (6") OF SEATING PENETRATION.
12. ADDITIONAL LOGS OF EXPLORATIONS ARE SHOWN ON SHEET NOS. B–4 THROUGH B–17 AND B–19 THROUGH B–21.

GRAPHIC SCALE

SCALE 1 : 25 — 0, 0.5, 1, 1.5, 2, 2.5 METERS

US Army Corps of Engineers
Sacramento District

Description | Date | Approved

Symbol | Description | Date | Approved

Updated title block information. M.K.Mc.BG

Symbol | Modified note

Designed by: J. SOANDRONE
Drawn by: COE–SOIL
Cad by: R. IWASA
Reviewed by: J. SOANDRONE
Submitted by: /S/ KEN PATTERMANN
CHIEF, GEOTECHNICAL SECTION

Date:
Design file no: 1–04–474
SPEC. No.: 1034
File name: 1034B18.dwg
Plot date: 5 OCT 2001
Plot scale: 1:1

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN–HOUSE DESIGN
1325 "J" STREET
SACRAMENTO, CA 95814–2922

AMERICAN RIVER WATERSHED PROJECT
CALIFORNIA
AMERICAN RIVER
JET GROUT SECTIONS
CONTRACT 1

LOG OF EXPLORATION
2F–00–114

Sheet reference number:
B–18
SEQ. 24

Soil Design Section Sheet No.: 18 OF 21

Reference — Exploration Log File No.: 1–01–486

MASTER DESIGN FILE: 1034B18.DWG
PLOT DATE: 05–OCT–2001
PLOT TIME:

2F – 96 – 28

STA. 4+737

DEPTH		N	GR	SA	FI	LL	PI	MC	
EL. 12.8 m (41.9')	0								
	SP–SM	44	–	–	–	–	–	–	POORLY GRADED SAND WITH SILT, SP–SM: Dense; moist; brown; about 90% fine to coarse, angular to subrounded sand; about 10% low plasticity fines
(2.0')	0.61 m								
	SM	40	–	–	–	–	–	–	SILTY SAND, SM: Dense; moist; brown; about 85% fine to coarse, angular to subrounded sand; about 15% low plasticity fines
(4.0')	1.22 m								
	ML	21	–	–	–	–	–	–	SANDY SILT, ML: Very stiff; moist; brown; about 65% low plasticity fines; about 35% fine to medium sand
(6.0')	1.83 m								
		14	–	–	–	–	–	–	SILT WITH SAND, ML: Stiff; moist; very dark gray; about 80% low plasticity fines; about 20% fine to medium sand
(8.0')	2.44 m								
		13	–	–	–	–	–	–	SILT WITH SAND, ML: Stiff; moist; olive–brown; about 75% low plasticity fines; about 25% fine to medium sand
(10.0')	3.05 m								
	SM	22	–	–	–	–	–	–	SILTY SAND, SM: Very firm; moist; dark brown; about 75% fine to coarse, subangular to subrounded sand; about 25% nonplastic fines
(13.5')	4.1 1 m								
	SC	11	1	66	33	28	8	–	CLAYEY SAND, SC: Firm; moist; olive–brown; fine to coarse, mostly medium, subangular to subrounded sand; low plasticity fines; gravel maximum particle size 19 mm (3/4"); charcoal material present
(15.0')	4.57 m								
(17.0')	5.18 m								
	ML	10	–	–	–	–	–	–	SANDY SILT, ML: Stiff; moist; brown; about 55% low plasticity fines; about 45% fine to medium sand
(20.5')	6.25 m								
		8	–	–	–	–	–	–	SANDY SILT, ML: Firm; moist; brown; about 60% low plasticity fines; about 40% fine to medium sand
(24.0')	7.32 m								
		6	–	–	–	–	–	–	SILT, ML: Firm; moist; dark gray; about 90% low plasticity fines; about 10% fine sand
(27.5')	8.38 m								
	SM	8	–	–	–	–	–	–	SILTY SAND, SM: Loose; moist; very dark gray; about 60% fine sand; about 40% nonplastic fines
(31.0')	9.45 m								
	ML	10	–	–	–	–	–	–	SANDY SILT, ML: Stiff; moist; very dark gray; about 60% nonplastic fines; about 40% fine sand
(34.5')	10.52 m								

CONTINUED IN NEXT COLUMN

2F – 96 – 28

CONTINUED FROM PREVIOUS COLUMN

		N	GR	SA	FI	LL	PI	MC	
(34.5')	10.52 m								
	SM	10	–	–	–	–	–	–	SILTY SAND, SM: Loose; moist; very dark gray; about 85% fine to medium sand; about 15% low plasticity fines
(38.0')	1 1.58 m								▽
		14	–	–	–	–	–	–	SILTY SAND, SM: Firm; wet; very dark gray; about 85% fine to medium sand; about 15% low plasticity fine; organic material present
(41.5')	12.65 m								
		9	1	82	17	–	NP	–	SILTY SAND, SM: Loose; wet; very dark gray; fine to medium sand; nonplastic fines; gravel maximum particle size 10 mm (3/8"); organic material present
(43.0')	13.11 m								
(45.0')	13.72 m								
	SP–SM	8	–	–	–	–	–	–	POORLY GRADED SAND WITH SILT, SP–SM: Loose; wet; very dark gray; about 90% fine to coarse, subangular to subrounded sand; about 10% nonplastic fines; organic material present;
		7	–	–	–	–	–	–	
(50.0')	15.24 m								B.O.H.

2F – 96 – 29

STA. 5+904

DEPTH		N	GR	SA	FI	LL	PI	MC	
EL. 14.1 m (46.1')	0								
	SM	59	–	–	–	–	–	–	SILTY SAND WITH GRAVEL, SM: Very dense; moist; yellowish–brown; about 60% fine to coarse, subangular to subrounded sand; about 25% subangular gravel maximum particle size 19 mm (3/4"); about 15% low plasticity fines; no reaction with HCl; easy drilling
(2.0')	0.61 m								
		32	–	–	–	–	–	–	SILTY SAND, SM: Dense; moist; yellowish–brown; about 85% fine to medium sand; about 15% low plasticity to nonplastic fines; trace of gravel maximum particle size 13 mm (1/2"); trace of charcoal present; no reaction with HCl; no odor present; easy drilling
(4.0')	1.22 m								
		13	–	–	–	–	–	–	SILTY SAND, SM: Firm; moist; yellowish–brown; about 85% fine to medium sand; about 15% nonplastic to low plasticity fines; no reaction with HCl; no odor present; easy drilling
(6.0')	1.83 m								
		15	–	–	–	–	–	–	SILTY SAND, SM: Firm; moist; yellowish–brown; about 80% fine to medium sand; about 20% low plasticity fines; no reaction with HCl; no odor present; easy drilling
(8.0')	2.44 m								
		14	–	–	–	–	–	–	
(10.0')	3.05 m								
	SP–SM	9	2	92	6	–	NP	–	POORLY GRADED SAND WITH SILT, SP–SM: Firm to loose; moist; brown; fine to coarse, mostly medium sand; nonplastic fines; gravel maximum particle size 19 mm (3/4"); no reaction with HCl; easy drilling
(11.5')	3.51 m								
(13.5')	4.1 1 m								
	SM	9	–	–	–	–	–	–	SILTY SAND, SM: Loose; moist; grayish–brown; about 85% fine to medium sand; about 15% nonplastic fines; trace of subrounded gravel present; no reaction with HCl; no odor present; easy drilling
(17.0')	5.18 m								
	SP–SM	15	–	–	–	–	–	–	POORLY GRADED SAND WITH SILT, SP–SM: Firm; moist; very dark grayish–brown; about 90% fine to coarse, subangular to subrounded sand; about 10% nonplastic fines; no reaction with HCl; no odor present
(21.0')	6.40 m								
	MH	5	–	–	–	–	–	–	ELASTIC SILT, MH: Firm; moist; dark brown; about 90% low plasticity fines; about 10% fine sand; no reaction with HCl; weak iron oxide staining
(24.0')	7.32 m								
	ML	4	0	25	75	33	3	–	SILT WITH SAND, ML: Soft; wet; dark yellowish–brown; nonplastic fines; fine sand; no reaction with HCl
(25.5')	7.77 m								
(27.5')	8.38 m								
	SP–SM	4	–	–	–	–	–	–	POORLY GRADED SAND WITH SILT, SP–SM: Very loose; wet; dark brown; about 90% fine sand; about 10% nonplastic fines; no reaction with HCl
(28.7')	8.75 m								
	MH		–	–	–	–	–	–	ELASTIC SILT, MH: Soft; wet; dark yellowish–brown; about 95% low plasticity fines; about 5% fine sand; no reaction with HCl
(31.0')	9.45 m								

CONTINUED IN PREVIOUS COLUMN

2F – 96 – 29

CONTINUED FROM NEXT COLUMN

		N	GR	SA	FI	LL	PI	MC	
(31.0')	9.45 m								
	SM	8	–	–	–	–	–	–	SILTY SAND, SM: Loose; moist; dark brown; about 85% fine sand; about 15% nonplastic fines; no reaction with HCl
(32.0')	9.75 m								
	SP–SM	11	–	–	–	–	–	–	POORLY GRADED SAND WITH SILT, SP–SM: Loose; moist; very dark grayish–brown; about 90% fine to medium sand; about 10% nonplastic fines; no reaction with HCl
(34.5')	10.52 m								
			–	–	–	–	–	–	POORLY GRADED SAND WITH SILT, SP–SM: Firm; moist; very dark grayish–brown; about 90% fine to medium sand; about 10% nonplastic fines; no reaction with HCl
(38.0')	1 1.58 m								
	CL	17	–	–	–	–	–	–	LEAN CLAY WITH SAND, CL: Very stiff; moist; very dark grayish–brown; about 80% medium plasticity fines; about 20% fine to medium sand; no reaction with HCl
(41.5')	12.65 m								
	SM	13	–	–	–	–	–	–	SILTY SAND, SM: Firm; wet; dark brown; about 80% fine to medium with trace of coarse sand; about 20% nonplastic fines; no reaction with HCl; weak iron oxide staining
(43.5')	13.26 m								
(45.0')	13.72 m								POORLY GRADED SAND WITH SILT, SP–SM: Very firm; wet; dark brown; fine to medium, mostly medium sand; nonplastic fines; no reaction with HCl At 13.56 m (44.5'), as above except very dark grayish–brown
	SP–SM	25	0	93	7	–	NP	–	
									B.O.H.

NOTES:

1. THE LEGENDS AND NOTES ARE SHOWN ON SHEET B–1.

GRAPHIC SCALE

SCALE 1 : 25 (0, 0.5, 1, 1.5, 2, 2.5 METERS)

US Army Corps of Engineers
Sacramento District

Data Approved | Description | Symbol | Date Approved | Description | Symbol

Rev.

Date: 18 JAN. 2000
Design file no: 1–04–477
SPEC. No 9824
1140
File name A98SR02.DWG
Plot date 14 JAN 2000
Plot scale 1 : 1

Designed by: R. IWASA (USACE)
Cad by: LI. LUSCHER
Dwn. by: R. AGUANO
Reviewed by: S. PUNYAMURTHULA
Submitted by:
Chief, Civil Design Section A

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

URS Greiner Woodward Clyde
OAKLAND, CALIFORNIA

SMD SAJAH-MARS

AMERICAN RIVER WATERSHED PROJECT
AMERICAN RIVER, CALIFORNIA
LEFT (SOUTH) BANK LEVEE STRENGTHENING
CONTRACT 2

LOGS OF EXPLORATIONS
2F–96–28 & 2F–96–29

REGISTERED PROFESSIONAL ENGINEER
SAID SALAH-MARS
No. C 050445
Exp. 06/30/01
CIVIL
STATE OF CALIFORNIA

Sheet reference number:
B–6
SEQ. 61

J:\DESIGN\GEO\AR\PRIVATE\CONTRACT2\A98SR02.DWG DATE=10-28-99 DN

2F-97-23

STA. 7+41 17

EL. 14.2 m (46.5') 0

DEPTH	Elev. (m)	Symbol	N	GR	SA	FI	LL	PI	MC	Description
0		SM	21	-	-	-	-	-	-	SILTY SAND, SM: Very firm; moist; dark yellowish-brown; about 60% fine to medium sand; about 40% low plasticity fines
(3.0')	0.91 m	SM	10	-	-	-	-	-	-	SILTY SAND, SM: Loose; moist; dark yellowish-brown; about 80% fine to medium sand; about 20% low plasticity fines. At 1.7 m (5.5'), as above except lenses of POORLY GRADED SAND, SP and SILTY SAND, SM present
			5							
(7.0')	2.13 m	SP	7	-	-	-	-	-	-	POORLY GRADED SAND, SP: Loose; moist; brown; about 95% fine to coarse, subangular to subrounded sand; about 5% fines
			6							
(11.0')	3.35 m	SP	5	0	98	2	-	NP	4	
(12.5')	3.81 m	SP	6	-	-	-	-	-	-	POORLY GRADED SAND, SP: Loose; moist; fine to medium, mostly medium with trace of coarse sand; nonplastic fines
(15.0')	4.57 m	SM	6	-	-	-	-	-	-	SILTY SAND, SM: Loose; moist; dark yellowish-brown; about 65% fine to medium sand; about 35% low plasticity fines
(18.0')	5.49 m	SM	TUBE #1	0	58	42	26	3	14	SILTY SAND, SM: Moist; brown; fine to medium, mostly fine sand; nonplastic to low plasticity fines; easy to push tube
(20.0')	6.10 m			-	-	-	-	-	-	
(21.5')	6.55 m	ML	5							
		ML	7	-	-	-	-	-	-	SILT, ML: Firm; moist; dark brown; about 95% low plasticity fines; about 5% fine sand
(28.5')	8.69 m	ML	6	-	-	-	-	-	-	SILT, ML: Firm; moist; brown; about 90% low plasticity fines; about 10% fine sand
(31.5')	9.60 m	CL	3	-	-	-	-	-	-	LEAN CLAY WITH SAND, CL: Soft; moist; dark brown; about 80% low to medium plasticity fines; about 20% fine sand; mud added to hole in anticipation of flowing sands
(35.0')	10.67 m	CL	8	-	-	-	-	-	-	SANDY LEAN CLAY, CL: Firm; moist; dark brown; about 70% low to medium plasticity fines; about 30% fine sand
(38.5')	11.73 m									

CONTINUED IN NEXT COLUMN

2F-97-23

CONTINUED FROM PREVIOUS COLUMN

DEPTH	Elev. (m)	Symbol	N	GR	SA	FI	LL	PI	MC	Description
(38.5')	11.73 m	SM	13	-	-	-	-	-	-	SILTY SAND, SM: Firm; moist; olive-brown; about 80% fine sand; about 20% low plasticity fines
▽(41.5')	12.65 m	SP-SM	12	0	88	12	-	NP	27	POORLY GRADED SAND WITH SILT, SP-SM: Firm; wet; olive-brown; fine to medium sand; nonplastic fines; water elevation varies
(43.0')	13.11 m			-	-	-	-	-	-	
(45.0')	13.72 m	SM	9	-	-	-	-	-	-	SILTY SAND, SM: Loose; wet; dark olive-brown; about 60% fine sand; about 40% low plasticity fines
(48.5')	14.78 m	SP-SM	16	0	88	12	-	NP	33	POORLY GRADED SAND WITH SILT, SP-SM: Firm; wet; very dark gray; fine to medium, mostly fine sand; nonplastic fines
(50.0')	15.24 m			-	-	-	-	-	-	
(51.5')	15.70 m	SM	12	-	-	-	-	-	-	SILTY SAND, SM: Firm; wet; very dark gray; about 85% fine to coarse, subangular to subrounded sand; about 15% low plasticity fines; traces of fine, subrounded gravel maximum particle size 13 mm (1/2"). At 16.3 m (53.5'), as above except gravels present; rough drilling
(55.0')	16.76 m	GRAVEL AND COBBLES	84*	84	12	4	-	NP	8	GRAVEL AND COBBLES with a matrix of POORLY GRADED GRAVEL, GP: Very dense; wet; very dark gray; fine to coarse, angular to subrounded gravel maximum particle size 51 mm (2"); fine to coarse, angular to subrounded sand; nonplastic fines; switched to 64 mm (2-1/2") I.D. sampler; rough drilling but good rate of advancement
(56.5')	17.22 m			-	-	-	-	-	-	
(60.0')	18.29 m	GRAVEL AND COBBLES	84*	-	-	-	-	-	-	GRAVEL AND COBBLES with a matrix of POORLY GRADED SAND, SP: Very dense; wet; very dark gray; about 95% fine to coarse, subangular to subrounded sand; about 5% fines; 64 mm (2-1/2") I.D. sampler; rough drilling. At 19.5 m (64.0'), as above except smooth drilling
(65.0')	19.81 m	GRAVEL AND COBBLES	24	23	66	11	-	NP	20	GRAVEL AND COBBLES with a matrix of POORLY GRADED SAND WITH SILT AND GRAVEL, SP-SM: Very firm; wet; olive; fine to coarse, mostly fine, angular to subrounded sand; fine, angular to subangular gravel maximum particle size 25 mm (1"); smooth drilling
(66.5')	20.27 m			-	-	-	-	-	-	
(70.0')	21.34 m	ML	A	0	17	83	-	9	34	SILT WITH SAND, ML: Hard; moist; light olive-brown; low plasticity fines; fine to medium, mostly fine sand
(71.5')	21.79 m			-	-	-	-	-	-	
(73.0')	22.25 m	ML		-	-	-	-	-	-	At 22.3 m (73.0'), attempted Shelby tube; rock in tube, no recovery. At 23.2 m (76.0'), smooth drilling
(78.5')	23.93 m	CL	45	-	-	-	-	-	-	SANDY LEAN CLAY, CL: Hard; moist; olive-brown; about 70% low to medium plasticity fines; about 30% fine to coarse, mostly fine to medium, subangular to subrounded sand
(80.0')	24.38 m									B.O.H.

NOTES:

1. THE LEGENDS AND NOTES ARE SHOWN ON SHEET B-1.

GRAPHIC SCALE

SCALE 1 : 25 0 0.5 1 1.5 2 2.5 METERS

REGISTERED PROFESSIONAL ENGINEER SAID SALAH-MARS No. C 050445 Exp. 06/30/01 CIVIL STATE OF CALIFORNIA

US Army Corps of Engineers Sacramento District

Designed by: R. IWASA (USACE) | Date: 18 JAN. 2000 | Rev.
Dwn by: RA/AK | Ckd by: U. LUSCHER | Design file no. 1-04-477
Reviewed by: S. PUNYAMURTHULA | SPEC. No. 1140
Submitted by: Chief, Civil Design Section A | File name: AR820-02.DWG | Plot date: 14 JAN. 2000 | Plot scale: 1:1

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

URS Greiner Woodward Clyde OAKLAND, CALIFORNIA

SAID SALAH-MARS

AMERICAN RIVER CALIFORNIA
AMERICAN RIVER WATERSHED PROJECT (COMMON FEATURES), CALIFORNIA
LEFT (SOUTH) BANK LEVEE STRENGTHENING CONTRACT 2

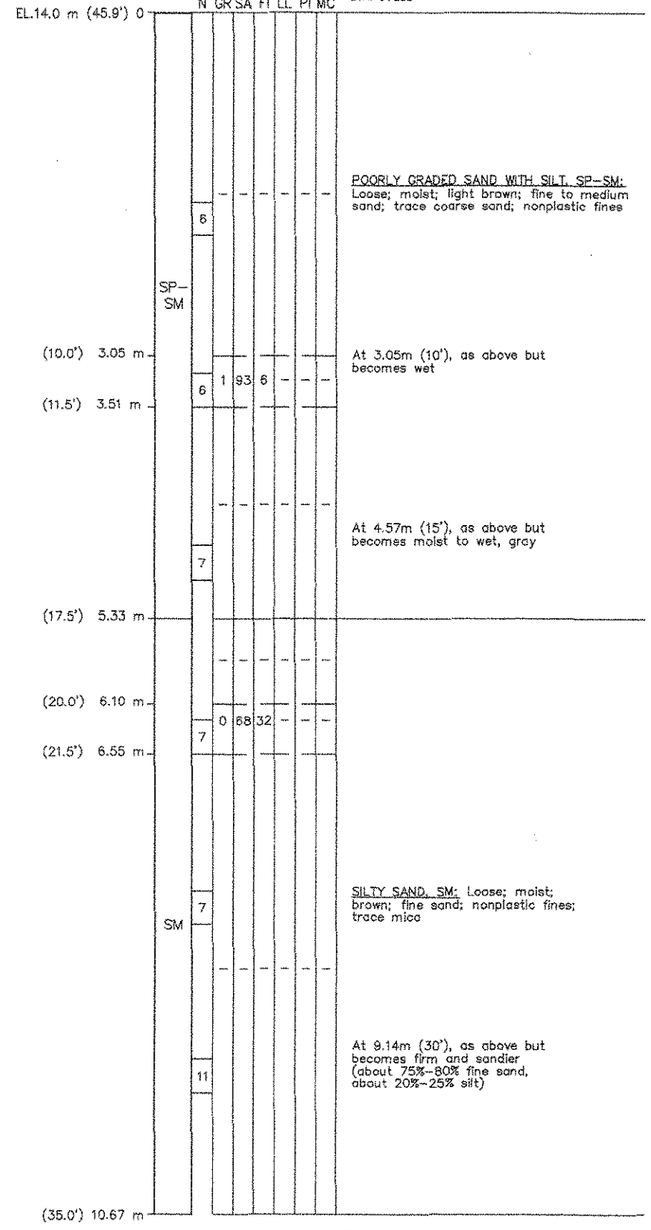
LOG OF EXPLORATION 2F-97-23

Sheet reference number: B-20

SEQ. 75

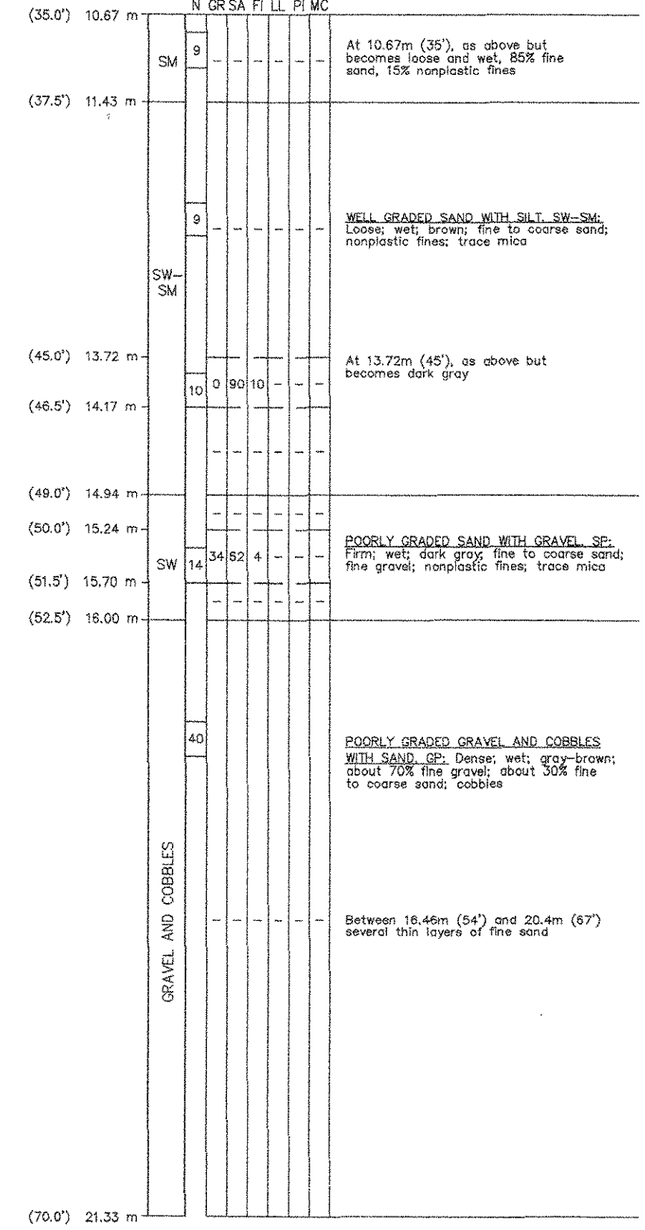
2F-99-17

STA. 6+899



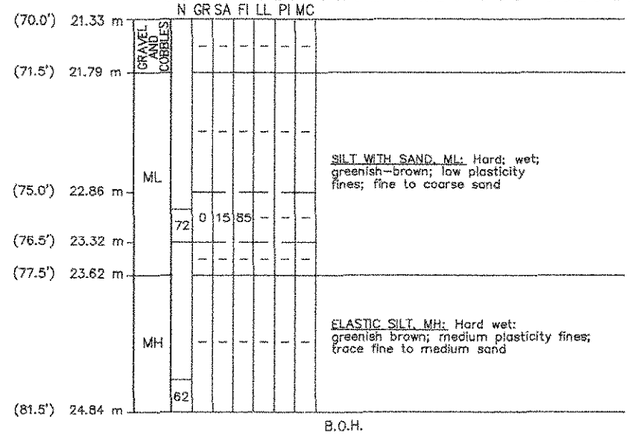
2F-99-17

CONTINUED FROM PREVIOUS COLUMN



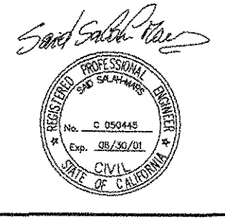
2F-99-17

CONTINUED FROM PREVIOUS COLUMN



NOTES:

1. SAMPLERS USED TO RECOVER SOIL SAMPLES IN THE FIELD GENERALLY CONSISTED OF STANDARD PENETRATION AND MODIFIED CALIFORNIA TEST SAMPLERS RAGING FROM 35mm (1 3/8-INCH) TO 64 mm (2 1/2-INCH) INSIDE DIAMETER. THEREFORE, PARTICLES LARGER THAN THE INSIDE DIAMETER OF SAMPLER WERE NOT RECOVERED. HENCE, ALL GRAVEL AND COBBLE LAYERS REFERENCED IN SOIL BORINGS CONTAINED LARGER PARTICLES OF GRAVEL, COBBLES, AND OCCASIONAL BOULDERS THAT ARE NOT REFLECTED IN THE LABORATORY GRADATION TEST RESULTS SHOWN IN THE SOIL BORING LOGS.
2. THE LEGENDS AND NOTES ARE SHOWN ON SHEET B-1.
3. DRILLING METHOD DID NOT ALLOW OBSERVATION OF DEPTH TO GROUNDWATER TABLE.



GRAPHIC SCALE

SCALE 1 : 25 (0, 0.5, 1, 1.5, 2, 2.5 METERS)

US Army Corps of Engineers
Sacramento District

Symbol	Description	Date	Approved	Symbol	Description	Date	Approved

Designed by: S. PARTHASARTHULA
Drawn by: M. IBRAHIM / L. LUESCHER
Checked by: S. PARTHASARTHULA
Submitted by: Chief, Civil Design section A
Date: 19 JAN. 2000
Design file no: 1-04-477
SPEC. No: 1140
File name: ARB3B902.DWG
Plot date: 14 JAN. 2000
Plot scale: 1 : 1
Rev.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

URS Greiner Woodward Clyde
OAKLAND, CALIFORNIA

SAID SALAH-MARS

AMERICAN RIVER
AMERICAN RIVER WATERSHED PROJECT
(COMMON FEATURES), CALIFORNIA
LEFT (SOUTH) BANK LEVEE STRENGTHENING
CONTRACT 2

LOG OF EXPLORATION
2F-99-17

Sheet reference number:
B-39
SEQ. 94

I:\CIVIL\BOB\SHARED\ARMYPAN\CONTRACT2\DGN\MISC\ARB3B902.DWG 11-FEB-L-75HP.pcp

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION DATUM	TOTAL DEPTH OF BORING
6/3/08	6/3/08	48.07 ft	NAVD 88	70.0 ft

DRILLING CONTRACTOR	DRILLER'S NAME	HELPER'S NAME	TOTAL DEPTH OF FILL
Gregg Drilling & Testing, Inc.	E. Santellan	R. Ryon/M. Ageev	13.2 ft

DRILLING METHOD	DRILL RIG MAKE AND MODEL	CONSULTANT COMPANY
0 - 3 ft: HA, 3 - 16.5 ft: HSA, 16.5 - 70 ft: Rotary Wash	MARL M-10 (Gregg Rig No. D-44)	GEI Consultants, Inc.

DRILL BIT SIZE AND TYPE (HOLE DIAMETER)	DRILLING ROD TYPE AND DIAMETER	FIELD LOGGER
5-inch drag bit; tricone drill through bit	6" HSA, 94mm	M. Horse

	CASING TYPE, DIAMETER, INSTALLATION DEPTH	FIELD LOG REVIEWER
☒ VERTICAL ☐ INCLINED	Surface, 6-in., 15 ft	G. Bradner

SAMPLER TYPE(S)	HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP	HAMMER EFFICIENCY
Bag, DCore(2.5"), MCal(2"), PCore(2.5"), SPT(1.375")	Marl, automatic, 140 lbs / 30-inch drop	83%

BOREHOLE BACKFILL OR COMPLETION	GROUNDWATER READING: DURING DRILLING	AFTER DRILLING (DATE-TIME)
5% bentonite grout	N/A due to rotary wash drilling method	

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	0		Gravel Road Base.												
	1		[LEVEE FILL] FAT CLAY (CH); very stiff; greenish black (5G 2.5/1); moist; 95% high plasticity, high dry strength, high toughness fines; 5% sand; 0% gravel.		1				3.0P						S01A_001_002B
	2				2										No Recovery; cobble removed
45	3		1-foot thick Fat Clay with Sand (CH) lense; 5% gravel, max. 1/2 in.; 10% fine to medium sand; 85% high plasticity fines.		3	100									S03B_003_004P S03A_004_005P
	4		[LEVEE FILL] SILTY CLAYEY SAND (SC-SM); dense; dark brown (7.5YR 3/4); moist; 75% fine to medium sand; 25% low plasticity fines; 0% gravel.												
	5				4	44	12 16 13 [29]	40					25	HD	S04A_005_007S
	6														
	7		[LEVEE FILL] Poorly Graded SAND with Silt (SP-SM); medium dense; olive brown (2.5Y 4/4); dry; 91% fine to medium sand; 9% fines; 0% gravel.		5	71				3			9		S05A_007_008P
40	8														
	9				6	0	9 9 10 [19]	26							No Recovery; soft material
	10		As above except moist.												S07A_011_011P Driller notes very soft material
	11														
	12				7	40									Driller notes very easy drilling
FILL 13.35	13		[Approximate bottom of Levee Fill 13.2'].												
	14														
	15		SANDY SILT (ML); loose; dark yellowish brown (10YR 3/6); moist; 50% fine sand; 50% low plasticity fines; 0% gravel.												
	16				8	50	3 3 4 [7]	10					50	HD	S08A_016_016S
	17														
30	18				9	0									No Recovery Very soft material; easy drilling
	19														
	20														

Draft 4 After Final Markups 11/5/2009

DWR LEVEE U/NU SOIL LOG REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/5/09

Borehole Location: South Bank Crest **County:** Sacramento
Coordinates: Northing: 1,976,188.21 **Easting:** 6,719,198.27
Latitude: 38.58732 **Longitude:** -121.44887
Levee Station or Milepost: 1200+59 **Levee Mile:** 3.79
Levee Segment
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: American River

LOG OF BORING
WCSBAR_003B
Sheet 1 of 4

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	LABORATORY DATA: Other Lab Tests	REMARKS
	20		SANDY SILT (ML); as above except medium dense.		10	0	5 6 6 [12]	17							No Recovery Rock stuck in hole
	21														
	22		SANDY SILT (ML); medium dense; very dark brown (7.5YR 2.5/3); moist; 65% low plasticity fines; 35% fine to medium sand; 0% gravel.		11	0	7 8 11 [19]								No Recovery Sandy Silt observed in cuttings
25	23				12	0	5 4 7 [11]	15							No Recovery Driller notes rock still present in hole
	24														
	25		Poorly Graded SAND with Silt (SP-SM); medium dense; dark brown (7.5YR 3/4); moist; 91% fine to medium sand; 9% low plasticity fines; 0% gravel; predominantly fine sand.		13	100									S13A_025_025P 2.25-inch cobble fragment on top of sample
	26				14	100	7 10 10 [20]						9		S14A_025_027M
	27				15	44	5 5 9 [14]	19		11				SG	S15A_027_028S
20	28														
	29				16	42									S16A_028_029P
	30		SILTY CLAYEY SAND (SC-SM); medium dense; dark brown (7.5YR 3/4); moist; 77% fine sand; 23% low plasticity fines; 0% gravel.		17	56	7 5 11 [16]	22					23	HD	S17A_030_032S
	31														
	32				18	50									S18A_032_033P
15	33														
	34														
	35		SILTY SAND (SM); dense; dark yellowish brown (10YR 3/6); moist; 80% fine to medium sand; 20% fines; 0% gravel.		19	56	9 12 13 [25]	35		12			20		S19A_035_037S
	36														
	37				20	79									Box 1 Representative S20A_038_038P
10	38														
	39														
	40		As above except medium dense.		21	61	9 11 11 [22]	30							S21A_040_042P
	41														
	42		As above except very dark greenish gray (5G 3/1).		22	45									S22A_042_043P
5	43														
	44														
	45														

Draft 4 After Final Markups 11/5/2009

Borehole Location: South Bank Crest **County:** Sacramento
Coordinates: Northing: 1,976,188.21 **Easting:** 6,719,198.27
Latitude: 38.58732 **Longitude:** -121.44887
Levee Station or Milepost: 1200+59 **Levee Mile:** 3.79
Levee Segment
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: American River

LOG OF BORING
WCSBAR_003B
Sheet 2 of 4

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

DWR LEVEE U/NU SOIL LOG REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/5/09

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	LABORATORY DATA: Liquid Limit	LABORATORY DATA: Plasticity Index	LABORATORY DATA: Fines, % < #200	LABORATORY DATA: Other Lab Tests	REMARKS
	45		SILTY SAND (SM); as above.		23	67	7 8 8 [16]	22							S23A_045_047S
	46														
	47														S24B_047_047P S24A_048_048P
0	48		Well-Graded GRAVEL (GW); dense; dark olive gray (5Y 3/2); moist; 85% fine to coarse, subrounded gravel, max. 2 1/4 in.; 10% fine to medium sand; 5% fines.		24	36									Driller notes change; rig chatter
	49														
	50		3-inch thick Poorly Graded Sand (SP) lense; 96% fine to medium sand; 4% fines.		25	50	10 11 13 [24]	33		20			4		S25B_050_051S S25A_051_052S
	51														
	52				26	0									No Recovery Rig chatter and shaking
-5	53														
	54														
	55		3-inch thick Poorly Graded Sand (SP) lense; 95% fine to medium sand; 5% fines.		27	39	32 40 30 [70]	97							S27B_055_056S S27A_056_057S
	56		As above except very dense.												
	57				28	0									No Recovery Rig chatter; gravel and cobble fragments present in slough
-10	58														
	59														
	60		Well-Graded GRAVEL with Sand (GW); very dense; dark olive gray (5Y 3/2); moist; 70% fine to coarse, subrounded gravel; 25% fine to medium sand; 5% fines.		29	67	50/6"								S29A_060_061S
	61				30	0									No Recovery Rig chatter and shaking; driller notes gravels/cobbles
-15	62														
	63														Use tricone bit; rig chatter and shaking; driller notes cobbles
	64														
	65		Gravel and cobble fragments, max. 1 1/2 in., present in slough.		31	0	50/3"								No Recovery
	66														
	67														Driller notes gravels/cobbles
-20	68														
	69														
	70														

Draft 4 After Final Markups 11/5/2009

Borehole Location: South Bank Crest **County:** Sacramento
Coordinates: Northing: 1,976,188.21 **Easting:** 6,719,198.27
Latitude: 38.58732 **Longitude:** -121.44887
Levee Station or Milepost: 1200+59 **Levee Mile:** 3.79
Levee Segment
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: American River

LOG OF BORING
WCSBAR_003B
Sheet 3 of 4

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

DWR LEVEE U/NU SOIL LOG REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/5/09

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, % / Liquid Limit / Plasticity Index / Fines, % < #200 / Other Lab Tests	REMARKS
	70										Refusal due to gravel/cobbles
	71		Borehole terminated at 70 feet. Backfilled with 5% bentonite grout.								
	72										
-25	73										
	74										
	75										
	76										
	77										
-30	78										
	79										
	80										
	81										
	82										
-35	83										
	84										
	85										
	86										
	87										
-40	88										
	89										
	90										
	91										
	92										
-45	93										
	94										
	95										

Draft 4 After Final Markups 11/5/2009

Borehole Location: South Bank Crest **County:** Sacramento
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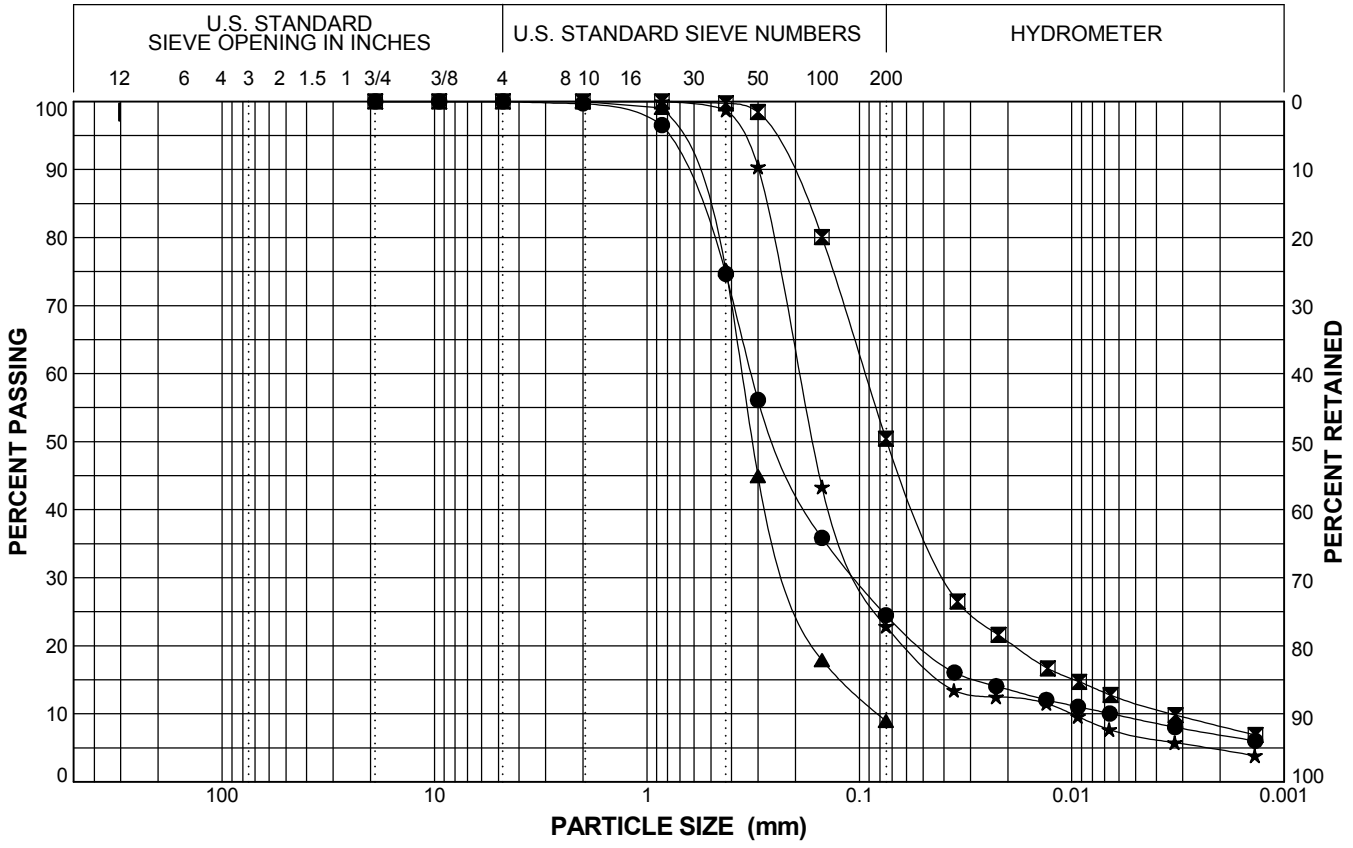
LOG OF BORING
WCSBAR_003B
Sheet 4 of 4

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

DWR LEVEE U/NU SOIL LOG REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/5/09

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	



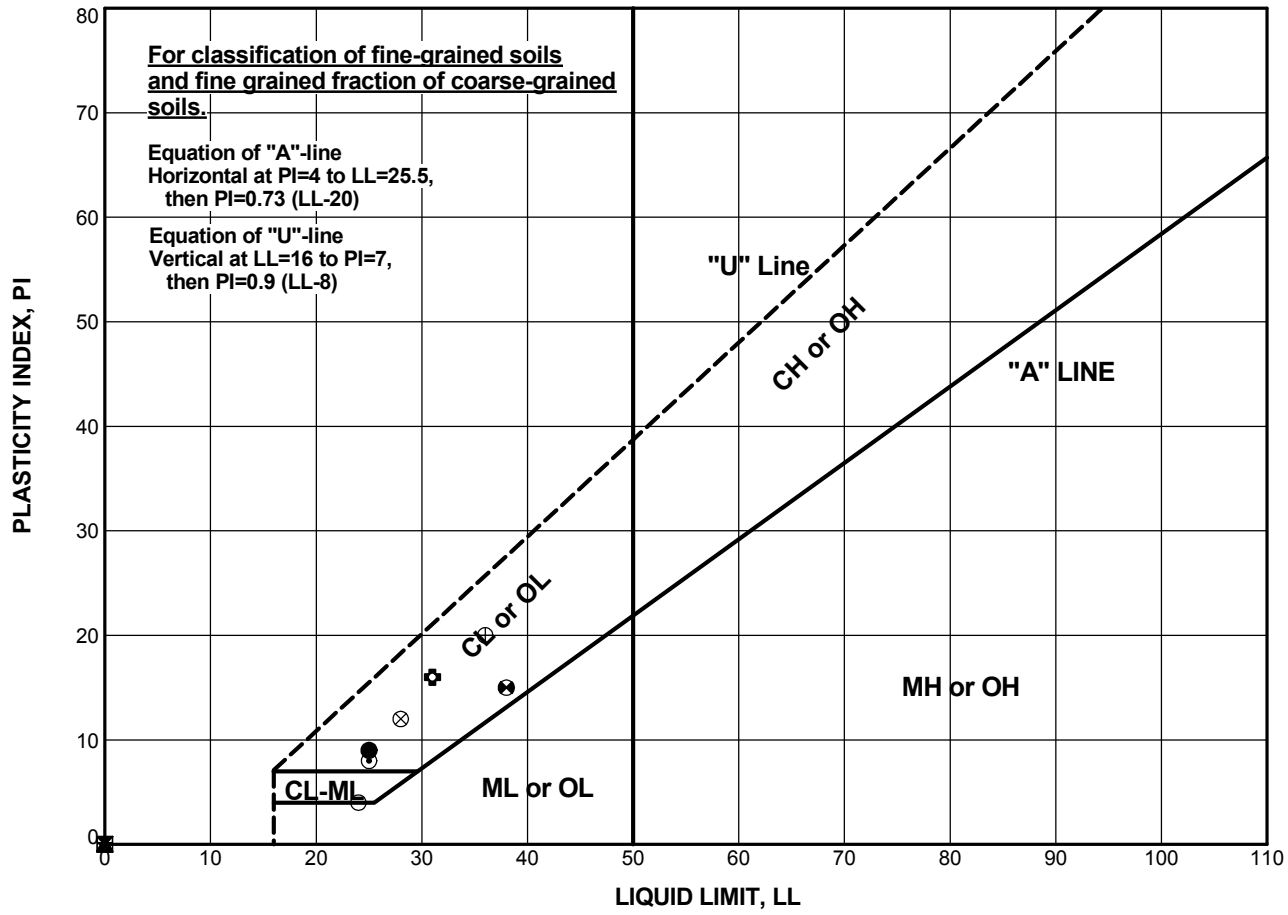
Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
WCSBAR_003B	S04A_005_007S	5	●	0.0	75.5	24.5	SILTY CLAYEY SAND (SC-SM)
WCSBAR_003B	S08A_016_016S	15	⊠	0.0	49.6	50.4	SANDY SILT (ML)
WCSBAR_003B	S14A_025_027M	25	▲	0.0	91.0	9.0	Poorly Graded SAND with Silt (SP-SM)
WCSBAR_003B	S17A_030_032S	30	★	0.0	77.1	22.9	SILTY CLAYEY SAND (SC-SM)

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

American River

PARTICLE SIZE DISTRIBUTION CURVES

DWR LEVEE U/NU SIEVE CURVES #200 REV1; AMERICAN RIVER LEVEE BORINGS 11-5-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 2/3/10



Boring Number	Sample Number	Depth (feet)	Test Symbol	WC (%)	LL	PL	PI	Classification
WCNBAR_001B	S06A_015_017S	15	●	13.7	25	16	9	CLAYEY SAND (SC)
WCNBAR_002B	S04A_005_007S	5	⧓	17.5	NP	NP	NP	SANDY SILT (ML)
WCNBAR_002B	S08A_015_017S	15	▲		NP	NP	NP	SILTY SAND (SM)
WCNBAR_003B	S04A_005_007S	5	★	15.6	NP	NP	NP	SANDY SILT (ML)
WCNBAR_003B	S29A_070_072S	70	⊙	18.5	25	17	8	LEAN CLAY (CL)
WCNBAR_004B	S02A_002_003B	2	✿	15.9	31	15	16	LEAN CLAY (CL)
WCNBAR_004B	S08A_014_014P	13.5	○	17.6	24	20	4	SANDY SILTY CLAY (CL-ML)
WCNBAR_005B	S08A_010_012S	10	△	10.4	NP	NP	NP	SILTY SAND (SM)
WCNBAR_005B	S16A_036_036S	35	⊗	17.8	28	16	12	LEAN CLAY with Sand (CL)
WCNBAR_005B	S18A_041_042S	40	⊕	16.3	36	16	20	LEAN CLAY with Sand (CL)
WCNBAR_005B	S22A_050_052S	50	□	17.7	NP	NP	NP	SILTY SAND (SM)
WCSBAR_001B	S02A_002_003B	2	⊠	16.8	38	23	15	LEAN CLAY with Sand (CL)

Urban Levee Geotechnical Evaluations Program
Engineering Support Services

American River

PLASTICITY CHART

DWR LEVEE U/NU ATT. PLOT (U LINE) REV1; AMERICAN RIVER LEVEE BORINGS 11-3-2009.GPJ; DWR WORKING LIBRARY 092009.GLB; 11/3/09

Vector Engineering Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448

LABORATORY SERVICES

WATER CONTENT & MINUS # 200 % with GRAVEL

Client : GEI Consultants

Project No: 061724.0026

Lab Log: **2565**

Project Name: URS/DWR Urban Levee Program-American River TO-44 WO-26

Report Date: July 9, 2008

LSN	Sample ID	Soil Classification **	Water Content (%)	Percent Minus #200	Percent Sand	Percent Gravel
2565BC	WCSBAR_002B_50_S23A_050_052S	Brown Sand w/ Silt (SM)*	20.1	10.2	89.8	0.0
2565BE	WCSBAR_003B_7_S05A_007_008P	Brown Sand w/ Silt (SM)*	3.3	9.5	90.5	0.0
2565BJ	WCSBAR_003B_35_S19A_035_037S	Brown Sand w/ Silt (SM)*	12.3	19.9	80.1	0.0
2565BK	WCSBAR_003B_50_S25B_050_051S	Brown Sand w/ Silt (SM)*	20.2	4.0	96.0	0.0
2565BV	WCSBAR_005B_14_S07A_014_015P	Dark Brown Sandy Silt (ML)	22.9	50.6	49.4	0.0

Notes: ** Classifications are based on ASTM D-2487 when appropriate test results are available and per ASTM D-2488 when visual

These results apply only to the above listed samples. The data and information are proprietary and can not be released without authorization of Vector Engineering Inc. By accepting the data and results represented on this page, Client agrees to limit the liability of Vector Engineering, Inc. from Client and all other parties claims arising out of the use of this data to the cost for the respective test(s) represented here, and Client agrees to indemnify and hold harmless Vector from and against all liability in excess of the aforementioned limit.

Entered By: SK

Rev. By:

Lab Log: **2565**

ARS REACH F – SACRAMENTO RIVER EAST – U1 LM 5.92

STRATIGRAPHY INPUT

BORING LOGS

LABORATORY TESTING

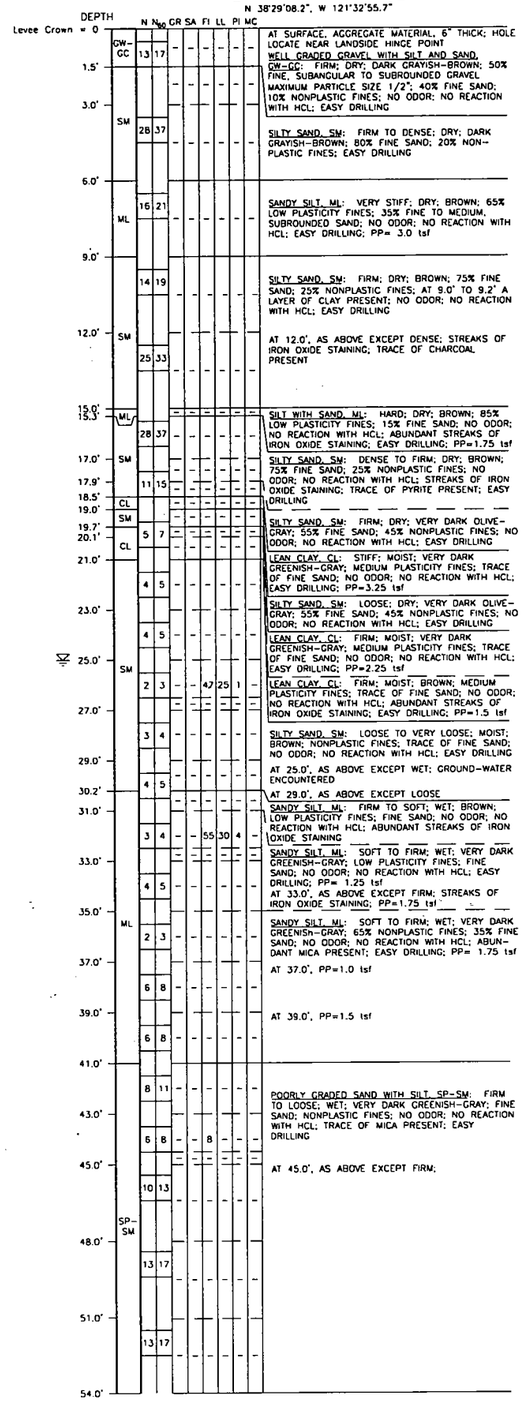
AMERICAN RIVER WATERSHED - COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT - GEOTECHNICAL ANALYSIS
SACRAMENTO RIVER SOUTH RF2 U9 LM 5.92
Table F-2-14: Permeability and Strength Selection for Analysis

Boring Number	Top of Boring Elevation (ft, NAVD 88)	Layer ID	Soil Description	USCS Soil Classification	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Elevation of Top of Layer (ft, NAVD 88)	Elevation of Bottom of Layer (ft, NAVD 88)	Layer Thickness (ft)	Average Depth to Groundwater During Drilling	Laboratory and Field Data										Comments
											Average % Fines	Average Field N (blows/ft)	Average N_{60} (blows/ft)[1]	Average Normalized Blow Count, $N_{1,60}$ (blows/ft)[2]	Torvane (tsf)	Pocket Penetrometer (tsf)	Average Unit Weight (pcf)	PI	LL	LI	
2F-05-G4-2, 2F-05-G4-2A	34.00	1	Silty Sand (SM) with Silty (ML) and Poorly Graded	SM	0.00	16.00	34.00	18.00	16.00			16	25								
		2	Silt Blanket (ML)	ML	16.00	21.50	18.00	12.50	5.50		57	6	7								
		3	Silty Sand (SM)	SM	14.49	28.69	12.50	4.80	7.70		44										
		4	Silt (ML) and Lean Clay (CL)	ML	21.50	40.00	4.80	-6.00	10.80		9	19	22								
		5	Silty Sand (SM), Poorly Graded Sand (SP)	SM	40.00	98.00	-6.00	-64.00	58.00		10	57	59								
		6	Poorly Graded Gravel (GP) Poorly Graded	GP	98.00	133.98	-64.00	-99.98	35.98		4	25									
		7	Lean Clay with Silt (CL w/ ML)	CL	133.98	143.00	-99.98	-109.00	9.02												
		8	Impervious Clay Cap (CL)	CL																	
		9	Cutoff Wall	SB WALL																	
					Total Depth (ft.)	**143.00**															

Layer ID	Recommended Hydraulic Conductivity					Strenth Coorelations							Strength from Lab Test Data						Recommended Strength Parameters			Comments
	Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Total Overburden Pressure at Mid Layer During Drilling (psf)	Effective Overburden Stress at Mid Layer During Drilling (psf)	OCR from N_{60}[3]	OCR from LI[3]	Su from N (psf)[4]	Su/σ'_o from PI (psf)[4]	Calculated Maximum Past Pressure (psf)[5]	Drained Friction Angle[7]	OCR	σ'_p (psf)	Su (psf)	Su/σ'_o	Φ'	C' (psf)	Φ'	C' (psf)	γ (pcf)	
1	1.00E-02	4.00	2.50E-03	28.350	7.088	0	-499													34	0	125	Sensitivity run w/ phi= 34. Matching URS Sac River P1GER. Original run at phi=
2	2.00E-04	4.00	5.00E-05	0.567	0.142	0	-1170													28	0	120	Sensitivity run w/ phi= 28. Matching URS Sac River P1GER. Original run at
3	5.00E-04	4.00	1.25E-04	1.418	0.354	0	-1144													30	0	125	
4	2.00E-04	4.00	5.00E-05	0.567	0.142	0	-1679													30	50	120	
5	5.00E-03	4.00	1.25E-03	14.175	3.544	0	-4306													30	0	125	
6	2.50E-02	10.00	2.50E-03	70.875	7.088	0	-7238													35	0	135	

2 F - 05 - G 4 - 2

N 38°29'08.2", W 121°32'55.7"



AT SURFACE, AGGREGATE MATERIAL, 6" THICK; HOLE LOCATE NEAR LANDSIDE HINGE POINT

WELL GRADED GRAVEL WITH SILT AND SAND, GW-GC: FIRM; DRY; DARK GRAYISH-BROWN; 50% FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1/2"; 40% FINE SAND; 10% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; EASY DRILLING

SILTY SAND, SM: FIRM TO DENSE; DRY; DARK GRAYISH-BROWN; 80% FINE SAND; 20% NON-PLASTIC FINES; EASY DRILLING

SANDY SILT, ML: VERY STIFF; DRY; BROWN; 65% LOW PLASTICITY FINES; 35% FINE TO MEDIUM, SUBROUNDED SAND; NO ODOR; NO REACTION WITH HCL; EASY DRILLING; PP= 3.0 tsf

SILTY SAND, SM: FIRM; DRY; BROWN; 75% FINE SAND; 25% NONPLASTIC FINES; AT 9.0' TO 9.2' A LAYER OF CLAY PRESENT; NO ODOR; NO REACTION WITH HCL; EASY DRILLING

AT 12.0', AS ABOVE EXCEPT DENSE; STREAKS OF IRON OXIDE STAINING; TRACE OF CHARCOAL PRESENT

SILT WITH SAND, ML: HARD; DRY; BROWN; 85% LOW PLASTICITY FINES; 15% FINE SAND; NO ODOR; NO REACTION WITH HCL; ABUNDANT STREAKS OF IRON OXIDE STAINING; EASY DRILLING; PP=1.75 tsf

SILTY SAND, SM: DENSE TO FIRM; DRY; BROWN; 75% FINE SAND; 25% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; STREAKS OF IRON OXIDE STAINING; TRACE OF PYRITE PRESENT; EASY DRILLING

SILTY SAND, SM: FIRM; DRY; VERY DARK OLIVE-GRAY; 55% FINE SAND; 45% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; EASY DRILLING

LEAN CLAY, CL: STIFF; MOIST; VERY DARK GREENISH-GRAY; MEDIUM PLASTICITY FINES; TRACE OF FINE SAND; NO ODOR; NO REACTION WITH HCL; EASY DRILLING; PP=3.25 tsf

SILTY SAND, SM: LOOSE; DRY; VERY DARK OLIVE-GRAY; 55% FINE SAND; 45% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; EASY DRILLING

LEAN CLAY, CL: FIRM; MOIST; VERY DARK GREENISH-GRAY; MEDIUM PLASTICITY FINES; TRACE OF FINE SAND; NO ODOR; NO REACTION WITH HCL; EASY DRILLING; PP=2.25 tsf

LEAN CLAY, CL: FIRM; MOIST; BROWN; MEDIUM PLASTICITY FINES; TRACE OF FINE SAND; NO ODOR; NO REACTION WITH HCL; ABUNDANT STREAKS OF IRON OXIDE STAINING; EASY DRILLING; PP=1.5 tsf

SILTY SAND, SM: LOOSE TO VERY LOOSE; MOIST; BROWN; NONPLASTIC FINES; TRACE OF FINE SAND; NO ODOR; NO REACTION WITH HCL; EASY DRILLING

AT 25.0', AS ABOVE EXCEPT WET; GROUND-WATER ENCOUNTERED

AT 29.0', AS ABOVE EXCEPT LOOSE

SANDY SILT, ML: FIRM TO SOFT; WET; BROWN; LOW PLASTICITY FINES; FINE SAND; NO ODOR; NO REACTION WITH HCL; ABUNDANT STREAKS OF IRON OXIDE STAINING

SANDY SILT, ML: SOFT TO FIRM; WET; VERY DARK GREENISH-GRAY; LOW PLASTICITY FINES; FINE SAND; NO ODOR; NO REACTION WITH HCL; EASY DRILLING; PP= 1.25 tsf

AT 33.0', AS ABOVE EXCEPT FIRM; STREAKS OF IRON OXIDE STAINING; PP=1.75 tsf

SANDY SILT, ML: SOFT TO FIRM; WET; VERY DARK GREENISH-GRAY; 65% NONPLASTIC FINES; 35% FINE SAND; NO ODOR; NO REACTION WITH HCL; ABUNDANT MICA PRESENT; EASY DRILLING; PP= 1.75 tsf

AT 37.0', PP=1.0 tsf

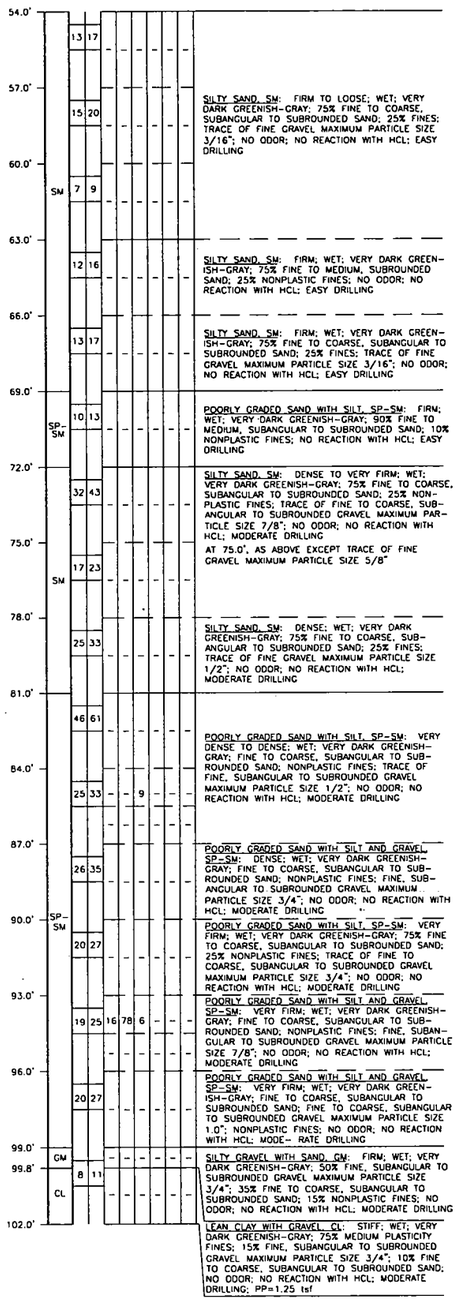
AT 39.0', PP=1.5 tsf

POORLY GRADED SAND WITH SILT, SP-SM: FIRM TO LOOSE; WET; VERY DARK GREENISH-GRAY; FINE SAND; NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; TRACE OF MICA PRESENT; EASY DRILLING

AT 45.0', AS ABOVE EXCEPT FIRM;

2 F - 05 - G 4 - 2

(CONTINUED FROM PREVIOUS COLUMN)



SILTY SAND, SM: FIRM TO LOOSE; WET; VERY DARK GREENISH-GRAY; 75% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; 25% FINES; TRACE OF FINE GRAVEL MAXIMUM PARTICLE SIZE 3/16"; NO ODOR; NO REACTION WITH HCL; EASY DRILLING

SILTY SAND, SM: FIRM; WET; VERY DARK GREENISH-GRAY; 75% FINE TO MEDIUM, SUBROUNDED SAND; 25% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; EASY DRILLING

SILTY SAND, SM: FIRM; WET; VERY DARK GREENISH-GRAY; 75% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; 25% FINES; TRACE OF FINE GRAVEL MAXIMUM PARTICLE SIZE 3/16"; NO ODOR; NO REACTION WITH HCL; EASY DRILLING

POORLY GRADED SAND WITH SILT, SP-SM: FIRM; WET; VERY DARK GREENISH-GRAY; 90% FINE TO MEDIUM, SUBANGULAR TO SUBROUNDED SAND; 10% NONPLASTIC FINES; NO REACTION WITH HCL; EASY DRILLING

SILTY SAND, SM: DENSE TO VERY FIRM; WET; VERY DARK GREENISH-GRAY; 75% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; 25% NONPLASTIC FINES; TRACE OF FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 7/8"; NO ODOR; NO REACTION WITH HCL; MODERATE DRILLING

AT 75.0', AS ABOVE EXCEPT TRACE OF FINE GRAVEL MAXIMUM PARTICLE SIZE 5/8"

SILTY SAND, SM: DENSE; WET; VERY DARK GREENISH-GRAY; 75% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; 25% FINES; TRACE OF FINE GRAVEL MAXIMUM PARTICLE SIZE 1/2"; NO ODOR; NO REACTION WITH HCL; MODERATE DRILLING

POORLY GRADED SAND WITH SILT, SP-SM: VERY DENSE TO DENSE; WET; VERY DARK GREENISH-GRAY; FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; NONPLASTIC FINES; TRACE OF FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1/2"; NO ODOR; NO REACTION WITH HCL; MODERATE DRILLING

POORLY GRADED SAND WITH SILT AND GRAVEL, SP-SM: DENSE; WET; VERY DARK GREENISH-GRAY; FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; NONPLASTIC FINES; FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 3/4"; NO ODOR; NO REACTION WITH HCL; MODERATE DRILLING

POORLY GRADED SAND WITH SILT, SP-SM: VERY FIRM; WET; VERY DARK GREENISH-GRAY; FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; 25% NONPLASTIC FINES; TRACE OF FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 3/4"; NO ODOR; NO REACTION WITH HCL; MODERATE DRILLING

POORLY GRADED SAND WITH SILT AND GRAVEL, SP-SM: VERY FIRM; WET; VERY DARK GREENISH-GRAY; FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; NONPLASTIC FINES; FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 7/8"; NO ODOR; NO REACTION WITH HCL; MODERATE DRILLING

POORLY GRADED SAND WITH SILT AND GRAVEL, SP-SM: VERY FIRM; WET; VERY DARK GREENISH-GRAY; FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1.0"; NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; MODE- RATE DRILLING

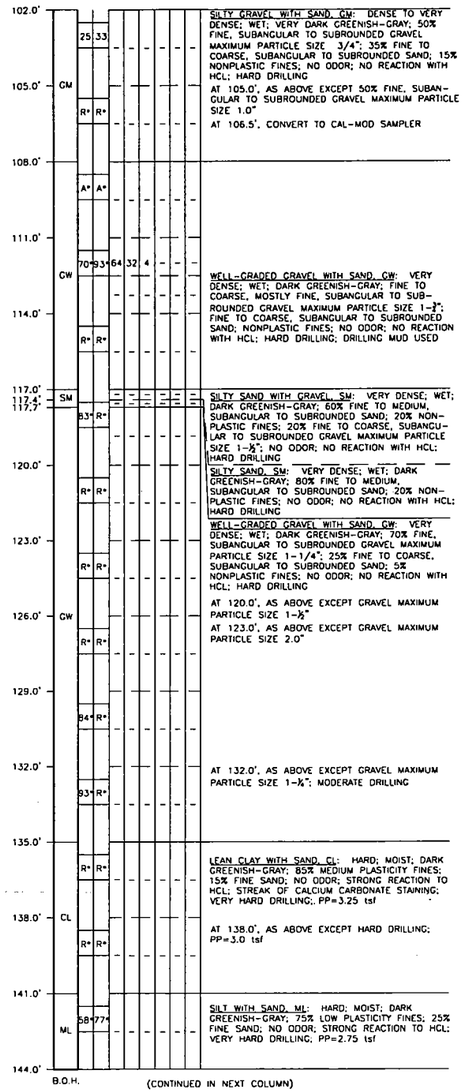
SILTY GRAVEL WITH SAND, GM: FIRM; WET; VERY DARK GREENISH-GRAY; 50% FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 3/4"; 35% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; 15% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; MODERATE DRILLING

LEAN CLAY WITH GRAVEL, CL: STIFF; WET; VERY DARK GREENISH-GRAY; 75% MEDIUM PLASTICITY FINES; 15% FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 3/4"; 10% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; NO ODOR; NO REACTION WITH HCL; MODERATE DRILLING; PP=1.25 tsf

(CONTINUED IN NEXT COLUMN)

2 F - 05 - G 4 - 2

(CONTINUED FROM PREVIOUS COLUMN)



SILTY GRAVEL WITH SAND, GM: DENSE TO VERY DENSE; WET; VERY DARK GREENISH-GRAY; 50% FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 3/4"; 35% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; 15% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; HARD DRILLING

AT 105.0', AS ABOVE EXCEPT 50% FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1.0"

AT 106.5', CONVERT TO CAL-MOD SAMPLER

WELL-GRADED GRAVEL WITH SAND, GW: VERY DENSE; WET; DARK GREENISH-GRAY; FINE TO COARSE, MOSTLY FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-½"; FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; HARD DRILLING; DRILLING MUD USED

SILTY SAND WITH GRAVEL, SM: VERY DENSE; WET; DARK GREENISH-GRAY; 60% FINE TO MEDIUM, SUBANGULAR TO SUBROUNDED SAND; 20% NONPLASTIC FINES; 20% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-½"; NO ODOR; NO REACTION WITH HCL; HARD DRILLING

SILTY SAND, SM: VERY DENSE; WET; DARK GREENISH-GRAY; 80% FINE TO MEDIUM, SUBANGULAR TO SUBROUNDED SAND; 20% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; HARD DRILLING

WELL-GRADED GRAVEL WITH SAND, GW: VERY DENSE; WET; DARK GREENISH-GRAY; 70% FINE, SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-1/4"; 25% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND; 5% NONPLASTIC FINES; NO ODOR; NO REACTION WITH HCL; HARD DRILLING

AT 120.0', AS ABOVE EXCEPT GRAVEL MAXIMUM PARTICLE SIZE 1-½"

AT 123.0', AS ABOVE EXCEPT GRAVEL MAXIMUM PARTICLE SIZE 2.0"

AT 132.0', AS ABOVE EXCEPT GRAVEL MAXIMUM PARTICLE SIZE 1-¼"; MODERATE DRILLING

LEAN CLAY WITH SAND, CL: HARD; MOIST; DARK GREENISH-GRAY; 85% MEDIUM PLASTICITY FINES; 15% FINE SAND; NO ODOR; STRONG REACTION TO HCL; STREAK OF CALCIUM CARBONATE STAINING; VERY HARD DRILLING; PP=3.25 tsf

AT 138.0', AS ABOVE EXCEPT HARD DRILLING; PP=3.0 tsf

SILT WITH SAND, ML: HARD; MOIST; DARK GREENISH-GRAY; 75% LOW PLASTICITY FINES; 25% FINE SAND; NO ODOR; STRONG REACTION TO HCL; VERY HARD DRILLING; PP=2.75 tsf

(CONTINUED IN NEXT COLUMN)

N O T E S :

1. LEGEND AND NOTES ARE SHOWN ON SHEET B-1.
2. LOCATION OF EXPLORATIONS ARE SHOWN IN APPENDIX C.

VERTICAL SCALE: 1" = 3'

GRAPHIC SCALE

0 3 6 9 12 FEET

VERTICAL SCALE 1 : 3

US Army Corps of Engineers
Sacramento District

Date	Description	Drawn	Approved

Mapping Unit (S/S) No.: MAPPING_UNIT_(S/S)_NO.

Soil Design Section Sheet No.: X of X

Reference - Exploration Log file no.: XXX-01-XXX

Date: 24 Aug 2005 | Rev:
Design File no: | Spec No:
Drawing Code:
File name: 11
Plot date: 11 NOV 0
Plot scale: 1=1
Designed by: SCHNOROWE
Drawn by: PHAM
Reviewed by: EDWARDS
Submitted by: A/E Section Chief
Date Submitted:

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 "J" STREET
SACRAMENTO, CA 95814-2922

SACRAMENTO RIVER
AMERICAN RIVER WATERSHED PROJECT
(COMMON FEATURES), CALIFORNIA
POCKET AREA FEMA EVALUATION (LEFT BANK)
GEOTECHNICAL SITE 4
LOG OF EXPLORATIONS
G4 - 2

CALIFORNIA

Sheet reference number:
B-24
24 of 50

MAY 2005

Revised 08/30/04, 05/03/05 DMC

2F-05-G4-2A

N XX°XX'XX.X", WXXX°XX'XX.X", ±XX'

DEPTH		N	N_{60}	GR	SA	FI	LL	PI	MC	
Levee Toe = 0										
		11	14	-	-	-	-	-	-	SILT WITH SAND, ML: STIFF TO FIRM; DRY; VERY DARK GRAYISH-BROWN; NONPLASTIC FINES; FINE SAND; TRACE OF SUBANGULAR TO ANGULAR GRAVEL MAXIMUM PARTICLE SIZE 1/2"; TRACE OF IRON OXIDE STAINING; ORGANIC MATERIAL (ROOTS) PRESENT
2.0'	ML	5	7	-	-	-	-	-	-	AT 2.0', AS ABOVE EXCEPT DARK YELLOWISH-BROWN
4.0'		4	5	-	-	83	33	10	-	AT 4.0', AS ABOVE EXCEPT MOIST
6.0'										
		2	3	-	-	-	-	-	-	
8.0'	SM									SILTY SAND, SM: VERY LOOSE; WET; DARK YELLOWISH-BROWN; FINE SAND; NONPLASTIC FINES
		3	4	-	-	40	23	0	-	
10.0'										
	ML/CL	4	5	-	-	-	-	-	-	CLAYEY SILT, ML/CL: FIRM; WET; DARK YELLOWISH-BROWN; NONPLASTIC TO LOW PLASTICITY FINES
11.0'	CL/ML									SILTY CLAY, CL/ML: FIRM; WET; VERY DARK GRAY; LOW PLASTICITY TO NONPLASTIC, MOSTLY LOW PLASTICITY FINES
12.0'										
		2	3	-	-	53	27	4	-	
14.0'	ML									SANDY SILT, ML: SOFT; WET; DARK YELLOWISH-BROWN; NONPLASTIC FINES; FINE SAND
		3	4	-	-	-	-	-	-	
16.0'										
		2	3	-	-	-	-	-	-	
18.0'	CL/ML									SILTY CLAY, CL/ML: SOFT TO FIRM; WET; VERY DARK GRAY; LOW PLASTICITY TO NONPLASTIC FINES
		4	5	-	-	-	-	-	-	
20.0'										
	ML	4	5	-	-	-	-	-	-	SILT, ML: FIRM; WET; VERY DARK GRAY; NONPLASTIC FINES
22.0'										
		4	5	-	-	-	-	-	-	
24.0'										CLAYEY SILT, ML/CL: FIRM TO SOFT; WET; VERY DARK GRAY; NONPLASTIC TO LOW PLASTICITY FINES
	ML/CL	3	4	-	-	-	-	-	-	
26.0'										AT 26.0', AS ABOVE EXCEPT STIFF
		8	11	-	-	-	-	-	-	
28.0'	ML									SILT, ML: STIFF; WET; VERY DARK GRAY; NONPLASTIC FINES
28.8'		10	13	-	-	-	-	-	-	POORLY GRADED SAND WITH SILT, SP-SM: FIRM; WET; VERY DARK GRAY; 90% FINE TO MEDIUM SAND; 10% NONPLASTIC FINES
30.0'										
		13	17	-	-	-	-	-	-	
32.0'										POORLY GRADED SAND WITH SILT, SP-SM: FIRM TO VERY FIRM; WET; VERY DARK GRAY; FINE TO MEDIUM SAND; NONPLASTIC FINES
		15	20	-	-	-	-	-	-	
34.0'										AT 34.0', AS ABOVE EXCEPT FINE SAND
	SP-SM	16	21	-	-	6	-	-	-	
36.0'										AT 36.0', AS ABOVE EXCEPT FINE TO MEDIUM SAND; TRACE OF SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1/4"
		17	23	-	-	-	-	-	-	
38.0'										
		21	28	-	-	-	-	-	-	
40.0'										AT 40.0', AS ABOVE EXCEPT NO GRAVEL
		18	24	-	-	-	-	-	-	
42.0'										AT 42.2', AS ABOVE EXCEPT VERY LOOSE
42.2'	CL	3	4	-	-	-	-	-	-	LEAN CLAY, CL: SOFT; WET; VERY DARK GRAY; LOW PLASTICITY FINES
44.0'	SM									SILTY SAND, SM: FIRM; WET; VERY DARK GRAY; 80% FINE TO MEDIUM SAND; 20% NONPLASTIC FINES
44.6'		15	20	-	-	-	-	-	-	
	ML									SILT, ML: VERY STIFF; WET; VERY DARK GRAY; NONPLASTIC FINES
47.0'										
		36	48	-	-	-	-	-	-	
	SM									SILTY SAND, SM: DENSE; WET; VERY DARK GRAY; 60% FINE TO MEDIUM SAND; 40% NONPLASTIC FINES
50.0'										

(CONTINUED IN NEXT COLUMN)

2F-05-G4-2A

(CONTINUED FROM PREVIOUS COLUMN)

DEPTH		N	N_{60}	GR	SA	FI	LL	PI	MC	
50.0'										
		13	17	-	-	-	-	-	-	
53.0'										SILTY SAND, SM: FIRM TO LOOSE; WET; VERY DARK GRAY; 85% FINE SAND; 15% NONPLASTIC FINES; MICA PRESENT
		10	13	-	-	-	-	-	-	
56.0'										AT 56.0', AS ABOVE EXCEPT TRACE OF SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-¼", MOSTLY SMALLER THAN 1/4"
		7	9	-	-	-	-	-	-	
59.0'										AT 59.0', AS ABOVE EXCEPT FIRM; NO GRAVEL
		9	12	-	-	-	-	-	-	
62.0'										AT 56.0', AS ABOVE EXCEPT TRACE OF SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1.0"
		12	16	-	-	-	-	-	-	
65.0'	SM									AT 65.0', AS ABOVE EXCEPT NO GRAVEL
		11	14	-	-	18	-	-	-	
68.0'										AT 68.0', AS ABOVE EXCEPT DENSE; 4% OF SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-¼", MOSTLY SMALLER THAN 1/4"
		27	36	-	-	-	-	-	-	
71.0'										AT 71.0', AS ABOVE EXCEPT VERY FIRM TO DENSE; GRAVEL MAXIMUM PARTICLE SIZE 3/4", MOSTLY SMALLER THAN 1/4"
		21	28	-	-	-	-	-	-	
74.0'										
75.1'										SILTY SAND WITH GRAVEL, SM: DENSE; WET; VERY DARK GRAY; 70% FINE TO COARSE SAND; 15% NONPLASTIC FINES; 15% SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1.0"; MICA PRESENT
		23	31	-	-	-	-	-	-	
77.0'										SILTY SAND, SM: VERY FIRM; WET; VERY DARK GRAY; 60% FINE TO MEDIUM SAND; 40% NONPLASTIC FINES; TRACE OF GRAVEL MAXIMUM PARTICLE SIZE 3/4", MOSTLY SMALLER THAN 1/4"
78.2'		18	24	-	-	-	-	-	-	SILTY SAND WITH GRAVEL, SM: VERY FIRM; WET; VERY DARK GRAY; 70% FINE TO COARSE SAND; 15% NONPLASTIC FINES; 15% SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1.0"; MICA PRESENT
80.0'										
81.1'		22	29	-	-	-	-	-	-	SILTY SAND, SM: VERY FIRM; WET; VERY DARK GRAY; 60% FINE TO MEDIUM SAND; 40% NONPLASTIC FINES; TRACE OF GRAVEL MAXIMUM PARTICLE SIZE 3/4", MOSTLY SMALLER THAN 1/4"
83.0'										
83.4'	CL	35	47	-	-	-	-	-	-	SILTY SAND WITH GRAVEL, SM: VERY FIRM; WET; VERY DARK GRAY; 70% FINE TO COARSE SAND; 15% NONPLASTIC FINES; 15% SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1.0"; MICA PRESENT
84.0'	GP-GC									SILTY SAND, SM: DENSE; WET; VERY DARK GRAY; 60% FINE TO MEDIUM SAND; 40% NONPLASTIC FINES; TRACE OF GRAVEL MAXIMUM PARTICLE SIZE 1/4"
86.0'										LEAN CLAY, CL: HARD; WET; VERY DARK GREENISH-GRAY; LOW PLASTICITY TO NONPLASTIC; MOSTLY LOW PLASTICITY FINES
	SM	53	71	-	-	-	-	-	-	POORLY GRADED GRAVEL WITH CLAY AND SAND, GP-GC: DENSE; WET; VERY DARK GREENISH-GRAY; 75% SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-½"; 15% FINE TO COARSE SAND; 10% LOW PLASTICITY FINES
89.0'										SILTY SAND WITH GRAVEL, SM: VERY DENSE; WET; VERY DARK GRAY; 70% FINE TO COARSE SAND; 15% NONPLASTIC FINES; 15% SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-½", MICA PRESENT
	GP-GM	50	67	-	-	-	-	-	-	POORLY GRADED GRAVEL WITH SILT AND SAND, GP-GM: VERY DENSE; WET; VERY DARK GREENISH-GRAY; 70% SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-½"; 20% FINE TO COARSE SAND; 10% NONPLASTIC FINES
92.0'										
	GP-GC	67	89	-	-	-	-	-	-	POORLY GRADED GRAVEL WITH CLAY AND SAND, GP-GC: VERY DENSE; WET; VERY DARK GREENISH-GRAY; 65% SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-½"; 25% FINE TO COARSE SAND; 10% LOW PLASTICITY FINES
95.0'	GP-GM									POORLY GRADED GRAVEL WITH SILT AND SAND, GP-GM: VERY DENSE; WET; VERY DARK GREENISH-GRAY; 70% SUBANGULAR TO SUBROUNDED GRAVEL MAXIMUM PARTICLE SIZE 1-½"; 20% FINE TO COARSE SAND; 10% NONPLASTIC FINES
96.0'		A	A							B.O.H.

NOTES:

1. LEGEND AND NOTES ARE SHOWN ON SHEET B-1.
2. LOCATION OF EXPLORATIONS ARE SHOWN IN APPENDIX C.

VERTICAL SCALE: 1" = 3'

GRAPHIC SCALE

0 3 6 9 12 FEET

VERTICAL SCALE 1 : 3

US Army Corps of Engineers
Sacramento District

Symbol	Date	Approved	Description

Date: 24 Aug 2005
Design file no.:
Drawing Code:
Rev.
Designed by: SCANDONE
Spec No.
Drawn by: PHAN
Reviewed by: EDWARDS
Submitted by: JV Section Chief
Chief, Soil Design Sec.
File name:
Plot date:
Orig scale: AS NOTED

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
INTERHOUSE SECTION
1325 J STREET
SACRAMENTO, CA 95814-2922

SACRAMENTO RIVER
AMERICAN RIVER WATERSHED PROJECT
(COMMON FEATURES), CALIFORNIA
POCKET AREA FEMA EVALUATION (LEFT BANK)
GEOTECHNICAL SITE 4
LOG OF EXPLORATIONS
G4 - 2A

Sheet reference number:
B-25
25 of 2005

MAY 2005

Mapping Unit (S/S) No.: MAPPING_UNIT_(S/S)_NO.

Soil Design Section Sheet No.: X of X

Reference - Exploration Log file no.: XXX-01-XXX

Border Revised 08/30/04, CDES/2002 DWG

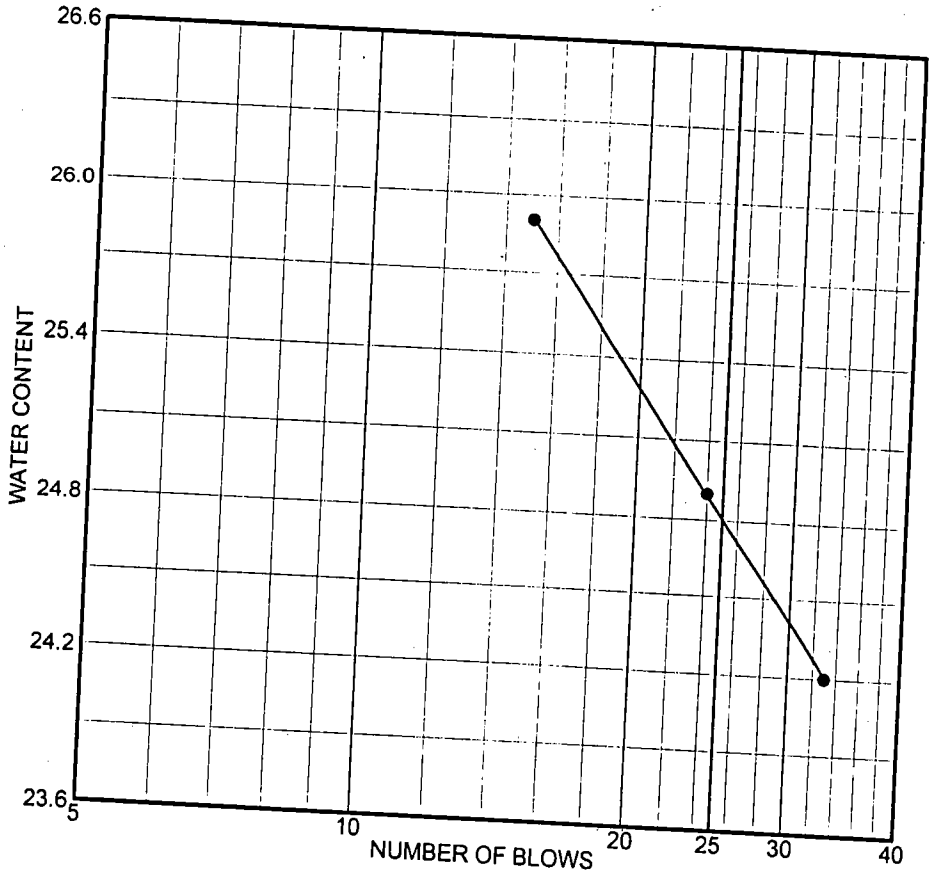
Table 1

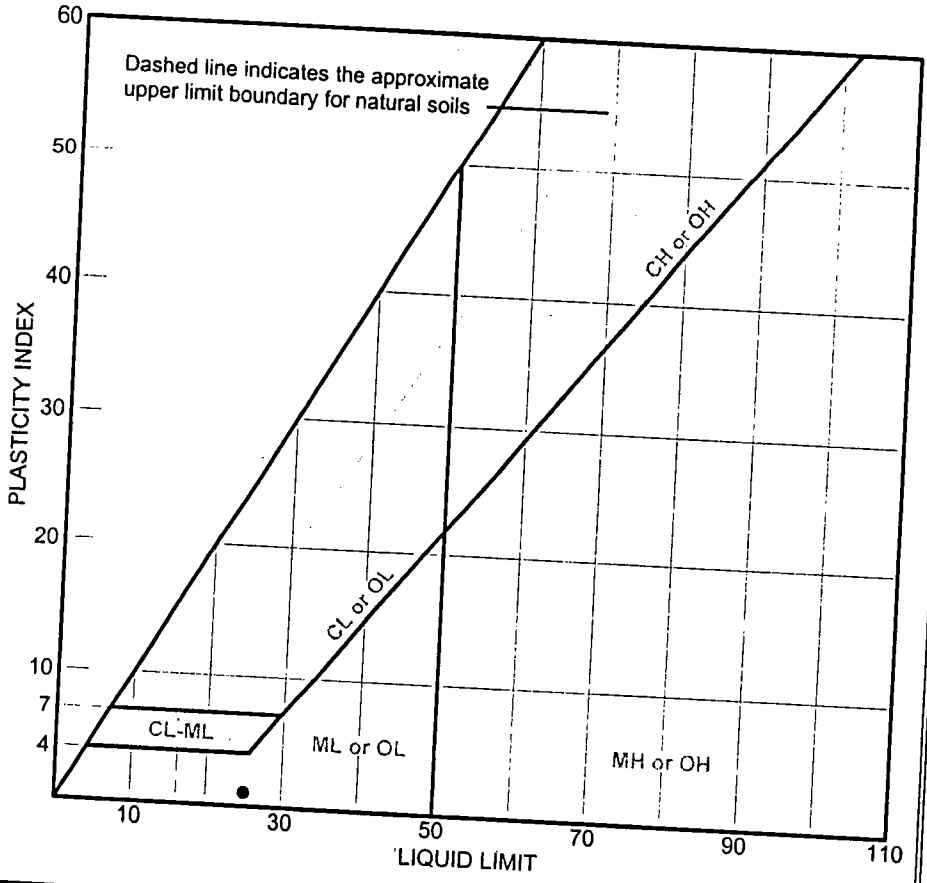
Percent Passing #200 (ASTM D1140)
Sacramento River FEMA –Geotech Sites
(Pocket Area)
STL Job #05-187

Sample Name	Percent Passing #200
2F-05-G4-2, FS11 25-26.5	47.3
2F-05-G4-2, FS14 31-32.5	55.1
2F-05-G4-2, FS20 43-44.5	7.9
2F-05-G4-2, FS34 84-85.5	8.7

Notes:

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	2F-05-G4-2	FS11	25-26.5	4/20/05				25	1

Client U.S. Army Corps of Engineers

Project Sacramento River FEMA - Geotech Sites

(Pocket Area)

Project No. 05-187 | Figure

SIERRA TESTING LABS, INC.

LIQUID AND PLASTIC LIMIT TEST DATA

Client: U.S. Army Corps of Engineers
Project: Sacramento River FEMA - Geotech Sites
(Pocket Area)
W91238-05-P-0097
Project Number: 05-187

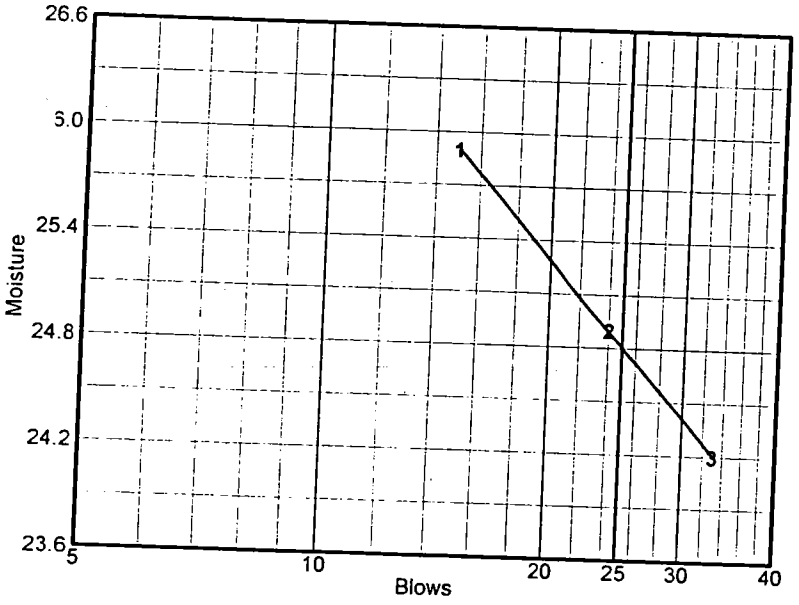
Sample Data

Source: 2F-05-G4-2
Sample No.: FS11
Elev. or Depth: 25-26.5
Location:
Description:
Date: 4/20/05
USCS Class.:
Testing Remarks:

Sample Length(in./cm.):
Natural Moisture:
AASHTO Class.:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	22.03	25.27	30.93			
Dry+Tare	17.80	20.53	25.18			
Tare	1.45	1.46	1.46			
# Blows	15	24	33			
Moisture	25.9	24.9	24.2			

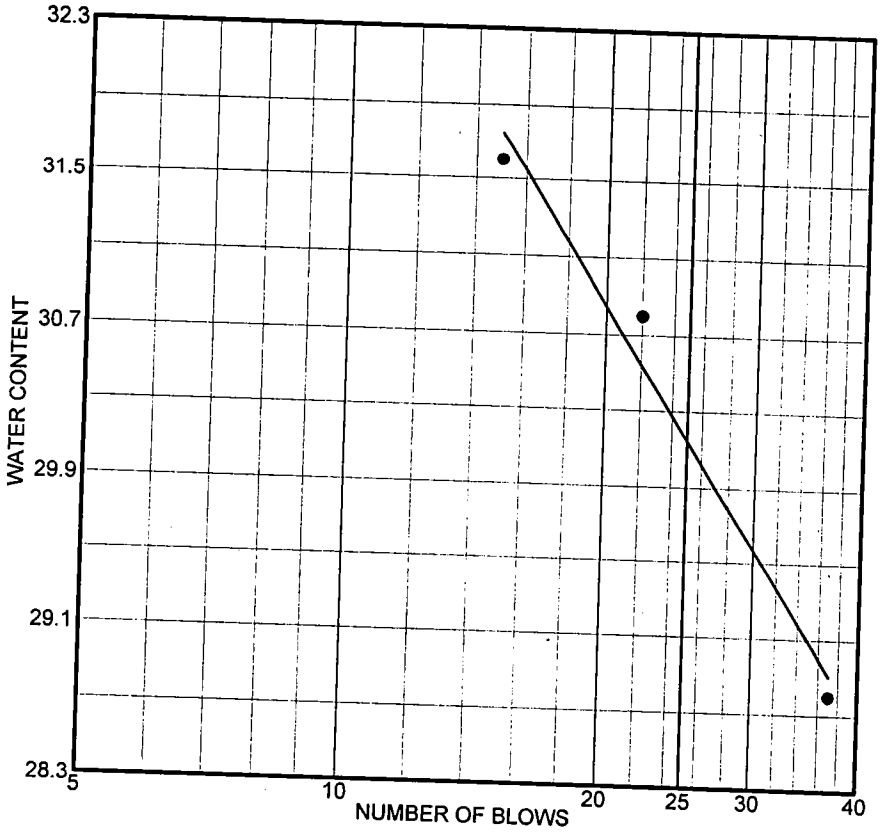


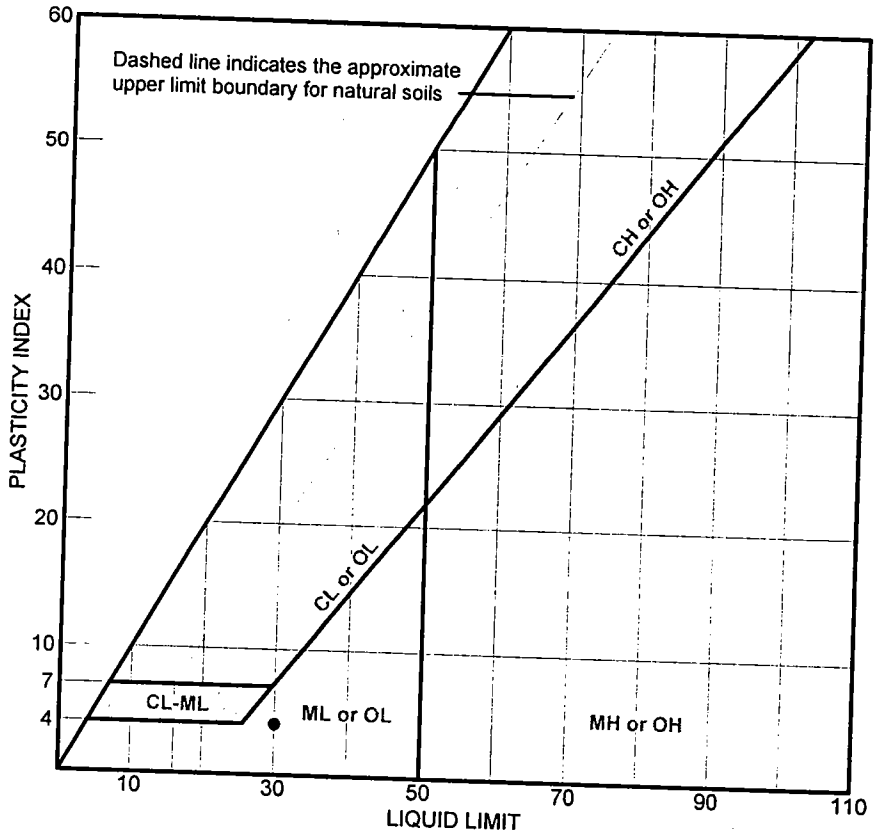
Liquid Limit= 25
Plastic Limit= 24
Plasticity Index= 1

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	4.05	4.95		
Dry+Tare	3.55	4.28		
Tare	1.45	1.46		
Moisture	23.8	23.8		

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	2F-05-G4-2	FS14	31.0-32.5	4/20/05				30	4

Client U.S. Army Corps of Engineers

Project Sacramento River FEMA - Geotech Sites

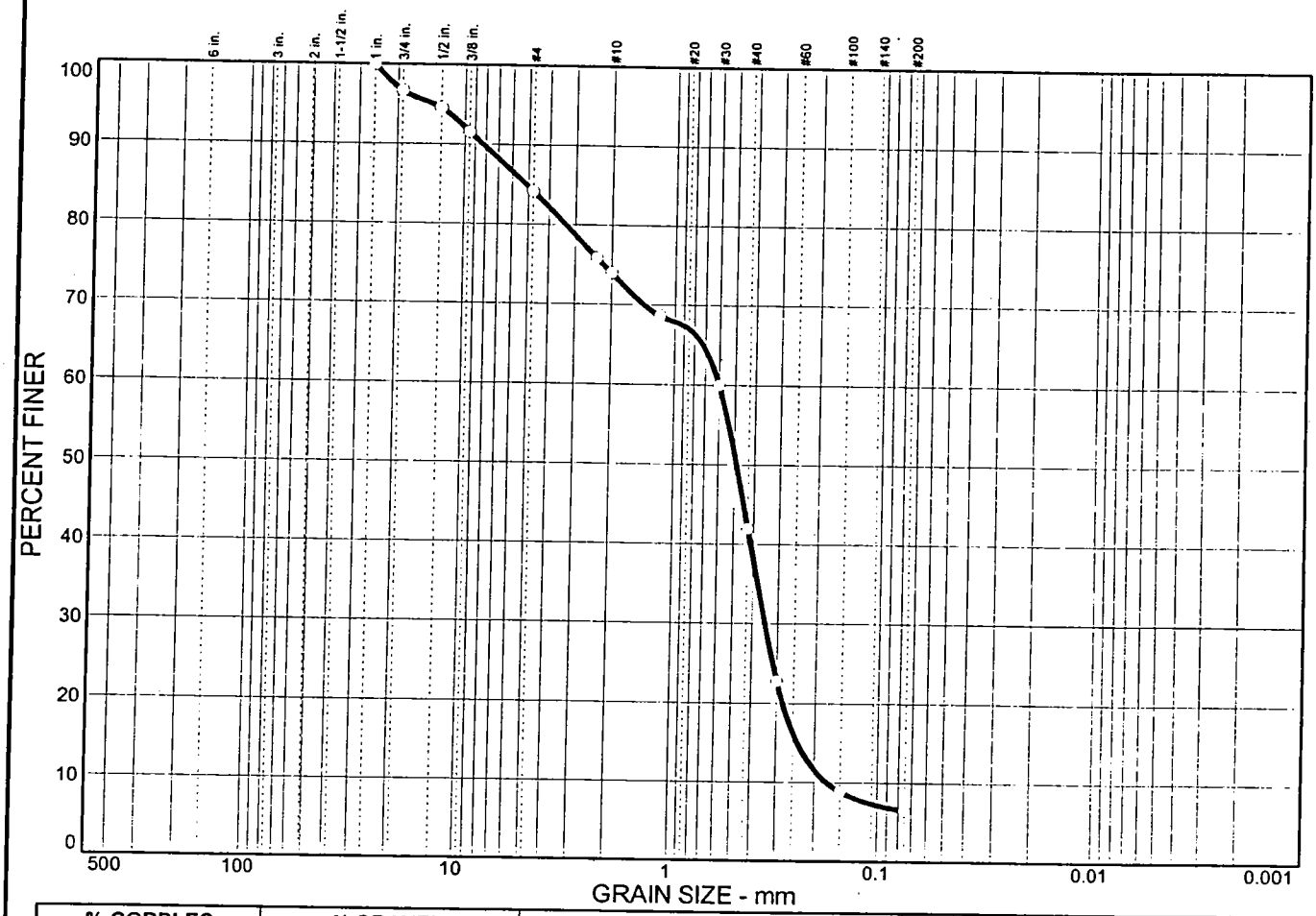
(Pocket Area)

Project No. 05-187 | Figure

SIERRA TESTING LABS, INC.

●

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	15.8	77.7	6.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
3/4 in.	96.7		
1/2 in.	94.6		
3/8 in.	91.6		
#4	84.2		
#8	75.9		
#10	74.0		
#16	68.6		
#30	60.0		
#40	42.0		
#50	22.8		
#100	8.9		
#200	6.5		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 5.11 D_{60}= 0.600 D_{50}= 0.487
D_{30}= 0.346 D_{15}= 0.238 D_{10}= 0.174
C_u= 3.45 C_c= 1.15

Classification

USCS= AASHTO=

Remarks

Sample No.: FS37 **Source of Sample:** 2F-05-G4-2 **Date:** 4/20/05
Location: **Elev./Depth:** 93-94.5

SIERRA TESTING LABS, INC.

Client: U.S. Army Corps of Engineers
Project: Sacramento River FEMA - Geotech Sites (Pocket Area)
Project No: 05-187 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

Client: U.S. Army Corps of Engineers
Project: Sacramento River FEMA - Geotech Sites
(Pocket Area)
W91238-05-P-0097
Project Number: 05-187

Sample Data

Source: 2F-05-G4-2
Sample No.: FS37
Elev. or Depth: 93-94.5
Location:
Description:
Date: 4/20/05
PL:
USCS Classification:
Testing Remarks:
Sample Length(in./cm.):
LL:
PI:
AASHTO Classification:

Mechanical Analysis Data

	Initial
Dry sample and tare=	317.80
Tare =	0.00
Dry sample weight =	317.80

Sieve tare method

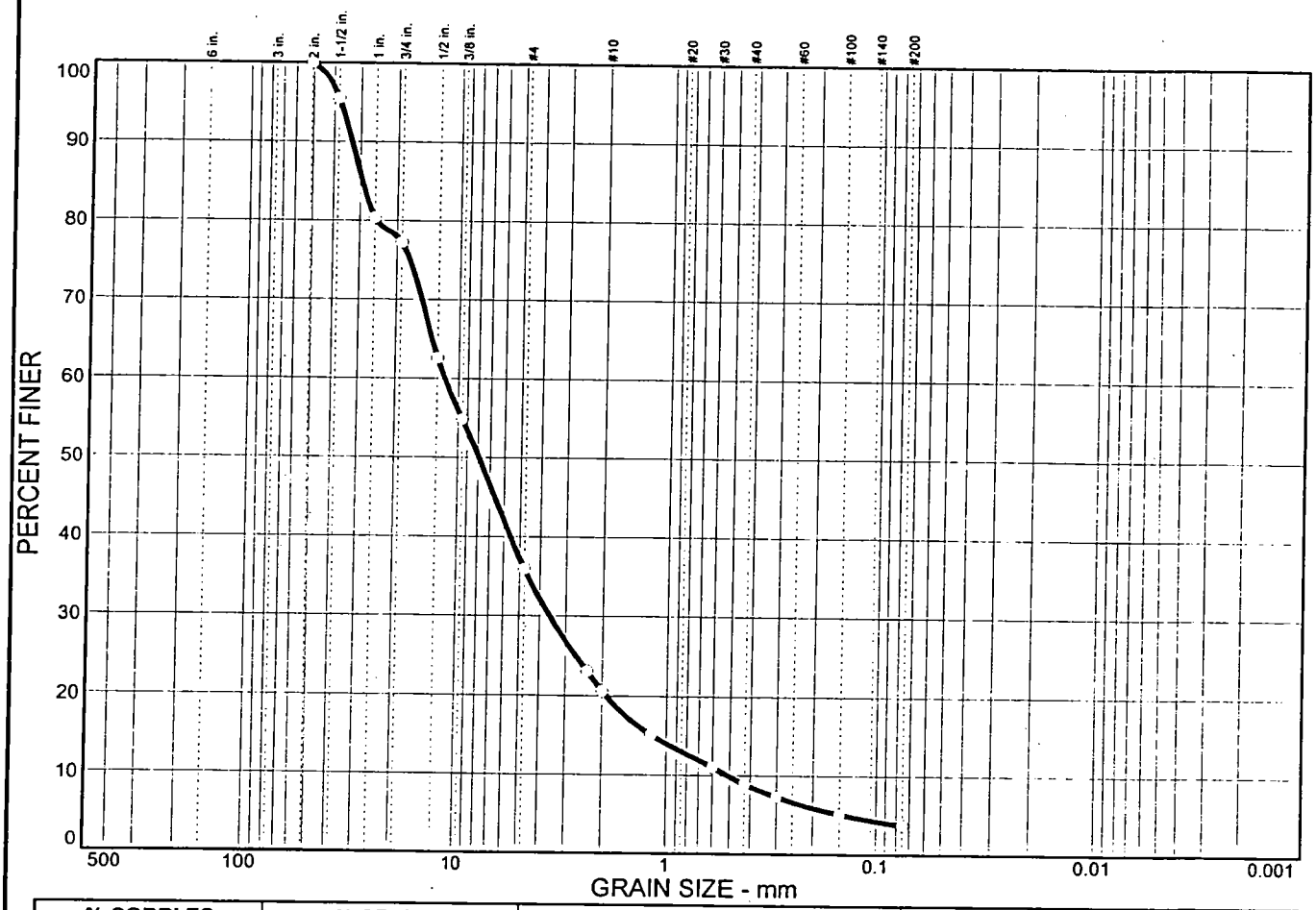
Sieve	Weight retained	Sieve tare	Percent finer
1 inch	0.00	0.00	100.0
3/4 inch	10.50	0.00	96.7
1/2 inch	6.80	0.00	94.6
3/8 inch	9.40	0.00	91.6
# 4	23.60	0.00	84.2
# 8	26.40	0.00	75.9
# 10	5.80	0.00	74.0
# 16	17.20	0.00	68.6
# 30	27.50	0.00	60.0
# 40	57.00	0.00	42.0
# 50	61.20	0.00	22.8
# 100	44.20	0.00	8.9
# 200	7.40	0.00	6.5

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = 15.8 % SAND = 77.7
% FINES = 6.5

D_{85}= 5.11 D_{60}= 0.60 D_{50}= 0.49
D_{30}= 0.35 D_{15}= 0.24 D_{10}= 0.17
C_c= 1.1485 C_u= 3.4466

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	64.0	32.3	3.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100.0		
1-1/2 in.	95.6		
1 in.	80.4		
3/4 in.	77.3		
1/2 in.	62.6		
3/8 in.	54.9		
#4	36.0		
#8	23.1		
#10	20.6		
#16	15.1		
#30	11.0		
#40	8.9		
#50	7.3		
#100	5.1		
#200	3.7		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 29.3 D_{60}= 11.7 D_{50}= 7.90
D_{30}= 3.58 D_{15}= 1.16 D_{10}= 0.511
C_u= 22.89 C_c= 2.14

Classification

USCS= AASHTO=

Remarks

Sample No.: FS43 **Source of Sample:** 2F-05-G4-2 **Date:** 4/20/05
Location: **Elev./Depth:** 111-112.5

SIERRA TESTING LABS, INC.

Client: U.S. Army Corps of Engineers
Project: Sacramento River FEMA - Geotech Sites (Pocket Area)
Project No: 05-187 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

Client: U.S. Army Corps of Engineers
Project: Sacramento River FEMA - Geotech Sites
(Pocket Area)
W91238-05-P-0097
Project Number: 05-187

Sample Data

Source: 2F-05-G4-2
Sample No.: FS43
Elev. or Depth: 111-112.5
Location:
Description:
Date: 4/20/05
PL:
USCS Classification:
Testing Remarks:

Sample Length(in./cm.):
LL:
PI:
AASHTO Classification:

Mechanical Analysis Data

	Initial
Dry sample and tare=	1919.80
Tare =	0.00
Dry sample weight =	1919.80

Sieve tare method

Sieve	Weight retained	Sieve tare	Percent finer
2 inch	0.00	0.00	100.0
1-1/2 inch	85.00	0.00	95.6
1 inch	290.50	0.00	80.4
3/4 inch	60.50	0.00	77.3
1/2 inch	281.60	0.00	62.6
3/8 inch	148.80	0.00	54.9
# 4	361.40	0.00	36.0
# 8	248.70	0.00	23.1
# 10	47.00	0.00	20.6
# 16	105.90	0.00	15.1
# 30	79.10	0.00	11.0
# 40	41.10	0.00	8.9
# 50	29.80	0.00	7.3
# 100	43.10	0.00	5.1
# 200	26.20	0.00	3.7

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = 64.0 % SAND = 32.3
% FINES = 3.7

D_{85}= 29.29 D_{60}= 11.69 D_{50}= 7.90
D_{30}= 3.58 D_{15}= 1.16 D_{10}= 0.51
C_c= 2.1439 C_u= 22.892

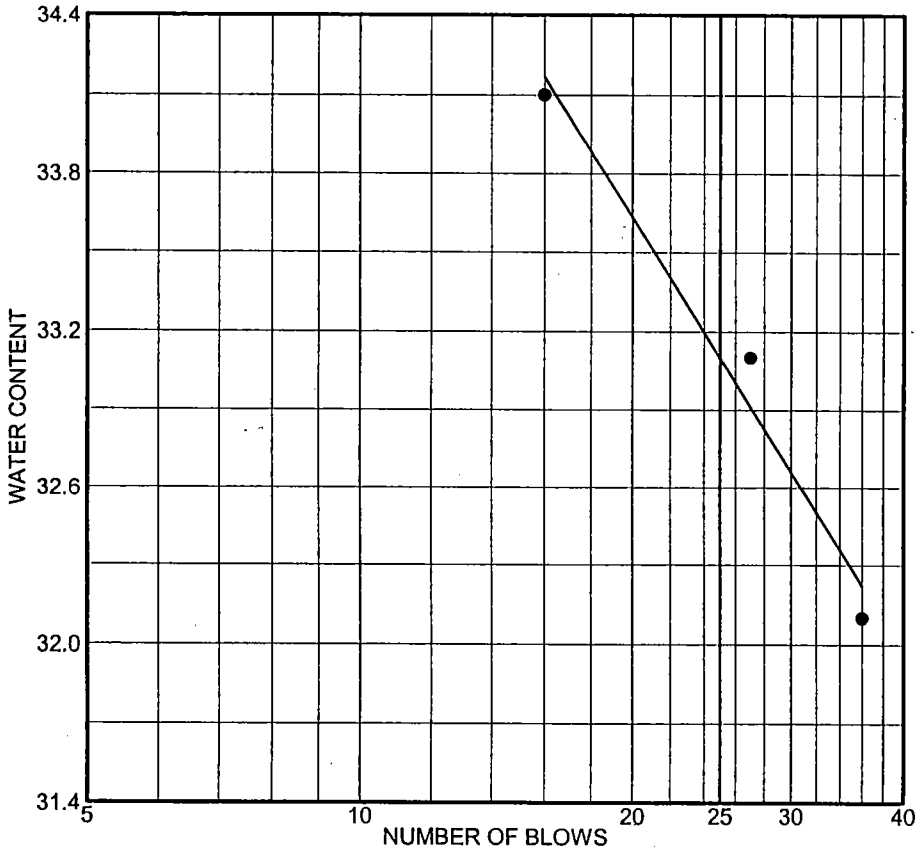
Table 1

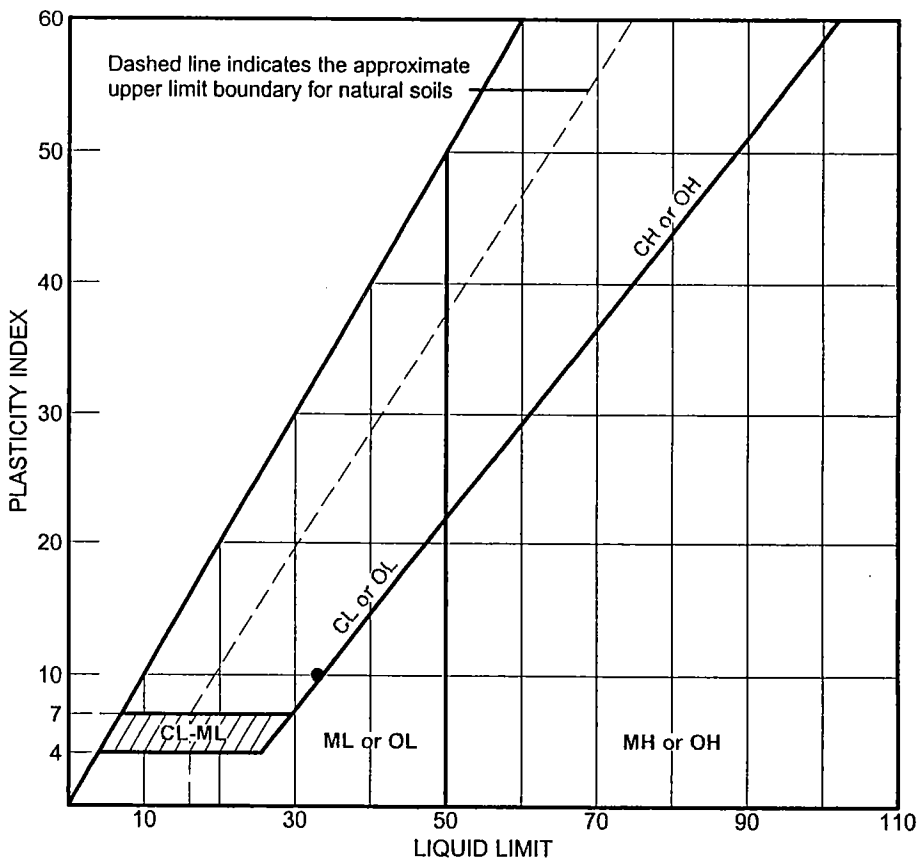
Percent Passing #200 (ASTM D1140)
Sacramento River FEMA-Geotech Sites
(Pocket Area)
STL Job #05-187

Sample Name	Percent Passing #200
2F-05-G4-2A, FS3 4.0'-5.5'	82.8
2F-05-G4-2A, FS5 8.0'-9.5'	40.4
2F-05-G4-2A, FS8 12.0'-13.5'	53.0
2F-05-G4-2A, FS20 34.0'-35.5'	5.8
2F-05-G4-2A, FS32 65.0'-66.5'	17.7

Notes:

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	2F-05-G4-2A	FS3	4.0-5.5	6/22/05				33	10

Client U.S. Army Corps of Engineers

Project Sacramento River FEMA - Geotech Sites

(Pocket Area)

Project No. 05-187 | Figure

SIERRA TESTING LABS, INC.

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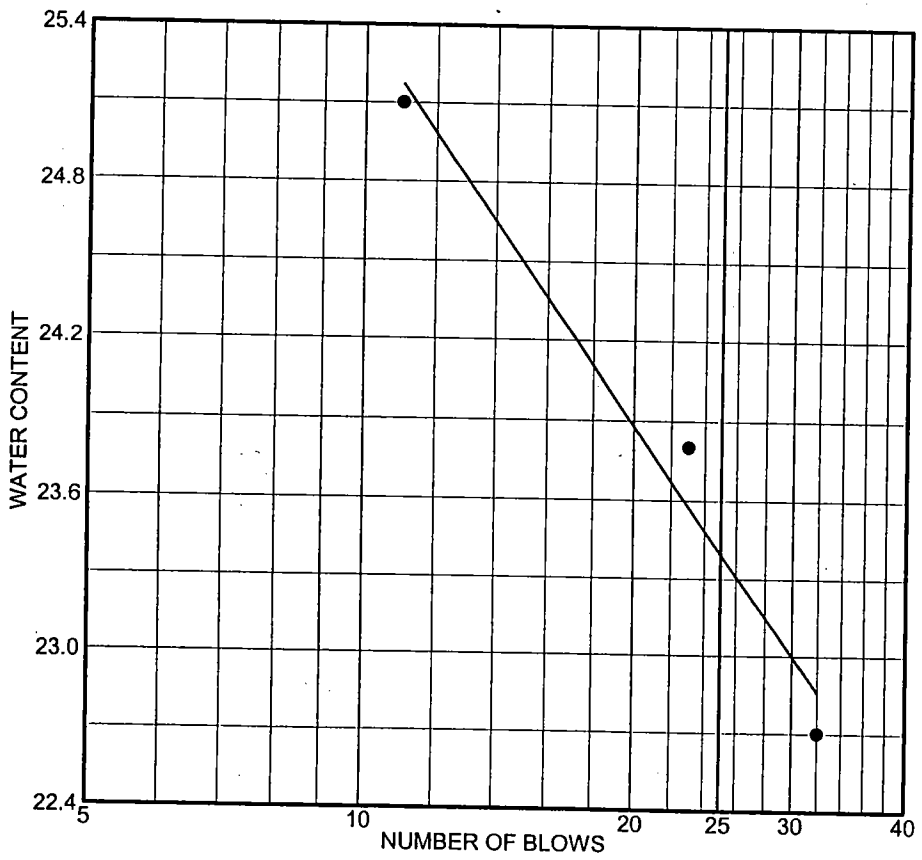
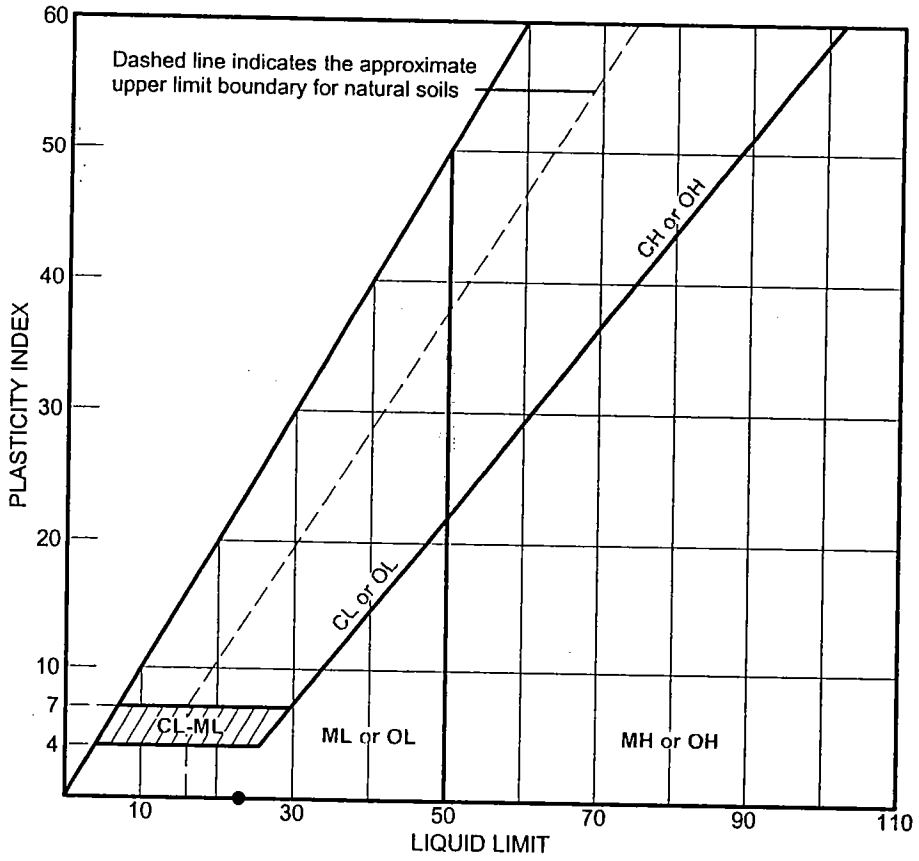
LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	2F-05-G4-2A	FS5	8.0-9.5	6/22/05				23	0

Client U.S. Army Corps of Engineers

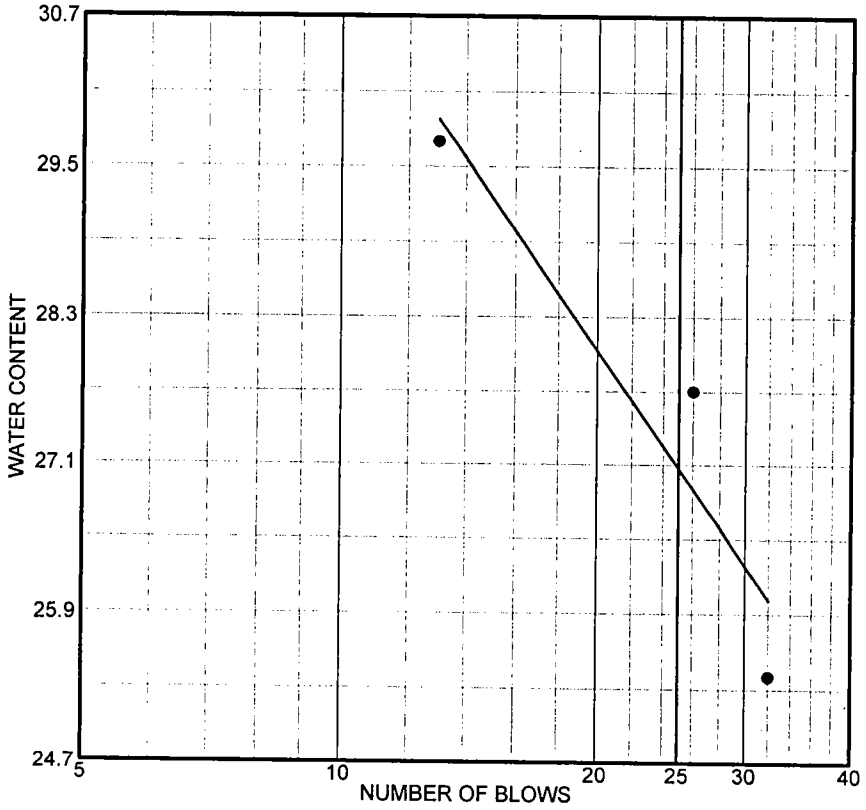
Project Sacramento River FEMA - Geotech Sites

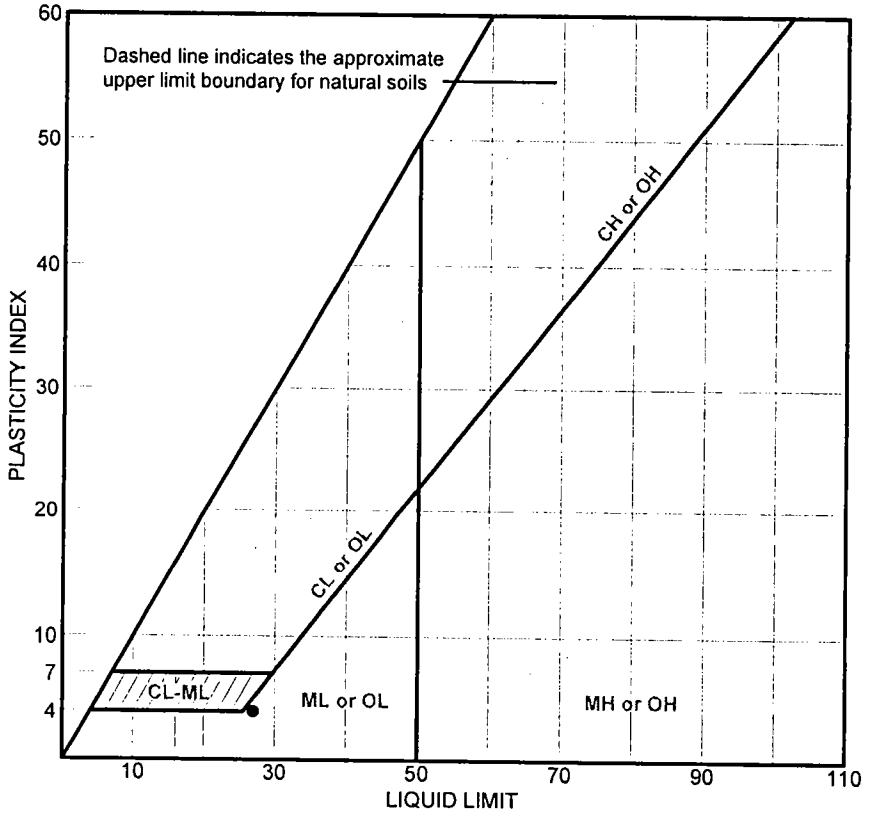
(Pocket Area)

Project No. 05-187 Figure

SIERRA TESTING LABS, INC.

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	2F-05-G4-2A	FS8	12.0-13.5	6/22/05				27	4

Client U.S. Army Corps of Engineers

Project Sacramento River FEMA - Geotech Sites

(Pocket Area)

Project No. 05-187 | Figure

SIERRA TESTING LABS, INC.

●

NATOMAS BASIN

NAT REACH D – NCC SOUTH – U1 LM 1.17

STRATIGRAPHY INPUT

BORING LOGS

LABORATORY TESTING

American River Common Features GRR
Natomas Cross Canal Sta. 956+00 LM 1.17
Table F-2-16: Permeability Selection for Seepage Analysis

Elevation of Levee Crest (NAVD 88)	Boring	Layer ID	USCS Soil Classification	Depth to Top of Layer (ft.)	Depth to Bottom of Layer (ft.)	Elevation of Top of Layer (NAVD 88)	Elevation of Bottom of Layer (NAVD 88)	Layer Thickness (ft.)	Laboratory and Field Data			Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
									% Fines (-Sieve 200) From Field Classification	PI	LL	Horizontal k_h (k_x) cm/sec	k_h/k_v	Vertical k_v (k_y) cm/sec	Horizontal k_h (k_x) ft/day	Vertical k_v (k_y) ft/day	Φ	C	γ
44.85	NCCB-6, NCCB-6-49	1	Clayey Sand (SC)	0	24.5	44.9	20.4	24.50	35			4.00E-05	4.00	1.00E-05	0.113	0.028	28	50	120
		2	Poorly Graded Sand w/ silt (SP-SM)	24.5	47	20.4	-2.2	22.50				1.00E-03	10.00	1.00E-04	2.835	0.284	33	0	130
		3	Poorly Graded Sand (SP)	47	81.5	-2.2	-36.7	34.50				5.00E-03	10.00	5.00E-04	14.175	1.418	34	0	135
		4	Sandy Fat Clay (CH)	81.5	86.2	-36.7	-41.4	4.70				1.00E-05	10.00	1.00E-06	0.028	0.003	30	50	110
		5	Clay Cap									1.00E-06	4.00	2.50E-07	0.00284	0.00071	28	50	115
		6	Cutoff Wall									1.00E-06	1.00	1.00E-06	0.00284	0.00284	0	50	85
				Total Depth (ft.)	**86.20**														

Landside Toe El **32.42** **(NAVD 88)**
Levee Height **12.4** **(ft.)**

Note:

NCC					NAVD 88			
		10-yr SAC	25-yr SAC	50-yr SAC	100-yr SAC	200-yr SHY	500-yr AMR	Top of Levee
Reach	River Sta	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	NLDB Left Bank
Main	**3.23**	**39.00**	**41.11**	**41.88**	**42.84**	**44.23**	**45.16**	**44.85**

Exit Gradient at Toe

Mitigation Height

500-yr +3 Levee Height	200-yr +3 Levee Height
48.16	**47.23**

Surface Conditions: Levee crown, loose gravel

Groundwater: Groundwater not measured.

Method: Hollow Stem Auger/Mud Rotary

Equipment: CME 75 with 140lb. Automatic Hammer

Date Completed: 6/26/2006

Logged By: Brian Honea

Total Depth: 91-1/2 feet

Boring Diameter: 8 inch/4 inch

Approximate Elevation: 42.5 feet (NGVD29*)
Approximate Northing: 2048063.91 feet
Approximate Easting: 6675533.77 feet

Elevation (ft., msl)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
														LOOSE GRAVEL (GM): (Levee Fill)
														Sandy SILT (ML): Gray brown, moist, firm (Levee Fill)
			1a	4										
			1b	5										
				6										
38	5													
				2										
			2a	2										
			2b	3										
														Silty SAND (SM): Gray, moist, fine sand, about 30% fines, about 30% fines (Levee Fill)
														Sandy FAT CLAY (CH): Gray brown, moist, firm, high plasticity, about 30% fine sand (Levee Fill)
				3										
			3a	3										
			3b	6										
33	10													
				3										
			4a	5										
			4b	6				51	29			Atterberg; see Plate B-2		
				3										
			5a	4										
			5b	6										
28	15													
				2										
			6a	3										
			6b	6										
				2										
			7a	3										
			7b	6										
23	20													
				3										**Sandy FAT CLAY** (CH): Gray brown, moist, firm, high plasticity, about 30% fine sand
			8a	6										
			8b	7										
				3										
			9a	6										
			9b	9										Some charcoal pieces
18	25													
				4										
			10a	8										
			10b	9										Dark gray to black
				9										**Sandy SILT** (ML): Gray brown, moist, firm
			11a	10										
			11b	14										

P-LOG_2006 BLOWS PER 6 INCHES 72834-DNCC06.GPJ 6/28/07

Drafted By: D. Ross
Date: 6/28/2007

Project No.: 72834/DNCC06
File Number: 72834-DNCC06

LOG OF BORING NCCB-6- 4

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THROUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
1 of 3
A-6

Elevation (ft., msl)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
					FIELD				LABORATORY					
13	30		12a	9										
			12b	14										
				18							55			
			13a	5										**Silty SAND** (SM): Olive brown, moist to wet, fine sand, about 25% fines
			13b	5										
				7							25			
8	35		14a	3										
			14b	7										
				13										
			15a	4										
			15b	5										
				6							44			About 44% fines
3	40		16a	4										**Sandy SILT** (ML): Olive brown, moist to wet, about 39% fine sand
			16b	6										
				7							61			
			17a	2										**Silty SAND** (SM): Gray brown, wet, fine sand, about 35% fines
			17b	5										
				7										
-3	45		18a	3										
			18b	9										
				18							21			About 21% fines
			19a	7										
			19b	13										About 44% fines
				20							44			
-8	50		20a	10										
			20b	15										
				22										**SILT** (ML): Light gray with orange, moist, hard
			21a	6										**Silty SAND** (SM): Gray brown, wet, fine sand, about 35% fines
			21b	11										
				17										
-13	55		22a	7										**Sandy SILT** (ML): Gray with orange, moist, very stiff, fine sand, about 16% fine sand
			22b	12										
				21							84			
			23a	9										Decreasing sand
			23b	23										
				31							54			**SILT** (ML): Olive brown, moist, very hard
-18	60		24a	11										
			24b	23										**Sandy SILT** (ML): Gray brown, moist to wet, very hard, about 47% fine to medium sand
				26							53			
														SILT (ML): Gray with orange, moist, hard, about

P-LOG_2006 BLOWS PER 6 INCHES 72834-DNCC06.GPJ 6/28/07

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LOG OF BORING NCCB-6- 4

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THROUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
2 of 3
A-6

Elevation (ft., msl)	Depth (feet)	FIELD: Sample Type	FIELD: Sample No.	FIELD: Blows/6 inches	FIELD: Pocket Penetrometer (tsf)	LABORATORY: Dry Density (pcf)	LABORATORY: Moisture Content (%)	LABORATORY: Liquid Limit	LABORATORY: Plasticity Index	LABORATORY: Passing #4 Sieve (%)	LABORATORY: Passing #200 Sieve (%)	LABORATORY: Other Tests	Graphic Log	DESCRIPTION
-23	65			7										5% fine sand
			25a	11										Firm
			25b	18										
-28	70			13										Very hard
			26a	24										
			26b	32										
-33	75			8										Gray, about 20% fine sand
			27a	19										
			27b	25										**Silty SAND** (SM): Gray, moist to wet, fine to medium sand, about 25% fines
-38	80			6										
			28a	15										
			28b	21							27			About 27% fines
-43	85			10										**Sandy SILT** (ML): Dark gray, moist, very hard, about 30% fine sand
			29a	22										
			29b	31										Greenish gray
-48	90			14										**Silty SAND** (SM): Dark gray, wet, about 30% fines
			30a	23										
			30b	34							30			
-53	95													Boring completed at a depth of 91-1/2 feet below existing site grade.

P-LOG_2006 BLOWS PER 6 INCHES 72834-DNCC06.GPJ 6/28/07

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Date: 6/28/2007
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LOG OF BORING NCCB-6- 4

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THROUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
3 of 3
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Surface Conditions: Levee toe, grassy

Groundwater: Groundwater not measured.

Method: Mud Rotary

Equipment: CME 750 with 140lb. Automatic Hammer

Date Completed: 7/5/2006

Logged By: C. Wilhite

Total Depth: 66-1/2 feet

Boring Diameter: 4 inch

Approximate Elevation: 21.5 feet (NGVD29*)
Approximate Northing: 2048016.25 feet
Approximate Easting: 6675610.83 feet

Elevation (ft., msl)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
														LEAN CLAY (CL): Brown, dry, firm
			1a	8 9										
			1b	9										Moist
17	5													
			2a	4 4	1.75									Olive brown
			2b	23										**Sandy SILT** (ML): Brown, moist, firm, about 30% fine sand
				17										**Clayey GRAVEL** (GC): Brown to red, moist, fine to coarse gravel, about 30% fines
			3a	39	>4.5									**SILT** (ML): Brown, moist, very hard
			3b	39										
12	10													Firm, some red mottling
			4a	7 10										
			4b	20										
				7										
			5a	13										
			5b	20	>4.5									
7	15													**LEAN CLAY** (CL): Brownish gray, moist, firm
			6a	9 15										
			6b	15										
				6										**Silty SAND** (SM): Brown, moist, fine sand, about 39% fines
			7a	7										
			7b	8							39			
2	20													
			8a	3 5										
			8b	7										Olive brown
				3										
			9a	5							39			
			9b	6										**Sandy SILT** (ML): Brown, moist, firm, about 30% fine to medium sand
4	25													
			10a	3 6										**Silty SAND** (SM): Brown, moist, fine to medium sand, about 32% fines
			10b	10							32			
				5										
			11a	10										
			11b	18							23			Medium sand, about 23% fines

P-LOG_2006 BLOWS PER 6 INCHES 72834-DNCC06.GPJ 6/28/07

Drafted By: D. Ross
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Project No.: 72834/DNCC06
File Number: 72834-DNCC06

LOG OF BORING NCCB-6- 5

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THROUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
1 of 3
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Elevation (ft., msl)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
-9	30													
			12a	9										**Sandy SILT** (ML): Gray brown, moist, firm, about 30% fine sand
			12b	9 11	3.25									
			13a	9 17										**Silty SAND** (SM): Brown, moist, fine to medium sand, about 25% fines
			13b	21							25			
-14	35													
			14a	10 11										**SILT With Sand** (ML): Gray brown, moist, firm, about 15% fine sand
			14b	10	1.75									
			15a	11 14										**Silty SAND** (SM): Brown, moist, fine sand, about 20% fines
			15b	17	4.0									**LEAN CLAY With Sand And Gravel** (CL): Brown, moist, firm, about 10% fine to coarse sand, about 5% fine gravel
-19	40													
			16a	7 23										**Poorly Graded SAND With Silt** (SP-SM): Brown, moist, about 10% fines
			16b	28							10			
			17a	8 18										**LEAN CLAY** (CL): Brown, moist, hard
			17b	17	3.25									
-24	45													
			18a	7 14										Firm
			18b	14	>4.5									
			19a	17 20										**SILT With Sand** (ML): Olive brown, moist, very hard, about 10% fine sand
			19b	28	>4.5									
-29	50													
			20a	10 12										
			20b	14										**LEAN CLAY** (CL): Olive brown, moist, firm, about 5% fine sand
			21a	5 7										**SILT With Sand** (ML): Olive brown, moist, firm, about 10% fine sand
			21b	11										
-34	55													
			22a	3 5							63			**Sandy SILT** (ML): Olive gray, moist to wet, firm, about 37% fine sand
			22b	7	.25									
			23a	8 10	3.25									
			23b	20										
-39	60													
			24a	13 18										Very hard
			24b	25	>4.5									

P-LOG_2006 BLOWS PER 6 INCHES 72834-DNCC06.GPJ 6/28/07

Drafted By: D. Ross
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LOG OF BORING NCCB-6- 5

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THROUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
2 of 3
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Elevation (ft., msl)	Depth (feet)	FIELD: Sample Type	FIELD: Sample No.	FIELD: Blows/6 inches	FIELD: Pocket Penetrometer (tsf)	LABORATORY: Dry Density (pcf)	LABORATORY: Moisture Content (%)	LABORATORY: Liquid Limit	LABORATORY: Plasticity Index	LABORATORY: Passing #4 Sieve (%)	LABORATORY: Passing #200 Sieve (%)	LABORATORY: Other Tests	Graphic Log	DESCRIPTION
-44	65			8										**Silty SAND** (SM): Brown, moist, fine sand, about 47% fines
			25a	12										
			25b	16							47			
														Boring completed at a depth of 66-1/2 feet below existing site grade.
-49	70													
-54	75													
-59	80													
-64	85													
-69	90													
-74	95													

P-LOG_2006 BLOWS PER 6 INCHES 72834-DNCC06.GPJ 6/28/07

Drafted By: D. Ross
Date: 6/28/2007

Project No.: 72834/DNCC06
File Number: 72834-DNCC06

LOG OF BORING NCCB-6- 5

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THROUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
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BORING NO.	SAMPLE DEPTH (ft)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (% of dry weight)	PARTICLE SIZE SIEVE SIZE (percent passing)						ATTERBERG LIMITS		OTHER TESTS
				3"	3/4"	#4	#10	#40	#200	L.L.	P.I.	
CCB-6-1	8.5								41			
NCCB-6-1	16.0								41			
NCCB-6-1	18.5					100	100	99	57			Sieve; see Plate B-3
NCCB-6-1	21.0								34			
NCCB-6-1	23.5								19			
NCCB-6-1	25.5									31	10	Atterberg; see Plate B-2
NCCB-6-1	28.5								93			
NCCB-6-1	46.0								51			
NCCB-6-1	48.5								44			
NCCB-6-1	53.5								40			
NCCB-6-1	61.0								32			
NCCB-6-1	63.5								9			
NCCB-6-1	70.5					100	99	70	11			Sieve; see Plate B-3
NCCB-6-2	11.0								61			
NCCB-6-2	16.0								42			
NCCB-6-2	21.0								51			
NCCB-6-2	26.0									46	19	Atterberg; see Plate B-2
NCCB-6-2	46.0								16			
NCCB-6-2	51.0								11			
NCCB-6-2	53.5					100	100	65	14			Sieve; see Plate B-3
NCCB-6-2	81.0								10			
NCCB-6-3	6.0								49			
CCB-6-3	11.0									46	18	Atterberg; see Plate B-2
NCCB-6-3	16.0								81			
NCCB-6-3	18.5					100	100	99	20			Sieve; see Plate B-3
NCCB-6-3	23.5								59			
NCCB-6-3	36.0								54			
NCCB-6-3	38.5								54			
NCCB-6-3	43.5								48			
NCCB-6-4	11.0									51	29	Atterberg; see Plate B-2
NCCB-6-4	31.0								55			
NCCB-6-4	33.5								25			
NCCB-6-4	38.5								44			
NCCB-6-4	41.0								61			
NCCB-6-4	46.0								21			
NCCB-6-4	48.5								44			
NCCB-6-4	56.0								84			
NCCB-6-4	58.5								54			
NCCB-6-4	61.0								53			
NCCB-6-4	81.0								27			
NCCB-6-4	91.0								30			

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SUMMARY OF LABORATORY TESTS

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THOUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
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Project No.: 72834/DNCC06
File Number: 72834-DNCC06

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KA-LAB

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BORING NO.	SAMPLE DEPTH (ft)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (% of dry weight)	PARTICLE SIZE SIEVE SIZE (percent passing)						ATTERBERG LIMITS		OTHER TESTS
				3"	3/4"	#4	#10	#40	#200	L.L.	P.I.	
CCB-6- 5	18.5								39			
NCCB-6- 5	23.0								39			
NCCB-6- 5	26.0								32			
NCCB-6- 5	28.5								23			
NCCB-6- 5	33.5								25			
NCCB-6- 5	41.0								10			
NCCB-6- 5	55.0								63			
NCCB-6- 5	66.0								47			
NCCB-6- 6	15.5								49			
NCCB-6- 6	28.5									61	38	Atterberg; see Plate B-2
NCCB-6- 6	43.5					100	100	49	9			Sieve; see Plate B-3
NCCB-6- 6	46.0								12			
NCCB-6- 6	53.5								60			
NCCB-6- 6	56.0								47			
NCCB-6- 6	61.0					100	100	90	16			Sieve; see Plate B-3
NCCB-6- 6	66.0					100	100	93	5			Sieve; see Plate B-3
NCCB-6- 6	86.0								58			
NCCB-6- 7	12.5									55	37	Atterberg; see Plate B-2
NCCB-6- 7	33.5								49			
NCCB-6- 7	36.0								34			
NCCB-6- 7	41.0								26			
NCCB-6- 7	55.5								90			
CCB-6- 8	31.0									53	37	Atterberg; see Plate B-2
NCCB-6- 8	58.5								41			
NCCB-6- 8	61.0								21			
NCCB-6- 8	81.0								61			
NCCB-6- 8	86.0								7			
NCCB-6- 8	91.0								7			
NCCB-6- 9	11.0								26			
NCCB-6- 9	16.0									54	34	Atterberg; see Plate B-2
NCCB-6- 9	31.0								65			
NCCB-6- 9	33.5								34			
NCCB-6- 9	36.0					100	99	31	6			Sieve; see Plate B-3
NCCB-6- 9	38.5								6			
NCCB-6- 9	41.0								21			
NCCB-6- 9	46.0								4			
NCCB-6-10	15.5								13			
NCCB-6-10	18.0								44			
NCCB-6-10	23.0								21			
NCCB-6-10	30.5								12			
NCCB-6-10	41.0								26			

2834-DNCC06.GPJ 6/4/08

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KA-LAE

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File Number: 72834-DNCC06

SUMMARY OF LABORATORY TESTS

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THOUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
2 of 5
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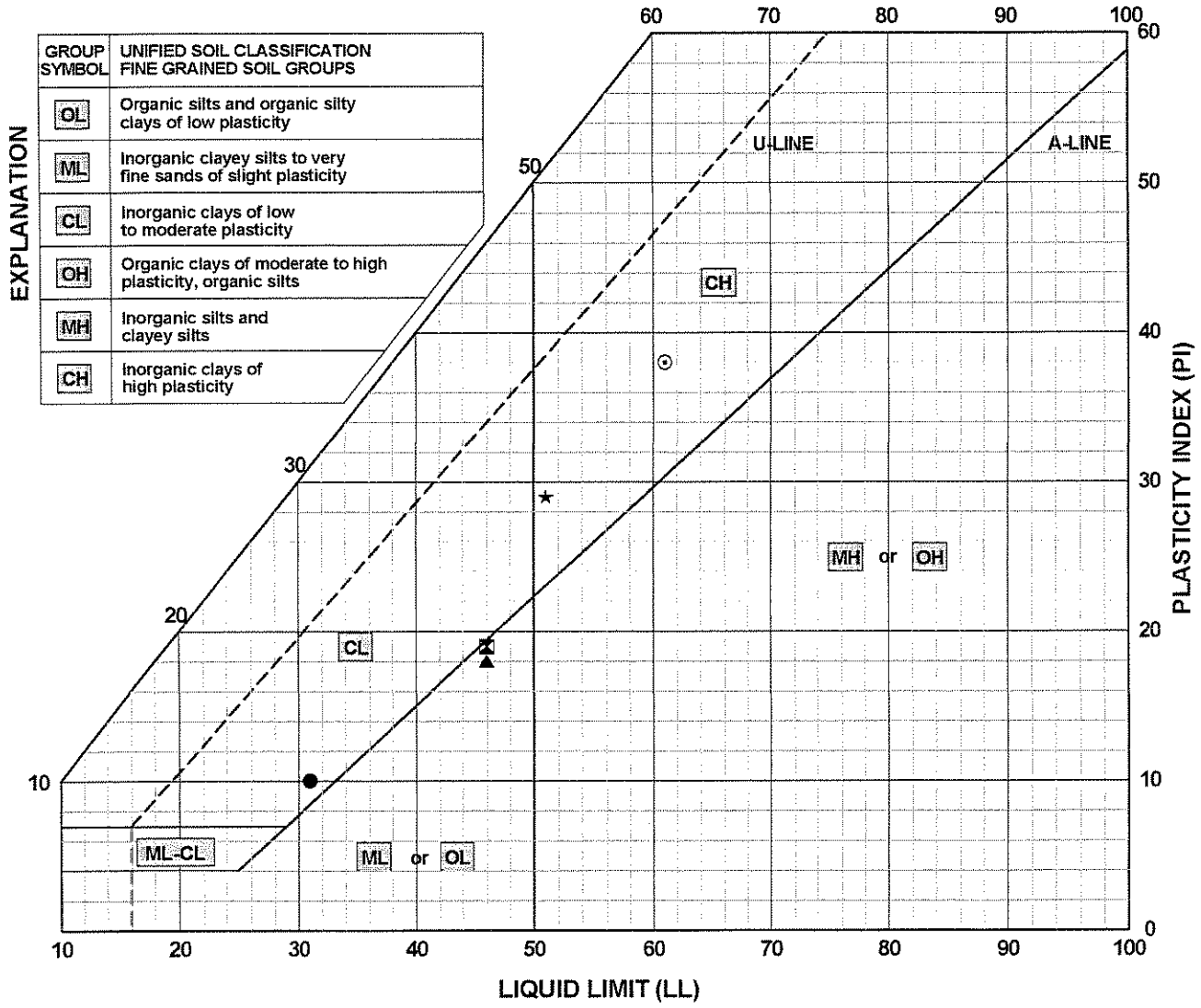

LEGEND:	SOURCE	DEPTH (ft)	LL	PL	PI	DESCRIPTION
●	NCCB-6-1	25.5	31	21	10	Lean CLAY (CL)
⧓	NCCB-6-2	26.0	46	27	19	Lean CLAY (CL)
▲	NCCB-6-3	11.0	46	28	18	Sandy CLAY (CL)
★	NCCB-6-4	11.0	51	22	29	Sandy Fat CLAY (CH)
⊙	NCCB-6-6	28.5	61	23	38	Fat CLAY (CH)

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File Number: 72834-DNCC06

PLASTICITY CHART

NATOMAS CROSS CANAL SOUTH LEVEE
REACHES 1 THOUGH 4
NATOMAS BASIN EVALUATION
SUTTER COUNTY, CALIFORNIA

PLATE
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KA_AT

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AMERICAN RIVER WATERSHED

COMMON FEATURES PROJECT

GENERAL REEVALUATION REPORT

ATTACHMENT C – GEOTECHNICAL REPORT

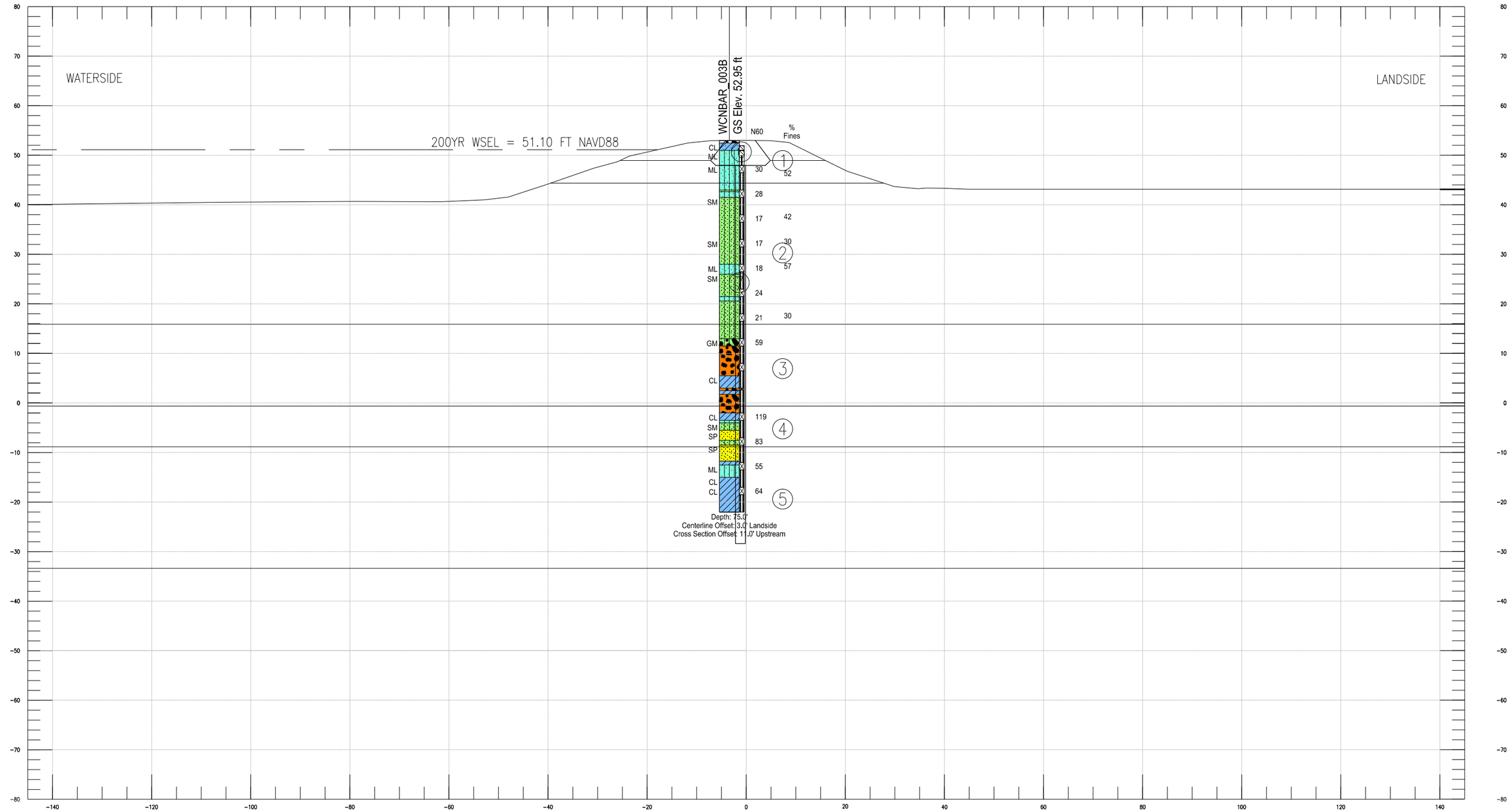
ENCLOSURE 2

STEADY STATE SEEPAGE AND LANDSIDE SLOPE STABILITY ANALYSES RESULTS

AMERICAN RIVER NORTH BASIN

ARN REACH A – AMERICAN RIVER NORTH – U9 LM 1.32

STEADY STATE SEEPAGE AND LANDSIDE SLOPE STABILITY ANALYSES RESULTS



Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WNCBAR_003B, 2F-97-6, DH-7, DH-7A	1	Silty Sand (SM) with Silt (ML) Levee Embankment	5.00E-04	4	1.25E-04	1.4175	0.3544	33	0	125
	2	Silty Sand (SM) with Silty (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	33	0	125
	3	Poorly Graded Gravel (GP) with Lean Clay (CL)	2.00E-01	4	5.00E-02	567.0000	141.7500	35	0	135
	4	Poorly Graded Sand with Silty Sand (SP-SM)	1.00E-03	4	2.50E-04	2.8350	0.7088	33	0	125
	5	Lean Clay (CL) with Silt (ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	6	Impervious Clay Cap (CL)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	7	Cutoff Wall	1.00E-06	4	2.50E-07	0.0028	0.0007	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

DEPARTMENT OF THE ARMY
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SACRAMENTO, CALIFORNIA

SACRAMENTO CALIFORNIA

AMERICAN RIVER WATERSHED - COMMON FEATURES GENERAL REEVALUATION REPORT GEOTECHNICAL ATTACHMENT

SECTION STRATIGRAPHY – 10 SCALE

ARN – REACH A – AMERICAN RIVER NORTH – U9 LM 1.32

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	1

PLOT BY: I:\EDGA\JD - May 22, 2013 - 4:10:20pm
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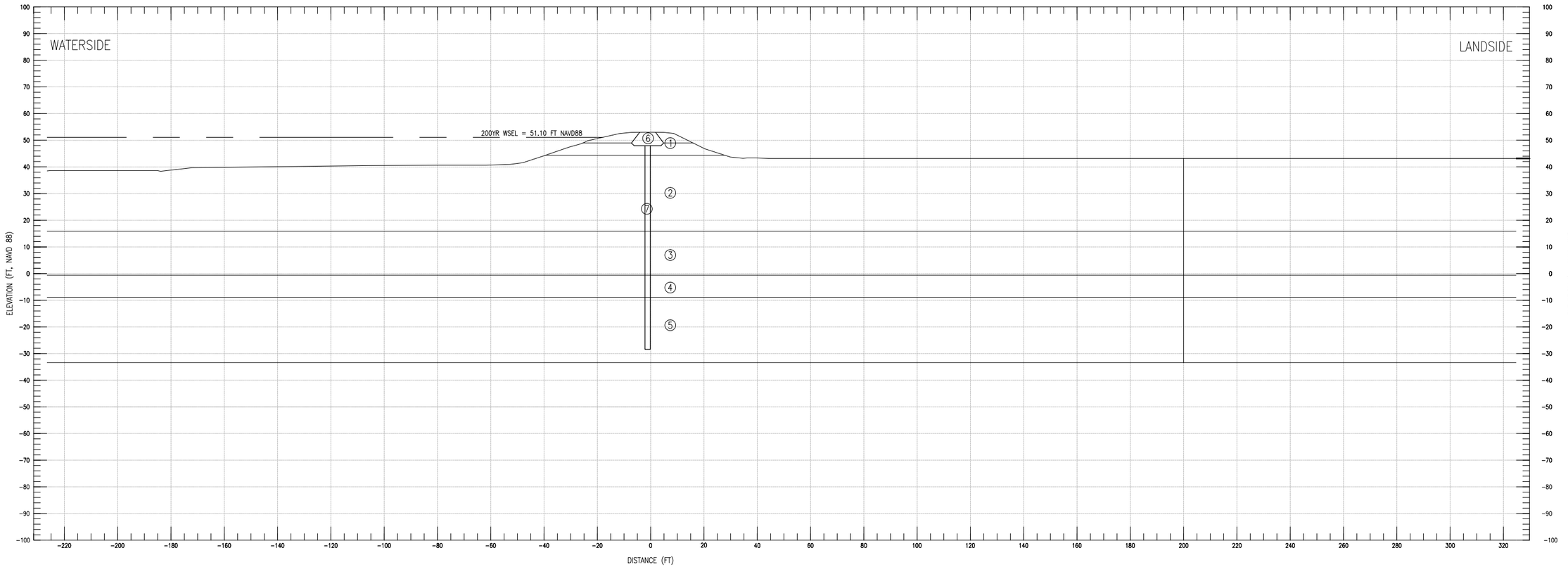

Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WNCBAR_003B, 2F-97-6, DH-7, DH-7A	1	Silty Sand (SM) with Silt (ML) Levee Embankment	5.00E-04	4	1.25E-04	1.4175	0.3544	33	0	125
	2	Silty Sand (SM) with Silty (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	33	0	125
	3	Poorly Graded Gravel (GP) with Lean Clay (CL)	2.00E-01	4	5.00E-02	567.0000	141.7500	35	0	135
	4	Poorly Graded Sand with Silty Sand (SP-SM)	1.00E-03	4	2.50E-04	2.8350	0.7088	33	0	125
	5	Lean Clay (CL) with Silt (ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	6	Impervious Clay Cap (CL)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	7	Cutoff Wall	1.00E-06	4	2.50E-07	0.0028	0.0007	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

DEPARTMENT OF THE ARMY
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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT
SECTION STRATIGRAPHY – 20 SCALE
ARN – REACH A – AMERICAN RIVER NORTH – U9 LM 1.32

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	2

PLOT BY: L2EDGAJD - May 22, 2013 - 4:10:25pm
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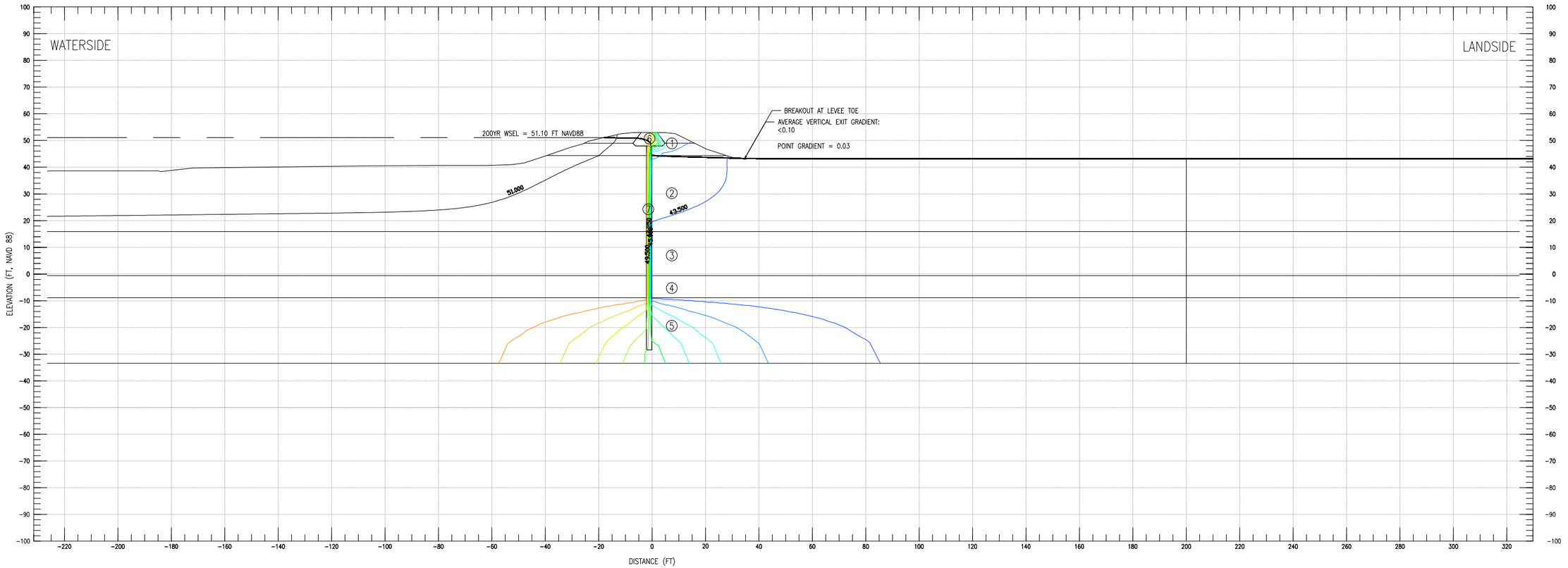

Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WNCBAR_003B, 2F-97-6, DH-7, DH-7A	1	Silty Sand (SM) with Silt (ML) Levee Embankment	5.00E-04	4	1.25E-04	1.4175	0.3544	33	0	125
	2	Silty Sand (SM) with Silty (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	33	0	125
	3	Poorly Graded Gravel (GP) with Lean Clay (CL)	2.00E-01	4	5.00E-02	567.0000	141.7500	35	0	135
	4	Poorly Graded Sand with Silty Sand (SP-SM)	1.00E-03	4	2.50E-04	2.8350	0.7088	33	0	125
	5	Lean Clay (CL) with Silt (ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	6	Impervious Clay Cap (CL)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	7	Cutoff Wall	1.00E-06	4	2.50E-07	0.0028	0.0007	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

DEPARTMENT OF THE ARMY
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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT
200YR WSEL-HEAD CONTOURS-WITHOUT PROJECT
ARN – REACH A – AMERICAN RIVER NORTH – U9 LM 1.32

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	3

PLOT BY: L2EDGAJD - May 22, 2013 - 4:10:30pm
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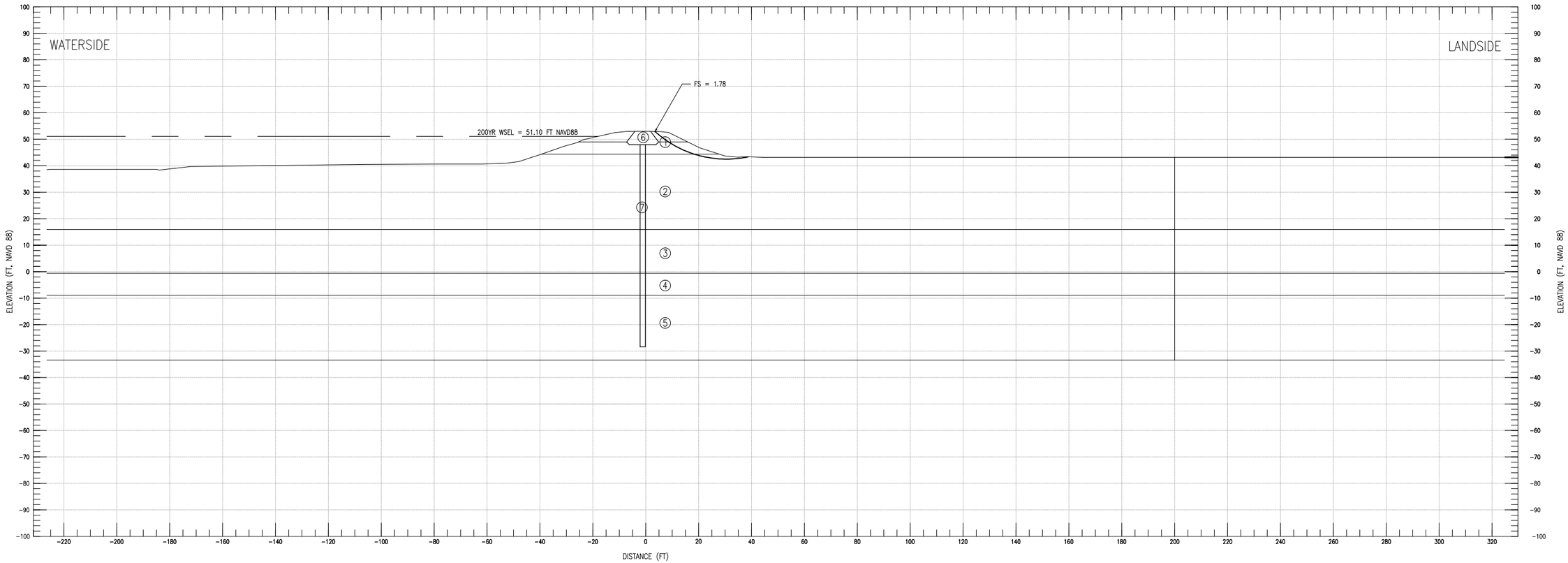

Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WNCBAR_003B, 2F-97-6, DH-7, DH-7A	1	Silty Sand (SM) with Silt (ML) Levee Embankment	5.00E-04	4	1.25E-04	1.4175	0.3544	33	0	125
	2	Silty Sand (SM) with Silty (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	33	0	125
	3	Poorly Graded Gravel (GP) with Lean Clay (CL)	2.00E-01	4	5.00E-02	567.0000	141.7500	35	0	135
	4	Poorly Graded Sand with Silty Sand (SP-SM)	1.00E-03	4	2.50E-04	2.8350	0.7088	33	0	125
	5	Lean Clay (CL) with Silt (ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	6	Impervious Clay Cap (CL)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	7	Cutoff Wall	1.00E-06	4	2.50E-07	0.0028	0.0007	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT

200YR WSEL-CRITICAL SHEAR SURFACE-WITHOUT PROJECT
ARN – REACH A – AMERICAN RIVER NORTH – U9 LM 1.32

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	4

PLOT BY: L2EDGAJD - May 22, 2013 - 4:10:36pm
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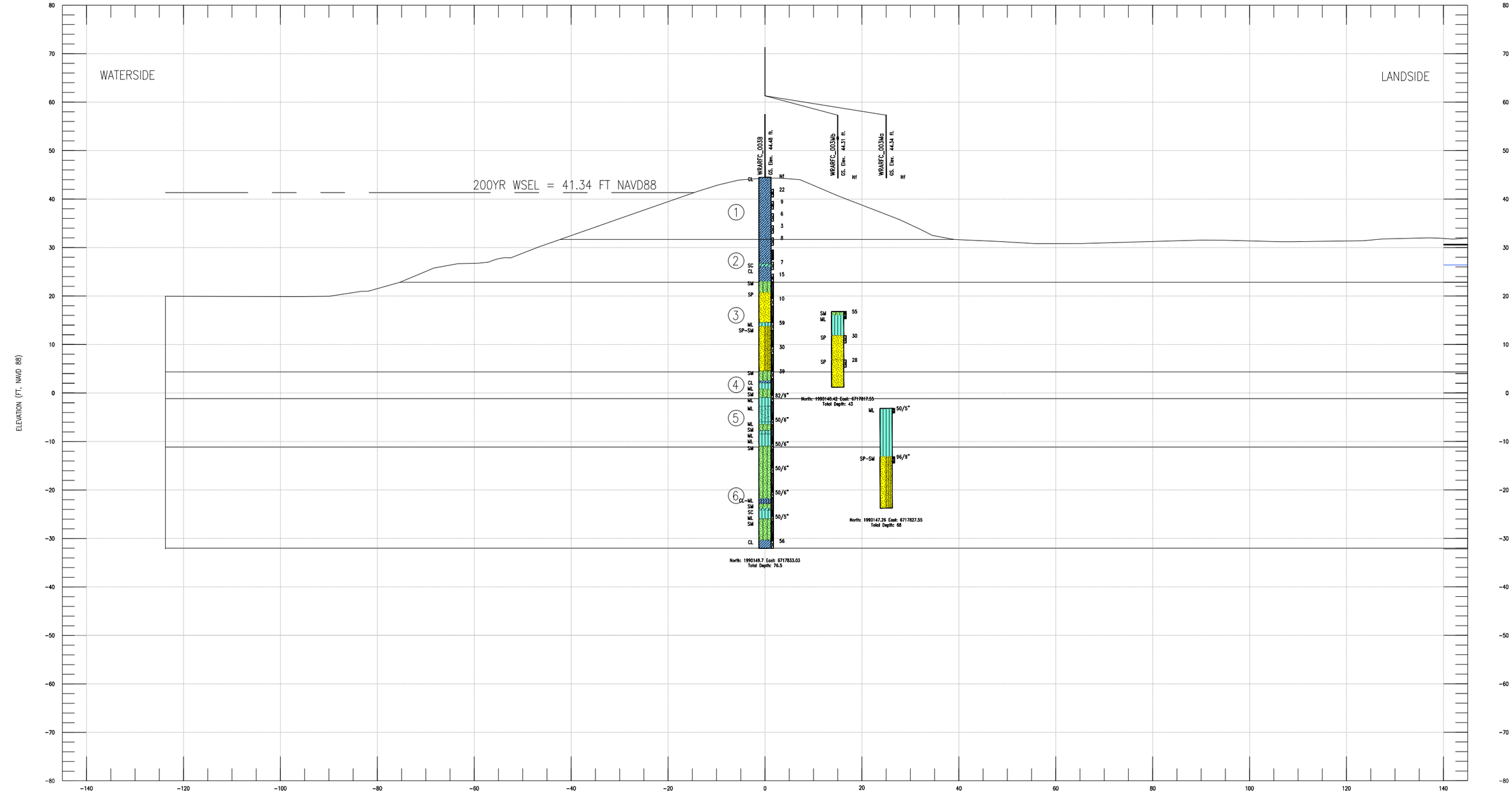
ARN REACH E – ARCADE CREEK NORTH – U7 LM 0.90

STEADY STATE SEEPAGE AND LANDSIDE SLOPE STABILITY ANALYSES RESULTS



Boring Number	Layer ID	Material Type	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WRARFC_003B	1	Sandy Lean Clay Levee	1.00E-05	4	2.50E-06	0.028	0.007	24	50	115
	2	Sandy Lean Clay Blanket	1.00E-05	1	1.00E-05	0.028	0.028	28	50	115
	3	Poorly Graded Sand	5.00E-03	4	1.25E-03	14.175	3.544	35	0	130
	4	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	33	0	125
	5	Sandy Silt	2.00E-04	4	5.00E-05	0.567	0.142	30	0	120
	6	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	35	0	125

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT

SECTION STRATIGRAPHY – 10 SCALE
ARN – REACH E – ARCADE CREEK NORTH – U7 LM 0.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	1

PLOT BY: L2EDGAD - May 22, 2013 - 4:56:12pm
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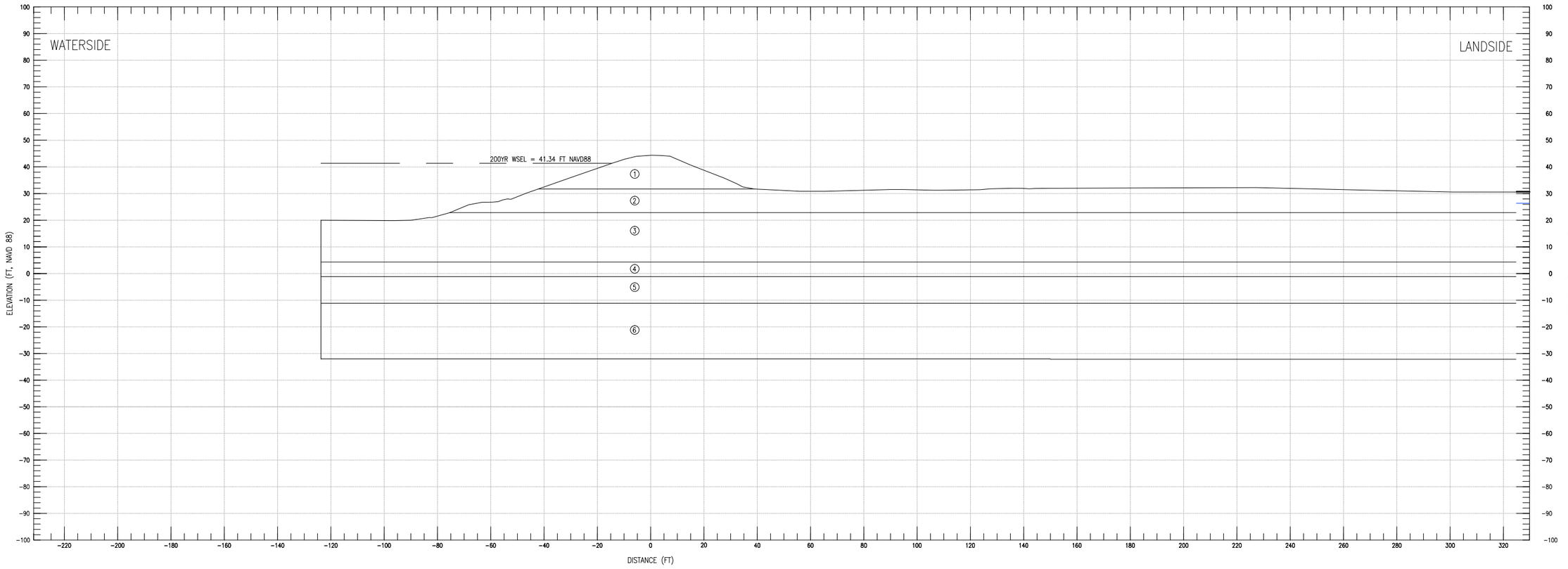

Boring Number	Layer ID	Material Type	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
W RARF C_003B	1	Sandy Lean Clay Levee	1.00E-05	4	2.50E-06	0.028	0.007	24	50	115
	2	Sandy Lean Clay Blanket	1.00E-05	1	1.00E-05	0.028	0.028	28	50	115
	3	Poorly Graded Sand	5.00E-03	4	1.25E-03	14.175	3.544	35	0	130
	4	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	33	0	125
	5	Sandy Silt	2.00E-04	4	5.00E-05	0.567	0.142	30	0	120
	6	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	35	0	125

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT

SECTION STRATIGRAPHY – 20 SCALE
ARN – REACH E – ARCADE CREEK NORTH – U7 LM 0.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	2

PLOT BY: I2EDGAJD - May 22, 2013 - 4:56:17pm
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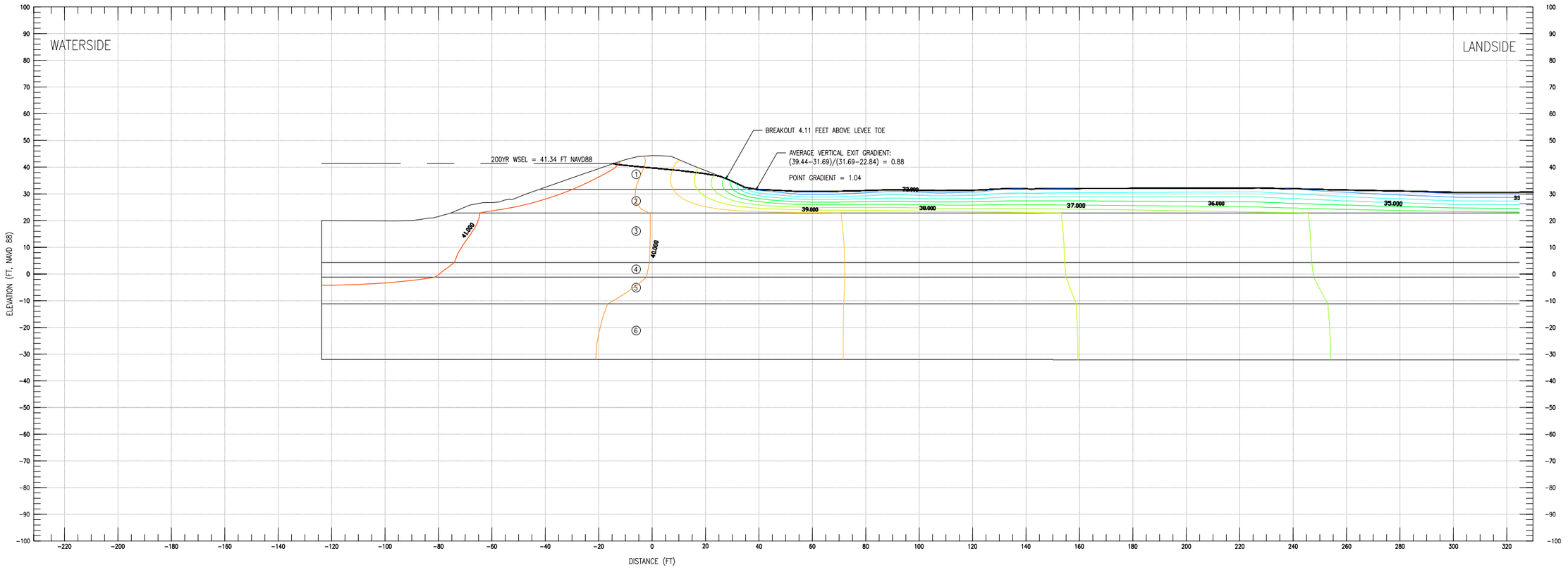

Boring Number	Layer ID	Material Type	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WRARF C_003B	1	Sandy Lean Clay Levee	1.00E-05	4	2.50E-06	0.028	0.007	24	50	115
	2	Sandy Lean Clay Blanket	1.00E-05	1	1.00E-05	0.028	0.028	28	50	115
	3	Poorly Graded Sand	5.00E-03	4	1.25E-03	14.175	3.544	35	0	130
	4	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	33	0	125
	5	Sandy Silt	2.00E-04	4	5.00E-05	0.567	0.142	30	0	120
	6	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	35	0	125

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT

200YR WSEL-HEAD CONTOURS-WITHOUT PROJECT
ARN – REACH E – ARCADE CREEK NORTH – U7 LM 0.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	3

PLOT BY: I2EDGAJD - May 22, 2013 - 4:56:22pm
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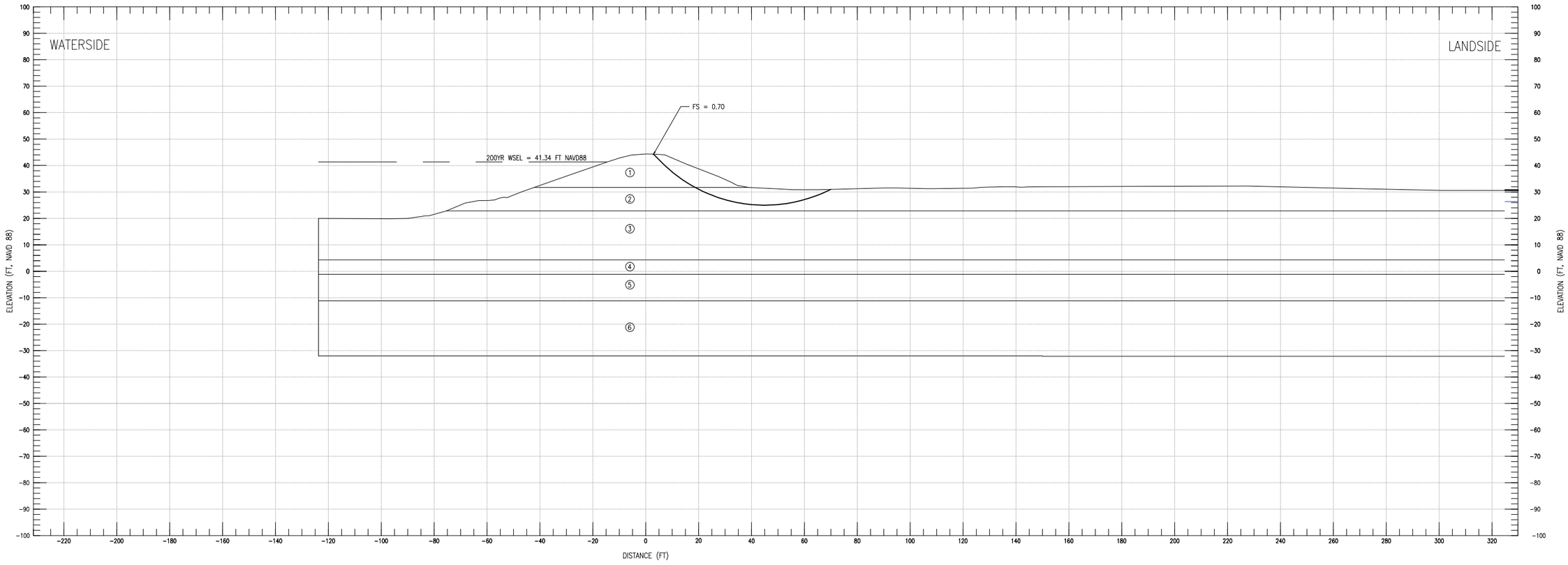

Boring Number	Layer ID	Material Type	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WRARF C_003B	1	Sandy Lean Clay Levee	1.00E-05	4	2.50E-06	0.028	0.007	24	50	115
	2	Sandy Lean Clay Blanket	1.00E-05	1	1.00E-05	0.028	0.028	28	50	115
	3	Poorly Graded Sand	5.00E-03	4	1.25E-03	14.175	3.544	35	0	130
	4	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	33	0	125
	5	Sandy Silt	2.00E-04	4	5.00E-05	0.567	0.142	30	0	120
	6	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	35	0	125

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES GENERAL REEVALUATION REPORT GEOTECHNICAL ATTACHMENT

200YR WSEL-CRITICAL SHEAR SURFACE-WITHOUT PROJECT
ARN – REACH E – ARCADE CREEK NORTH – U7 LM 0.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	4

PLOT BY: I2EDGAJD - May 22, 2013 - 4:56:28pm
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WATERSIDE

LANDSIDE

200YR WSEL = 41.34 FT NAVD88

BREAKOUT AT 2.26 FEET ABOVE LEVEE TOE

AVERAGE VERTICAL EXIT GRADIENT:
(35.47−31.53)/(31.53−22.84) = 0.45

POINT GRADIENT: 0.66

DISTANCE FROM BASELINE (FEET)

DISTANCE FROM BASELINE (FEET)

Boring Number	Layer ID	Material Type	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WRARF C_000B	1	Sandy Lean Clay Levee	1.00E-05	4	2.50E-06	0.028	0.007	24	50	115
	2	Sandy Lean Clay Blanket	1.00E-05	1	1.00E-05	0.028	0.028	28	50	115
	3	Poorly Graded Sand	5.00E-03	4	1.25E-03	14.175	3.544	35	0	130
	4	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	33	0	125
	5	Sandy Silt	2.00E-04	4	5.00E-05	0.567	0.142	30	0	120
	6	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	35	0	125
	7	Engineered Fill (SC)	1.00E-05	1.00	1.00E-05	0.028	0.028	32	50	125
	8	Cutoff Wall	1.00E-05	1.00	1.00E-05	0.028	0.028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

DEPARTMENT OF THE ARMY
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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT

200YR WSEL−HEAD CONTOURS−WITH PROJECT
ARN − REACH E − ARCADE CREEK NORTH − U7 LM 0.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	5

PLOT BY: L2EDGAJD - Feb 27, 2013 - 11:57:04am
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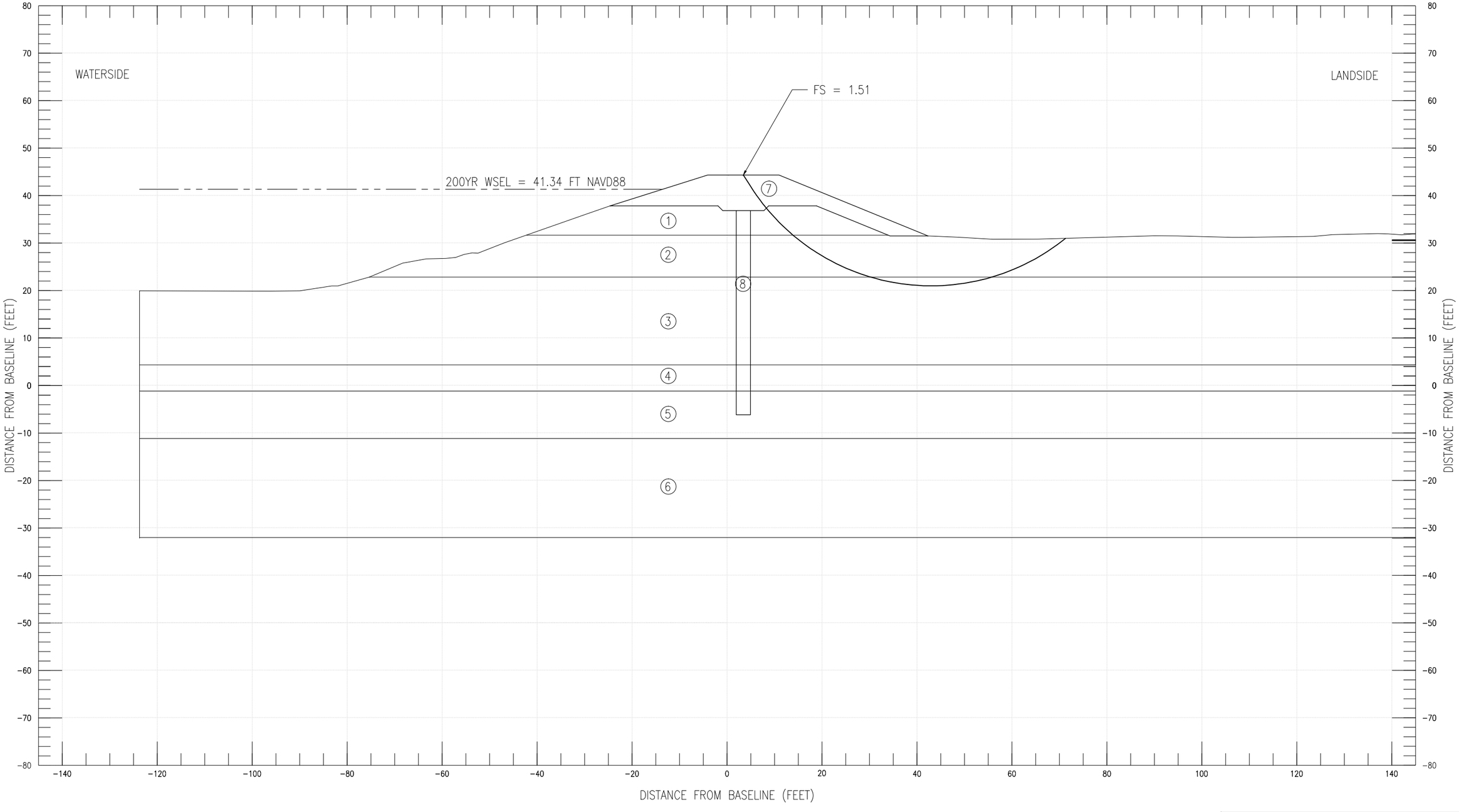

Boring Number	Layer ID	Material Type	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
WRARF C_003B	1	Sandy Lean Clay Levee	1.00E-05	4	2.50E-06	0.028	0.007	24	50	115
	2	Sandy Lean Clay Blanket	1.00E-05	1	1.00E-05	0.028	0.028	28	50	115
	3	Poorly Graded Sand	5.00E-03	4	1.25E-03	14.175	3.544	35	0	130
	4	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	33	0	125
	5	Sandy Silt	2.00E-04	4	5.00E-05	0.567	0.142	30	0	120
	6	Silty Sand	1.00E-03	4	2.50E-04	2.835	0.709	35	0	125
	7	Engineered Fill (SC)	1.00E-05	1.00	1.00E-05	0.028	0.028	32	50	125
	8	Cutoff Wall	1.00E-05	1.00	1.00E-05	0.028	0.028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

DEPARTMENT OF THE ARMY
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SACRAMENTO CALIFORNIA

AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT
200YR WSEL-CRITICAL SHEAR SURFACE-WITH PROJECT
ARN – REACH E – ARCADE CREEK NORTH – U7 LM 0.90

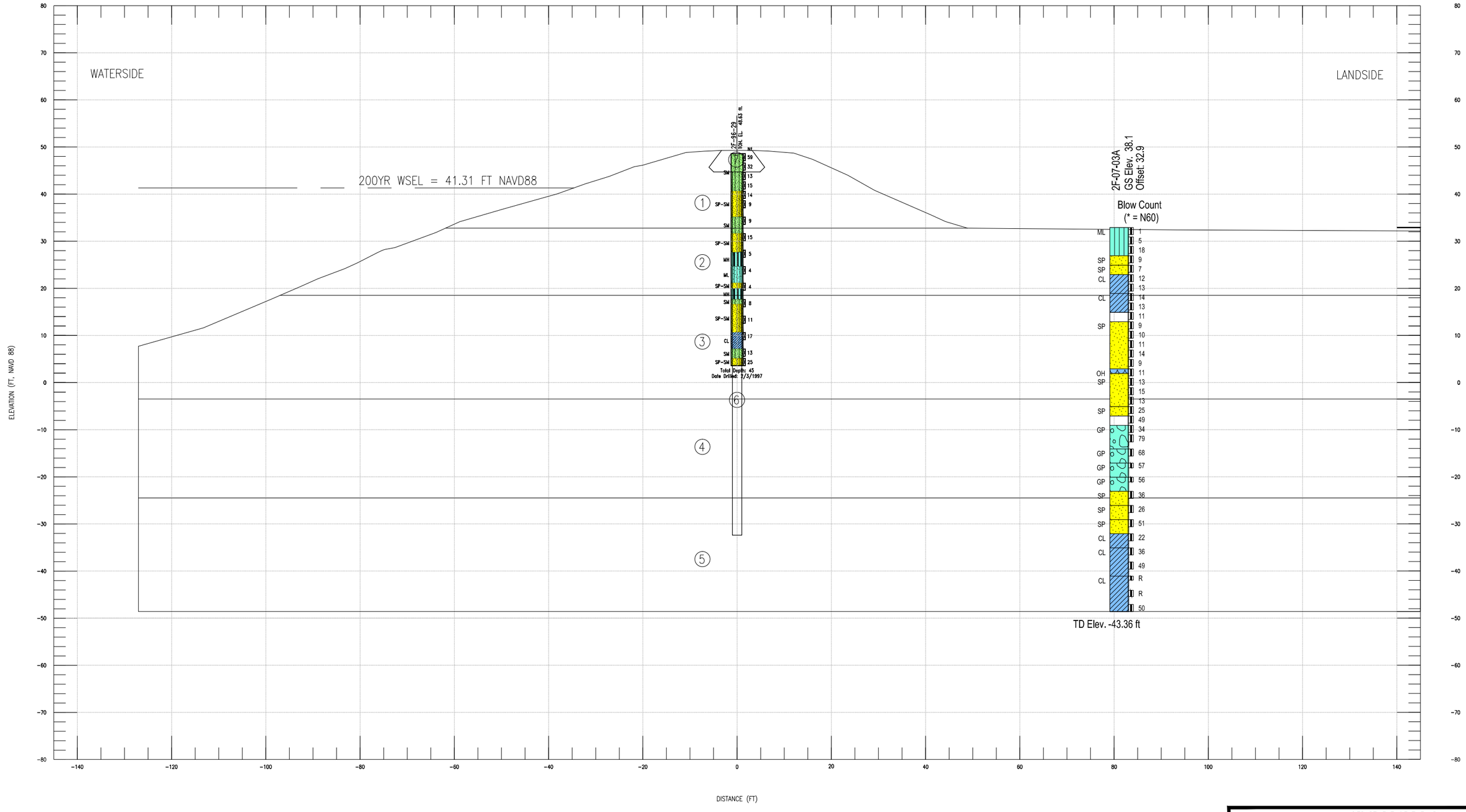
DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	6

PLOT BY: I2EDGAJD - Feb 27, 2013 - 11:57: 12am
DRAWING: X:\SOILS\common features gr\14 - cf gr\15 - submittals\arcf gr geotechnical report\arcf geotechnical appendix\gr appendix plates\ACN_RE_U7_LM_0.90(F4).dwg

AMERICAN RIVER SOUTH BASIN

ARS REACH B – AMERICAN RIVER SOUTH – U4 LM 3.90

STEADY STATE SEEPAGE AND LANDSIDE SLOPE STABILITY ANALYSES RESULTS



Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-96-29,	1	Poorly Graded Sand to Silty Sand (SP-SM)	1.00E-03	4	2.50E-04	2.8350	0.7088	33	0	125
2F-00-9W,	2	Levee Foundation Silt (ML)	2.00E-04	4.0	5.00E-05	0.5670	0.1418	30	0	120
2F-00-114,	3	Poorly Graded Silty Sand (SP-SM) with Clay & Silt	5.00E-03	4	1.25E-03	14.1750	3.5438	33	0	125
WCSBAR_0	4	Poorly Graded Gravel & Cobbles (GP)	1.20E-02	4	3.00E-03	34.0200	8.5050	35	0	135
03B, 2F-99-	5	Silt and Clay (CL-ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	0	120
17, 2F-97-	6	Cut-off Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85
23	7	Impervious Clay Cap	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115

HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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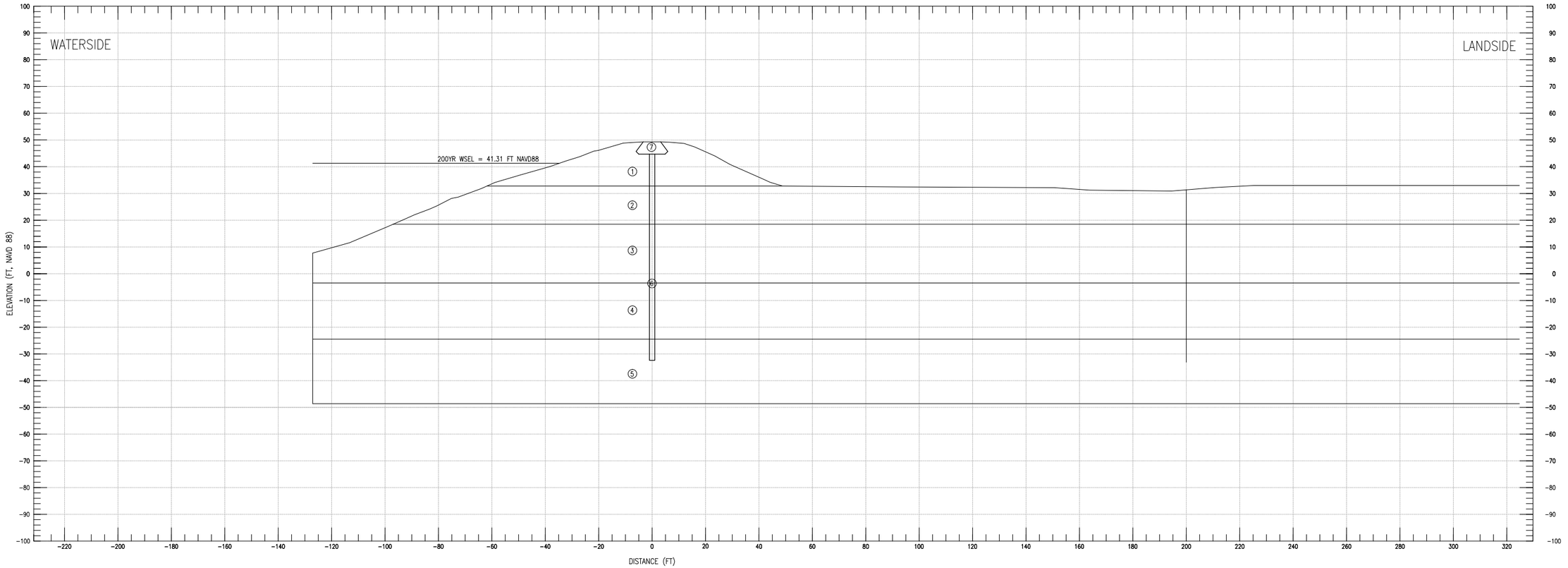
AMERICAN RIVER WATERSHED - COMMON FEATURES GENERAL REEVALUATION REPORT GEOTECHNICAL ATTACHMENT

SECTION STRATIGRAPHY – 10 SCALE

ARS – REACH B – AMERICAN RIVER SOUTH – U4 LM 3.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	1

PLOT BY: LZEDGAJD - May 23, 2013 - 9:42:06am
DRAWING: X:\SOILS\Common Features GRR\4 - CF GRR\15 - Submittals\ARCF GRR Geotechnical Report\ARCF Geotechnical Appendix\GRR Appendix Plates\200YR WSEL-CRITICAL SHEAR SURFACE-WITHOUT PROJECT.dwg



Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-96-29, 2F-00-9W, 2F-00-114, WCSBAR_0 03B, 2F-99-17, 2F-97-23	1	Poorly Graded Sand to Silty Sand (SP-SM)	1.00E-03	4	2.50E-04	2.8350	0.7088	33	0	125
	2	Levee Foundation Silt (ML)	2.00E-04	4.0	5.00E-05	0.5670	0.1418	30	0	120
	3	Poorly Graded Silty Sand (SP-SM) with Clay & Silt	5.00E-03	4	1.25E-03	14.1750	3.5438	33	0	125
	4	Poorly Graded Gravel & Cobbles (GP)	1.20E-02	4	3.00E-03	34.0200	8.5050	35	0	135
	5	Silt and Clay (CL-ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	0	120
	6	Cut-off Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85
	7	Impervious Clay Cap	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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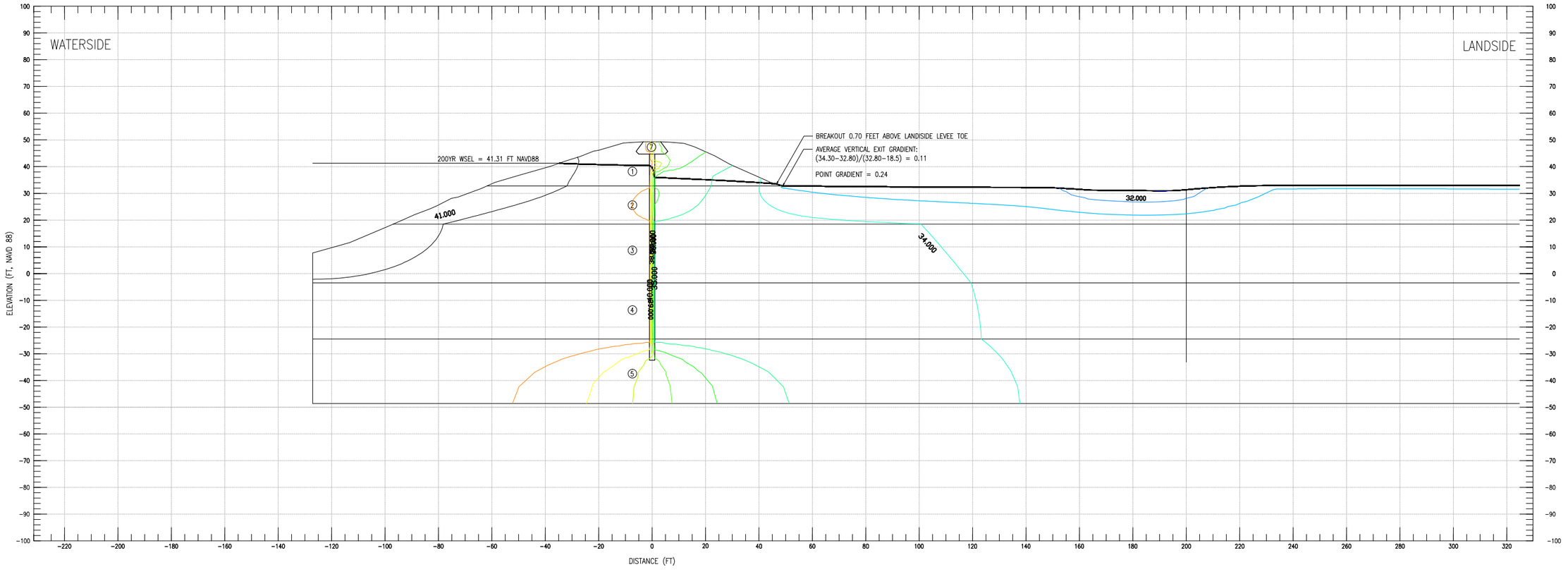
AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT
SECTION STRATIGRAPHY – 20 SCALE
ARS – REACH B – AMERICAN RIVER SOUTH – U4 LM 3.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	2

PLOT BY: LZEDGAJD - May 23, 2013 - 9:42:13am
DRAWING: X:\SOILS\Common Features GRR\4 - CF GRR\15 - Submittals\ARCF GRR Geotechnical Report\ARCF Geotechnical Appendix\GRR Appendix Plates\200YR WSEL-CRITICAL SHEAR SURFACE-WITHOUT PROJECT.dwg



Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-96-29,	1	Poorly Graded Sand to Silty Sand (SP-SM)	1.00E-03	4	2.50E-04	2.8350	0.7088	33	0	125
2F-00-9W,	2	Levee Foundation Silt (ML)	2.00E-04	4.0	5.00E-05	0.5670	0.1418	30	0	120
2F-00-114,	3	Poorly Graded Silty Sand (SP-SM) with Clay & Silt	5.00E-03	4	1.25E-03	14.1750	3.5438	33	0	125
WCSBAR_0	4	Poorly Graded Gravel & Cobbles (GP)	1.20E-02	4	3.00E-03	34.0200	8.5050	35	0	135
03B, 2F-99-	5	Silt and Clay (CL-ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	0	120
17, 2F-97-	6	Cut-off Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85
23	7	Impervious Clay Cap	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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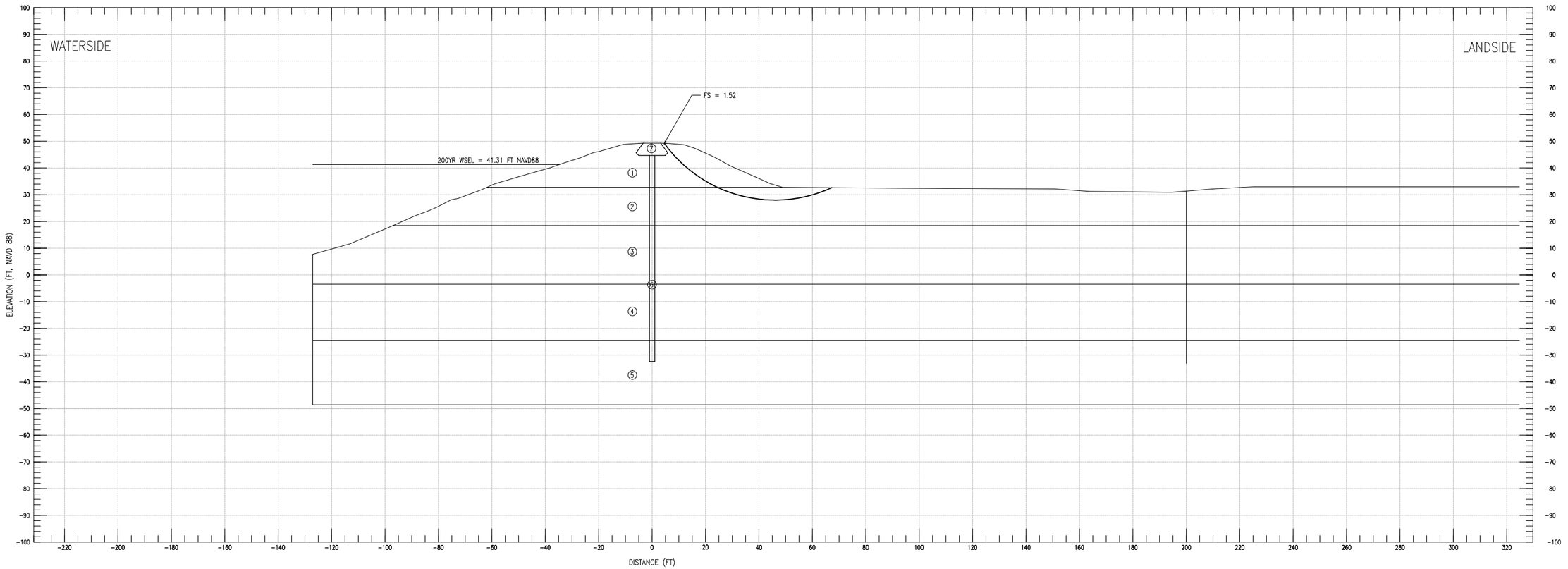
AMERICAN RIVER WATERSHED - COMMON FEATURES GENERAL REEVALUATION REPORT GEOTECHNICAL ATTACHMENT

200YR WSEL-HEAD CONTOURS-WITHOUT PROJECT

ARS – REACH B – AMERICAN RIVER SOUTH – U4 LM 3.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	

PLOT BY: I:2EDGAJD - May 23, 2013 - 5:12:10pm
DRAWING: X:\SOILS\Common Features GRR14 - CF GRR15 - Submittals\ARCF GRR Geotechnical Report\ARCF Geotechnical Appendix\GRR Appendix Plates\200YR WSEL-CRITICAL SHEAR SURFACE-WITHOUT PROJECT.dwg



Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-96-29, 2F-00-9W, 2F-00-114, WCSBAR_0 03B, 2F-99-17, 2F-97-23	1	Poorly Graded Sand to Silty Sand (SP-SM)	1.00E-03	4	2.50E-04	2.8350	0.7088	33	0	125
	2	Levee Foundation Silt (ML)	2.00E-04	4.0	5.00E-05	0.5670	0.1418	30	0	120
	3	Poorly Graded Silty Sand (SP-SM) with Clay & Silt	5.00E-03	4	1.25E-03	14.1750	3.5438	33	0	125
	4	Poorly Graded Gravel & Cobbles (GP)	1.20E-02	4	3.00E-03	34.0200	8.5050	35	0	135
	5	Silt and Clay (CL-ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	0	120
	6	Cut-off Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85
	7	Impervious Clay Cap	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115

HORIZONTAL SCALE: 1"=20' AT ORIGINAL D-SIZE DRAWING

VERTICAL SCALE: 1"=20' AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES GENERAL REEVALUATION REPORT GEOTECHNICAL ATTACHMENT

200YR WSEL-CRITICAL SHEAR SURFACE-WITHOUT PROJECT

ARS – REACH B – AMERICAN RIVER SOUTH – U4 LM 3.90

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	4

PLOT BY: LZEDGAJD - May 23, 2013 - 5:12:21pm
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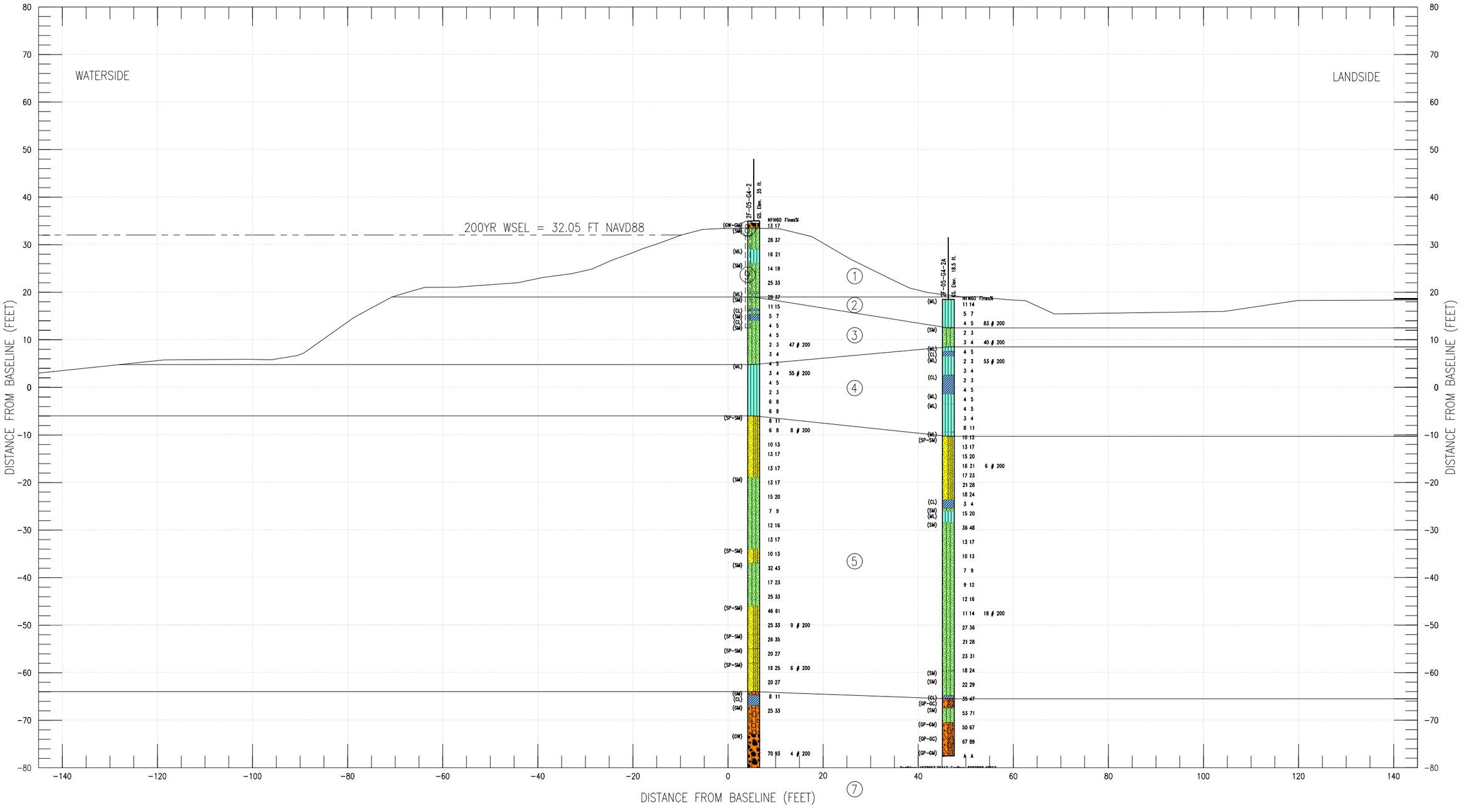
ARS REACH F – SACRAMENTO RIVER EAST – U1 LM 5.92

STEADY STATE SEEPAGE AND LANDSIDE SLOPE STABILITY ANALYSES RESULTS



Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-05-G4-2, 2F-05-G4-2A	1	Silty Sand (SM) with Silty (ML) and Poorly Graded Sand (SP) Levee Embankment	1.00E-02	4	2.50E-03	28.3500	7.0875	34	0	125
	2	Silt Blanket (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	28	0	120
	3	Silty Sand (SM)	5.00E-04	4	1.25E-04	1.4175	0.3544	30	0	125
	4	Silt (ML) and Lean Clay (CL)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	50	120
	5	Silty Sand (SM), Poorly Graded Sand (SP)	5.00E-03	4	1.25E-03	14.1750	3.5438	30	0	125
	6	Poorly Graded Gravel (GP) Poorly Graded Sand (SP)	2.50E-02	10	2.50E-03	70.8750	7.0875	35	0	135
	7	Lean Clay with Silt (CL w/ ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	8	Impervious Clay Cap (CL)	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115
	9	Cutoff Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES GENERAL REEVALUATION REPORT GEOTECHNICAL ENCLOSURE - F3

SECTION STRATIGRAPHY– 10 SCALE

ARS – REACH F – SACRAMENTO RIVER EAST – U1 LM 5.92

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	1

PLOT BY: L2EDGJAD - May 23, 2013 - 5:41:28pm
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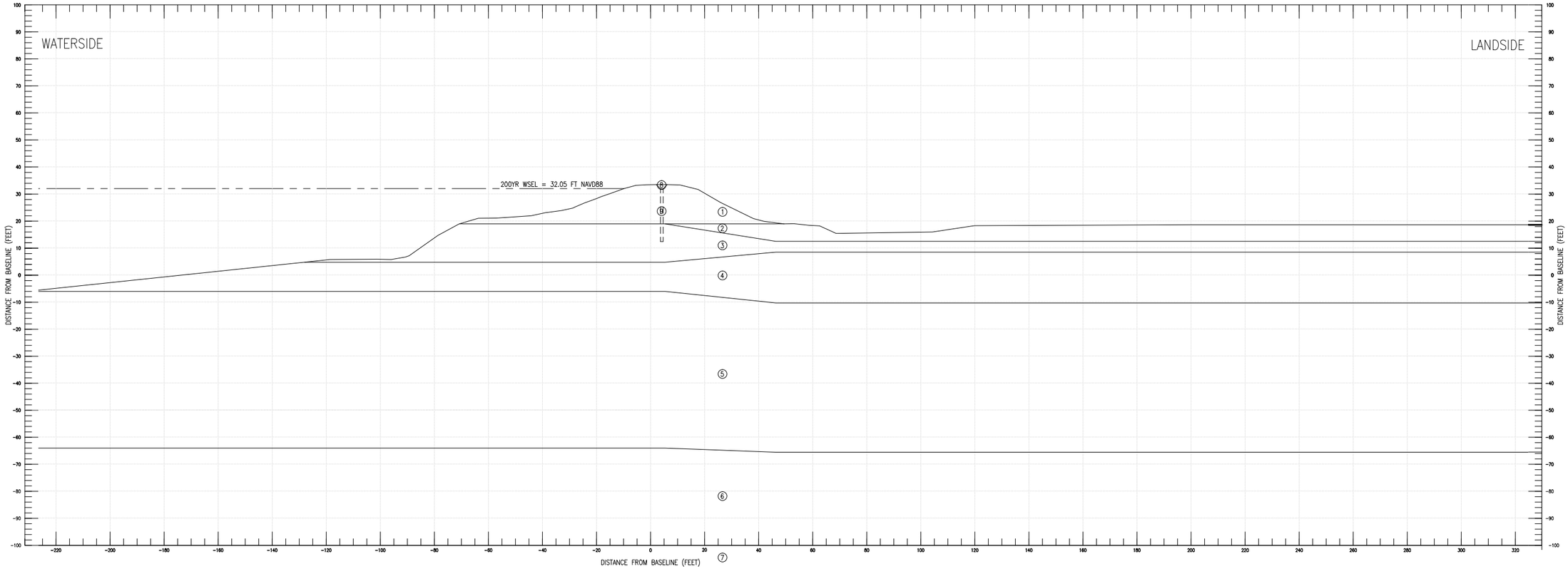

Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-05-G4-2, 2F-05-G4-2A	1	Silty Sand (SM) with Silty (ML) and Poorly Graded Sand (SP) Levee Embankment	1.00E-02	4	2.50E-03	28.3500	7.0875	34	0	125
	2	Silt Blanket (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	28	0	120
	3	Silty Sand (SM)	5.00E-04	4	1.25E-04	1.4175	0.3544	30	0	125
	4	Silt (ML) and Lean Clay (CL)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	50	120
	5	Silty Sand (SM), Poorly Graded Sand (SP)	5.00E-03	4	1.25E-03	14.1750	3.5438	30	0	125
	6	Poorly Graded Gravel (GP) Poorly Graded Sand (SP)	2.50E-02	10	2.50E-03	70.8750	7.0875	35	0	135
	7	Lean Clay with Silt (CL w/ ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	8	Impervious Clay Cap (CL)	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115
	9	Cutoff Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES GENERAL REEVALUATION REPORT GEOTECHNICAL ENCLOSURE - F3

SECTION STRATIGRAPHY– 20 SCALE

ARS – REACH F – SACRAMENTO RIVER EAST – U1 LM 5.92

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	2

PLOT BY: LZEDGAJD - May 23, 2013 - 5:41:33pm
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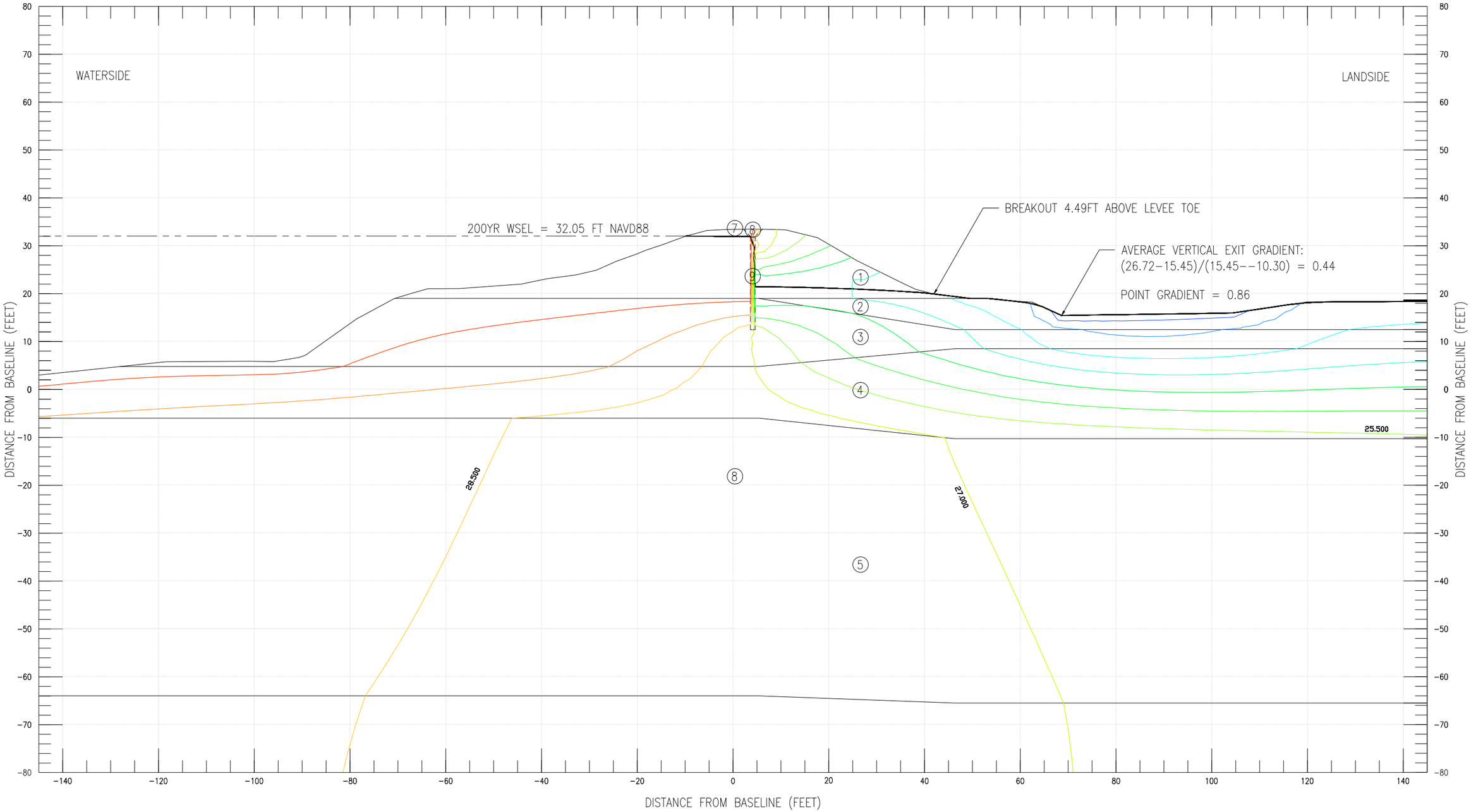

Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-05-G4-2, 2F-05-G4-2A	1	Silty Sand (SM) with Silty (ML) and Poorly Graded Sand (SP) Levee Embankment	1.00E-02	4	2.50E-03	28.3500	7.0875	34	0	125
	2	Silt Blanket (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	28	0	120
	3	Silty Sand (SM)	5.00E-04	4	1.25E-04	1.4175	0.3544	30	0	125
	4	Silt (ML) and Lean Clay (CL)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	50	120
	5	Silty Sand (SM), Poorly Graded Sand (SP)	5.00E-03	4	1.25E-03	14.1750	3.5438	30	0	125
	6	Poorly Graded Gravel (GP) Poorly Graded Sand (SP)	2.50E-02	10	2.50E-03	70.8750	7.0875	35	0	135
	7	Lean Clay with Silt (CL w/ ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	8	Impervious Clay Cap (CL)	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115
	9	Cutoff Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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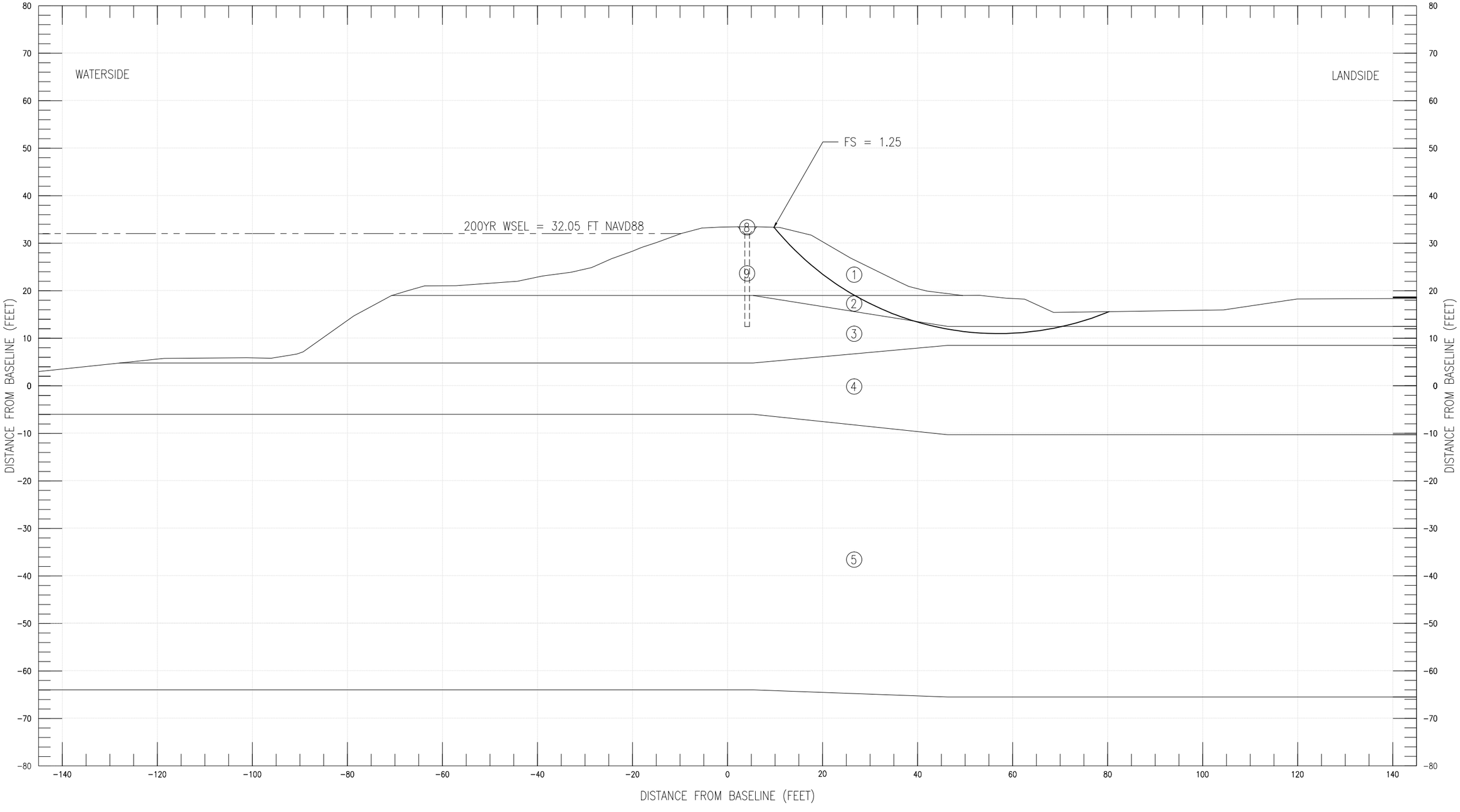
AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ENCLOSURE - F3

200YR WSEL-HEAD CONTOURS-WITHOUT PROJECT
ARS - REACH F - SACRAMENTO RIVER EAST - U1 LM 5.92

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	3

PLOT BY: I2EDGAJD - May 23, 2013 - 5:41:42pm
DRAWING: X:\SOILS\Common Features GRR\4 - CF GRR\15 - Submittals\ARCF GRR Geotechnical Report\ARCF Geotechnical Appendix\GRR Appendix Plates\200YR WSEL-CRITICAL SHEAR SURFACE M1.dwg



Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-05-G4-2, 2F-05-G4-2A	1	Silty Sand (SM) with Silty (ML) and Poorly Graded Sand (SP) Levee Embankment	1.00E-02	4	2.50E-03	28.3500	7.0875	34	0	125
	2	Silt Blanket (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	28	0	120
	3	Silty Sand (SM)	5.00E-04	4	1.25E-04	1.4175	0.3544	30	0	125
	4	Silt (ML) and Lean Clay (CL)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	50	120
	5	Silty Sand (SM), Poorly Graded Sand (SP)	5.00E-03	4	1.25E-03	14.1750	3.5438	30	0	125
	6	Poorly Graded Gravel (GP) Poorly Graded Sand (SP)	2.50E-02	10	2.50E-03	70.8750	7.0875	35	0	135
	7	Lean Clay with Silt (CL w/ ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	8	Impervious Clay Cap (CL)	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115
	9	Cutoff Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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SACRAMENTO, CALIFORNIA

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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ENCLOSURE - F3
200YR WSEL-CRITICAL SHEAR SURFACE-WITHOUT PROJECT
ARS - REACH F - SACRAMENTO RIVER EAST - U1 LM 5.92

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	4

PLOT BY: I:\ZEDGAJD - May 23, 2013 - 5:41:50pm
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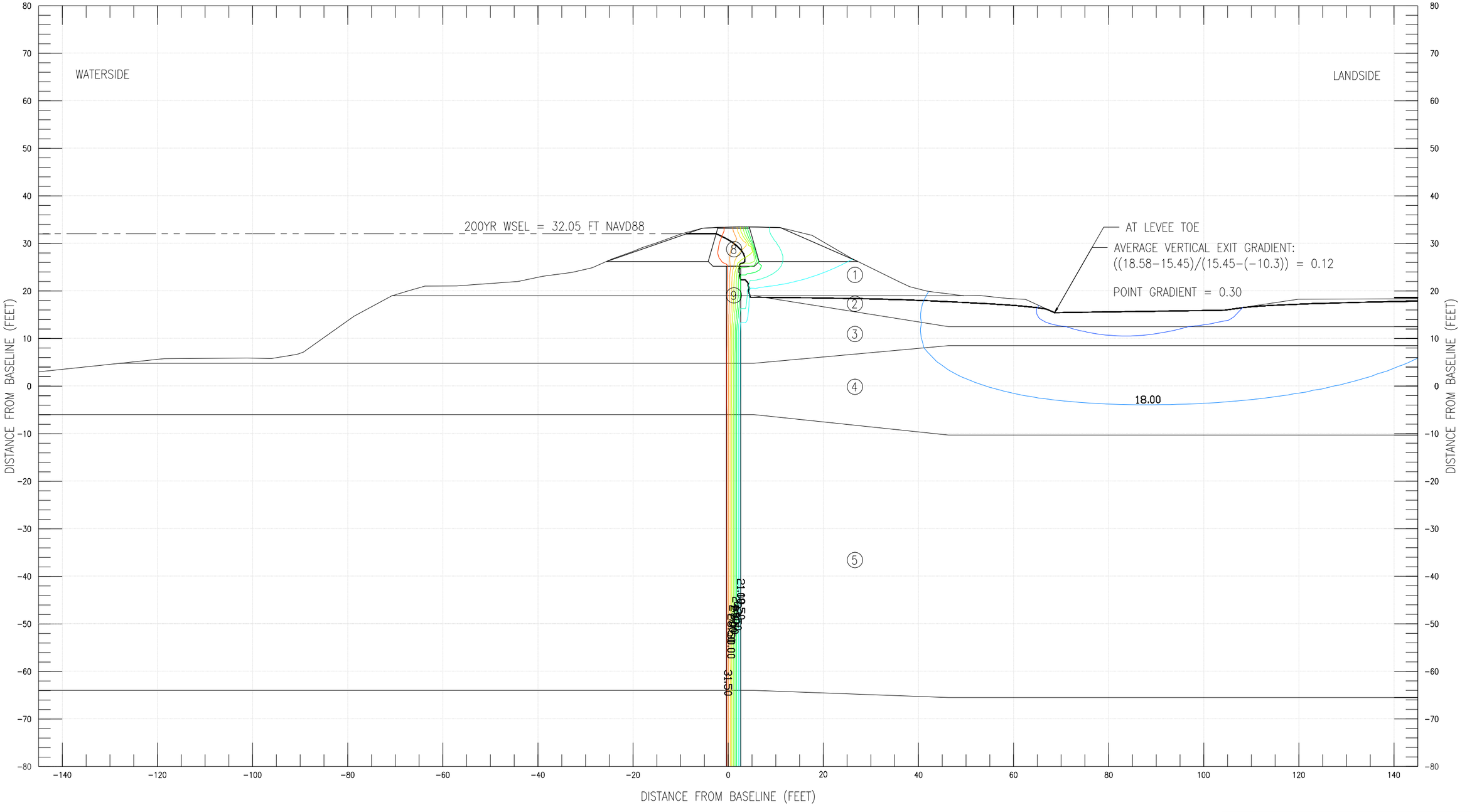

Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-05-G4-2, 2F-05-G4-2A	1	Silty Sand (SM) with Silty (ML) and Poorly Graded Sand (SP) Levee Embankment	1.00E-02	4	2.50E-03	28.3500	7.0875	34	0	125
	2	Silt Blanket (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	28	0	120
	3	Silty Sand (SM)	5.00E-04	4	1.25E-04	1.4175	0.3544	30	0	125
	4	Silt (ML) and Lean Clay (CL)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	50	120
	5	Silty Sand (SM), Poorly Graded Sand (SP)	5.00E-03	4	1.25E-03	14.1750	3.5438	30	0	125
	6	Poorly Graded Gravel (GP) Poorly Graded Sand (SP)	2.50E-02	10	2.50E-03	70.8750	7.0875	35	0	135
	7	Lean Clay with Silt (CL w/ ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	8	Impervious Clay Cap (CL)	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115
	9	Cutoff Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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SACRAMENTO, CALIFORNIA

SACRAMENTO CALIFORNIA

AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ENCLOSURE - F3
200YR WSEL-HEAD CONTOURS- WITH PROJECT
ARS - REACH F - SACRAMENTO RIVER EAST - U1 LM 5.92

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	5

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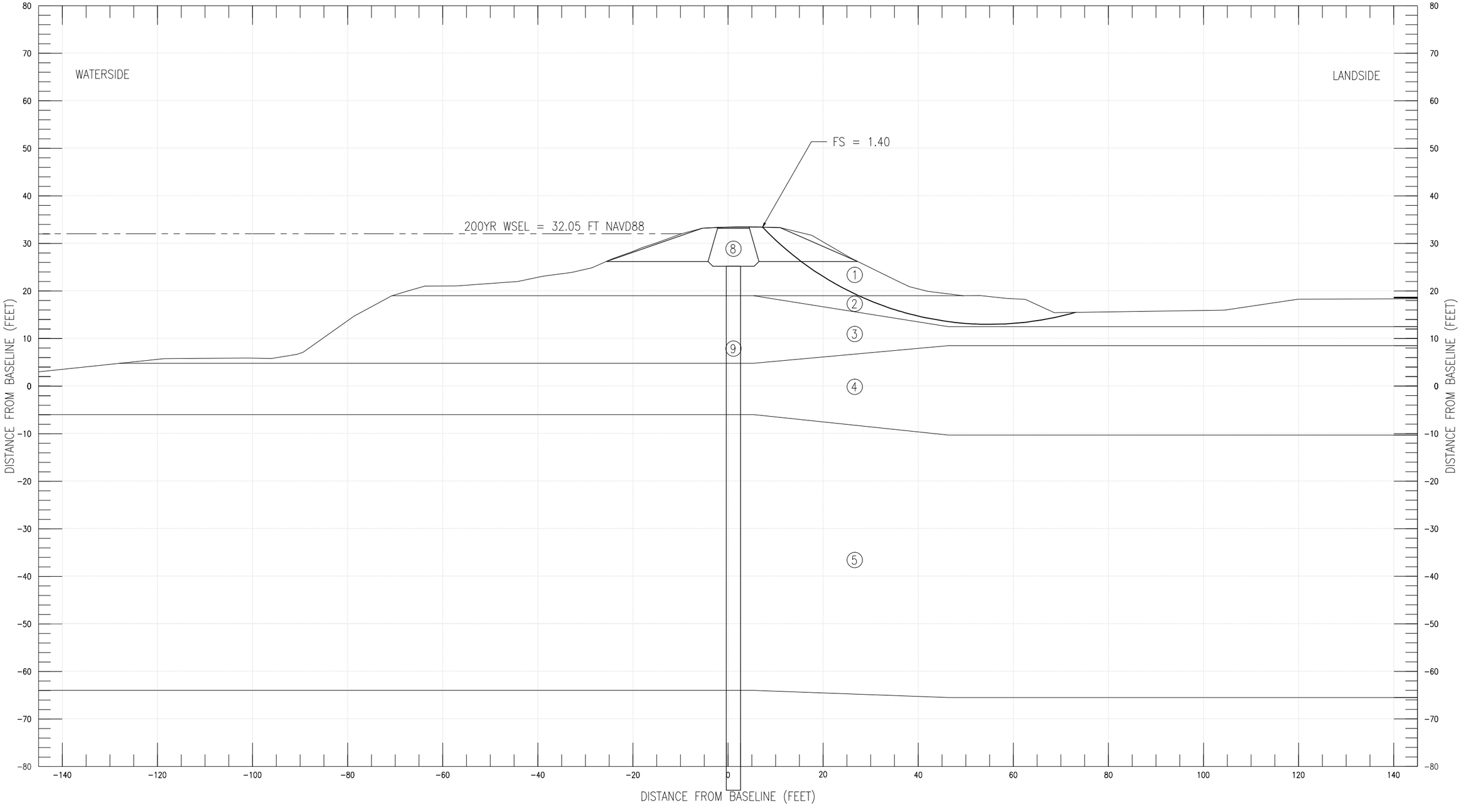

Boring Number	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal kh (kx) cm/sec	Anisotropy Ratio kh/kv	Vertical kv (ky) cm/sec	Horizontal kh (kx) ft/day	Vertical kv (ky) ft/day	Φ'	C' (psf)	γ (pcf)
2F-05-G4-2, 2F-05-G4-2A	1	Silty Sand (SM) with Silty (ML) and Poorly Graded Sand (SP) Levee Embankment	1.00E-02	4	2.50E-03	28.3500	7.0875	34	0	125
	2	Silt Blanket (ML)	2.00E-04	4	5.00E-05	0.5670	0.1418	28	0	120
	3	Silty Sand (SM)	5.00E-04	4	1.25E-04	1.4175	0.3544	30	0	125
	4	Silt (ML) and Lean Clay (CL)	2.00E-04	4	5.00E-05	0.5670	0.1418	30	50	120
	5	Silty Sand (SM), Poorly Graded Sand (SP)	5.00E-03	4	1.25E-03	14.1750	3.5438	30	0	125
	6	Poorly Graded Gravel (GP) Poorly Graded Sand (SP)	2.50E-02	10	2.50E-03	70.8750	7.0875	35	0	135
	7	Lean Clay with Silt (CL w/ ML)	1.00E-05	4	2.50E-06	0.0284	0.0071	28	50	115
	8	Impervious Clay Cap (CL)	1.00E-05	1	1.00E-05	0.0284	0.0284	28	50	115
	9	Cutoff Wall	1.00E-06	1	1.00E-06	0.0028	0.0028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ENCLOSURE - F3
200YR WSEL–CRITICAL SHEAR SURFACE– WITH PROJECT
ARS – REACH F – SACRAMENTO RIVER EAST – U1 LM 5.92

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	6

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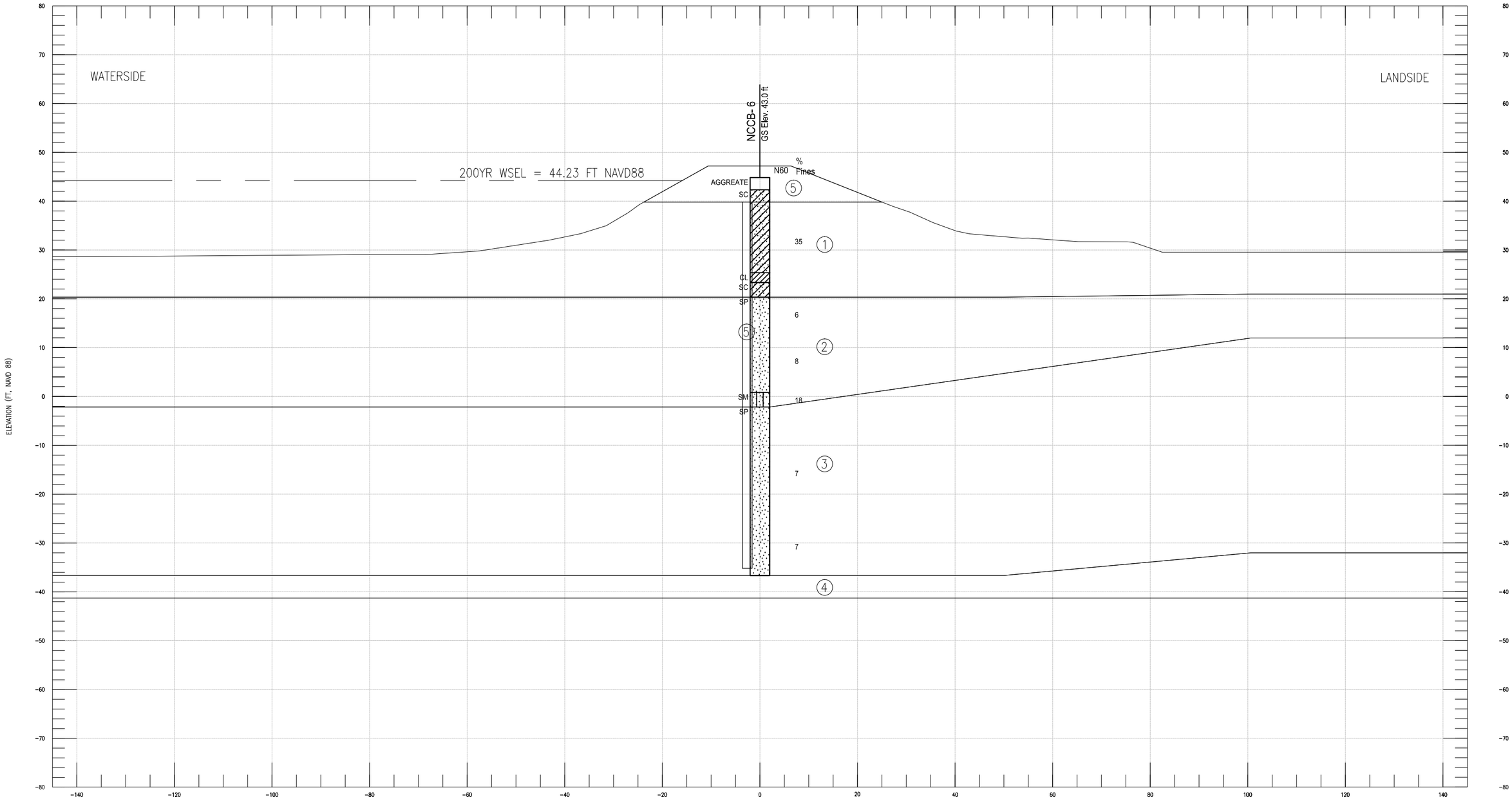
NATOMAS BASIN

NAT REACH D – NCC SOUTH – U1 LM 1.17

STEADY STATE SEEPAGE AND LANDSIDE SLOPE STABILITY ANALYSES RESULTS



Natomas Cross Canal Sta. 956+00 LM 1.17										
Boring	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal k_h (k_x) cm/sec	k_h/k_v	Vertical k_v (k_y) cm/sec	Horizontal k_h (k_x) ft/day	Vertical k_v (k_y) ft/day	Φ	C	γ
NCCB-6, NCCB-6-49	1	Clayey Sand (SC)	4.0E-05	4	1.0E-05	0.113	0.028	28	50	120
	2	Poorly Graded Sand w/ silt (SP-SM)	1.0E-03	10	1.0E-04	2.835	0.284	33	0	130
	3	Poorly Graded Sand (SP)	5.0E-03	10	5.0E-04	14.175	1.418	34	0	135
	4	Sandy Fat Clay (CH)	1.0E-05	10	1.0E-06	0.028	0.003	30	50	110
	5	Clay Cap	1.0E-06	4	2.5E-07	0.0028	0.0007	28	50	115
	6	Cutoff Wall	1.0E-06	1	1.0E-06	0.0028	0.0028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT
NAT REACH D UNIT 1 LM 1.17-SECTION STRATIGRAPHY-10 SCALE
NATOMAS BASIN

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	1

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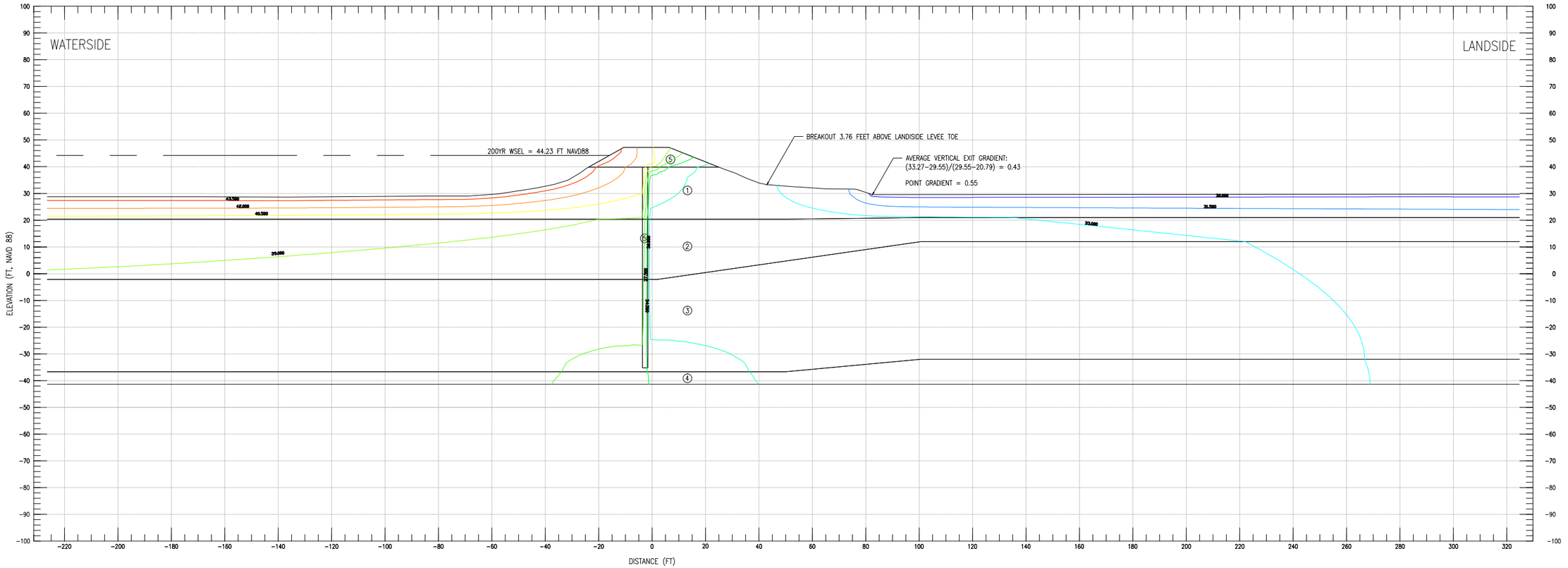

Natomas Cross Canal Sta. 956+00 LM 1.17										
Boring	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal k_h (k_x) cm/sec	k_h/k_v	Vertical k_v (k_y) cm/sec	Horizontal k_h (k_x) ft/day	Vertical k_v (k_y) ft/day	Φ	C	γ
NCCB-6, NCCB-6-49	1	Clayey Sand (SC)	4.0E-05	4	1.0E-05	0.113	0.028	28	50	120
	2	Poorly Graded Sand w/ silt (SP-SM)	1.0E-03	10	1.0E-04	2.835	0.284	33	0	130
	3	Poorly Graded Sand (SP)	5.0E-03	10	5.0E-04	14.175	1.418	34	0	135
	4	Sandy Fat Clay (CH)	1.0E-05	10	1.0E-06	0.028	0.003	30	50	110
	5	Clay Cap	1.0E-06	4	2.5E-07	0.0028	0.0007	28	50	115
	6	Cutoff Wall	1.0E-06	1	1.0E-06	0.0028	0.0028	0	50	85

0 20' 40'
HORIZONTAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

0 20' 40'
VERTICAL SCALE: 1"=20'
AT ORIGINAL D-SIZE DRAWING

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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT

NAT REACH D UNIT 1 LM 1.17-200YR WSEL-HEAD CONTOURS
NATOMAS BASIN

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	

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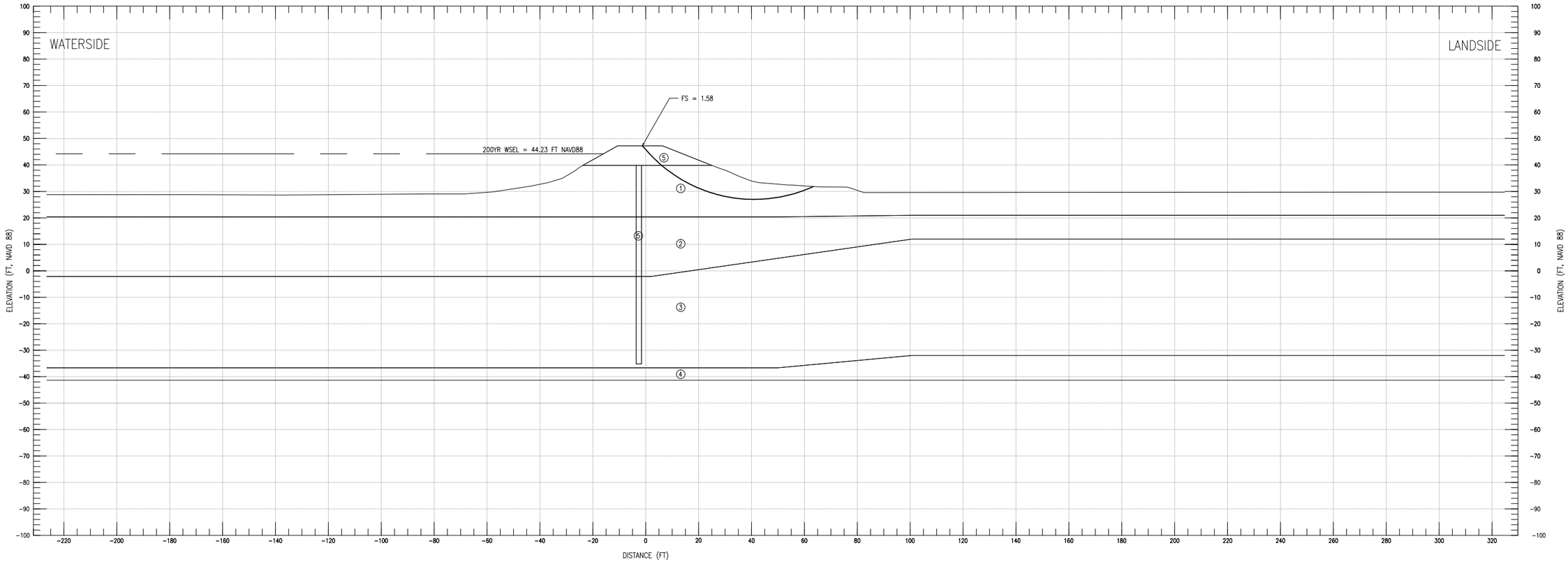

Natomas Cross Canal Sta. 956+00 LM 1.17										
Boring	Layer ID	USCS Soil Classification	Estimated Permeability for Seepage Analysis					Estimated Strength Parameters		
			Horizontal k_h (k_x) cm/sec	k_h/k_v	Vertical k_v (k_y) cm/sec	Horizontal k_h (k_x) ft/day	Vertical k_v (k_y) ft/day	Φ	C	γ
NCCB-6, NCCB-6-49	1	Clayey Sand (SC)	4.0E-05	4	1.0E-05	0.113	0.028	28	50	120
	2	Poorly Graded Sand w/ silt (SP-SM)	1.0E-03	10	1.0E-04	2.835	0.284	33	0	130
	3	Poorly Graded Sand (SP)	5.0E-03	10	5.0E-04	14.175	1.418	34	0	135
	4	Sandy Fat Clay (CH)	1.0E-05	10	1.0E-06	0.028	0.003	30	50	110
	5	Clay Cap	1.0E-06	4	2.5E-07	0.0028	0.0007	28	50	115
	6	Cutoff Wall	1.0E-06	1	1.0E-06	0.0028	0.0028	0	50	85

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0 20' 40'
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AMERICAN RIVER WATERSHED - COMMON FEATURES
GENERAL REEVALUATION REPORT
GEOTECHNICAL ATTACHMENT
NAT REACH D UNIT 1 LM 1.17-200YR WSEL-CRITICAL SHEAR SURFACE
NATOMAS BASIN

DATE:	SCALE:	SHEET NO.
29-Jan-13	AS SHOWN	4

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AMERICAN RIVER WATERSHED

COMMON FEATURES PROJECT

GENERAL REEVALUATION REPORT

ATTACHMENT C – GEOTECHNICAL REPORT

ENCLOSURE 3

PROBABILISTIC ANALYSES AND LEVEE PERFORMANCE CURVES

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Determination of Random Variables For Underseepage Reliability Analysis

Project: American River Common Features GRR
Channel: American River
Basin and Reach: ARN Reach A Unit 9

Levee Mile: 1.32
River Mile: 7.82
Analysis Case Without Project Cutoff Wall

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Boring #	Blanket Thickness Variable (z)					Aquifer Thickness Variable (d)					Hydraulic Conductivity Vairables (Kb and Kf)								
	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Blanket		Aquifer Material		Kf/Kb	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation
											Material	Kb (ft/day)	Material	Kf (ft/day)					
WCNBAR_03B	20					15					SM	0.709	GM	34	48				
2F-97-06	22.7					30					SM	0.709	SP-SM/GM	24.8	35				
2F-99-08A	24					10					SM	0.709	SP-SM/GM	28	39				
2F-99-15A	6					39					SM	0.709	SP-SM/GM	30.92	44				
2F-02-17	10	15	8	96	53	24	24	10	214	42	SM	0.709	SP-SM/GM	27.33	39	41	4	456	10
2F-07-18A	10					26					SM	0.709	SP/GP	28.62	40				

Boring #	Blanket Material 1 (lowest permeability)			Blanket Material 2			Transformed Blanket Thickness (z)	Aquifer Material 1			Aquifer Material 2			Aquifer Material 3			Transformed Aquifer Horizontal Permeability (kf)
	Material Type	Thickness (z)	Permeability (Kb)	Material Type	Thickness (z)	Permeability (Kb)		Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	
WCNBAR_03B	SM	20	0.709				20	GM	15	34							34
2F-97-06	SM	22.7	0.709				22.7	SP-SM	13.8	14	GM	16.2	34				24.8
2F-99-08A	SM	24	0.709				24	SP-SM	3	14	GM	7	34				28
2F-99-15A	SM	6	0.709				6	SP-SM	6	14	GM	33	34				30.92
2F-02-17	SM	10	0.709				10	SP-SM	8	14	GM	16	34				27.33
2F-07-18A	SM	10	0.709				10	SP	7	14	GP	19	34				28.62

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Underseepage Reliability Analysis With Blanket Theory Analysis

Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

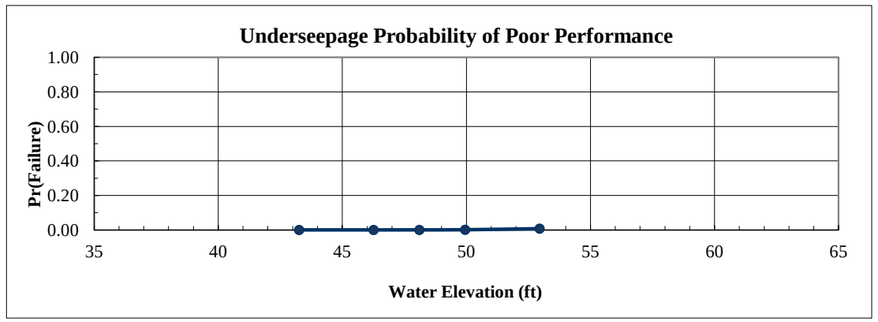
Levee Mile: 1.32
River Mile: 7.82
Analysis Case Without Project Cutoff Wall

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Permaebility Ratio	41	4	10
Blanket Thickness (z)	15	8	53
Aquifer Thickness (d)	24	10	42

Blanket Theory Analysis Inputs					
Pr(f)=0	**BTA Case No.**	**L1**	**L2**	**L3**	**γ Blanket**
NO	7A	265	85	∞	112



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	43.26	0.0000
Toe+3ft	3.00	46.26	0.0000
Half Height	4.85	48.11	0.0002
Crest-3ft	6.69	49.95	0.0010
Crest	9.69	52.95	0.0076

Crest		Rh
Head =	9.69	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	41	15.00	24.00	118.43	121.49	0.0739	3.62	0.24		
2	45	15.00	24.00	123.38	127.28	0.0715	3.67	0.24	0.000000	0.00
3	37	15.00	24.00	113.10	115.41	0.0766	3.57	0.24		
4	41	23.00	24.00	141.81	150.44	0.0636	3.86	0.17	0.021025	98.94
5	41	7.00	24.00	82.71	82.99	0.0957	3.21	0.46		
6	41	15.00	34.00	137.38	144.60	0.0926	3.82	0.25	0.000225	1.06
7	41	15.00	14.00	92.18	92.79	0.0519	3.33	0.22		
								Total	0.021250	100.00

E[I] = 0.240000 E[ln I] = -1.584129
Var[I]= 0.021250
σ[I]= 0.145774 σ [ln I] = 0.560379
V(I) = 0.607391

β =	-2.826888
F(z) =	0.992423
Pr(f) % =	0.757681

Ic= 0.80 ln(I crit) = -0.223144

Crest-3ft		Rh
Head =	6.69	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	41	15.00	24.00	118.43	121.49	0.0739	2.50	0.17		
2	45	15.00	24.00	123.38	127.28	0.0715	2.54	0.17	0.000025	0.24
3	37	15.00	24.00	113.10	115.41	0.0766	2.46	0.16		
4	41	23.00	24.00	141.81	150.44	0.0636	2.67	0.12	0.010000	97.56
5	41	7.00	24.00	82.71	82.99	0.0957	2.21	0.32		
6	41	15.00	34.00	137.38	144.60	0.0926	2.64	0.18	0.000225	2.20
7	41	15.00	14.00	92.18	92.79	0.0519	2.30	0.15		
								Total	0.010250	100.00

E[I] = 0.170000 E[ln I] = -1.923736
Var[I]= 0.010250
σ[I]= 0.101242 σ [ln I] = 0.550962
V(I) = 0.595543

β =	-3.491597
F(z) =	0.998988
Pr(f) % =	0.101233

Ic= 0.80 ln(I crit) = -0.223144

Half Height		Rh
Head =	4.85	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	41	15.00	24.00	118.43	121.49	0.0739	1.81	0.12		
2	45	15.00	24.00	123.38	127.28	0.0715	1.84	0.12	0.000000	0.00
3	37	15.00	24.00	113.10	115.41	0.0766	1.78	0.12		
4	41	23.00	24.00	141.81	150.44	0.0636	1.93	0.08	0.005625	98.25
5	41	7.00	24.00	82.71	82.99	0.0957	1.60	0.23		
6	41	15.00	34.00	137.38	144.60	0.0926	1.91	0.13	0.000100	1.75
7	41	15.00	14.00	92.18	92.79	0.0519	1.67	0.11		
								Total	0.005725	100.00

E[I] = 0.120000 E[ln I] = -2.287631
Var[I]= 0.005725
σ[I]= 0.075664 σ [ln I] = 0.578563
V(I) = 0.630531

β =	-3.953991
F(z) =	0.999820
Pr(f) % =	0.017965

Ic= 0.80 ln(I crit) = -0.223144

Toe+3ft		Rh
Head =	3.00	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	41	15.00	24.00	118.43	121.49	0.0739	1.12	0.07		
2	45	15.00	24.00	123.38	127.28	0.0715	1.14	0.08	0.000025	1.20
3	37	15.00	24.00	113.10	115.41	0.0766	1.10	0.07		
4	41	23.00	24.00	141.81	150.44	0.0636	1.20	0.05	0.002025	97.59
5	41	7.00	24.00	82.71	82.99	0.0957	0.99	0.14		
6	41	15.00	34.00	137.38	144.60	0.0926	1.18	0.08	0.000025	1.20
7	41	15.00	14.00	92.18	92.79	0.0519	1.03	0.07		
								Total	0.002075	100.00

E[I] = 0.070000 E[ln I] = -2.835809
Var[I]= 0.002075
σ[I]= 0.045552 σ [ln I] = 0.594220
V(I) = 0.650745

β =	-4.772323
F(z) =	0.999995
Pr(f) % =	0.000549

Ic= 0.80 ln(I crit) = -0.223144

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Through-Seepage Reliability Analysis With Khilar's Extended Model

Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

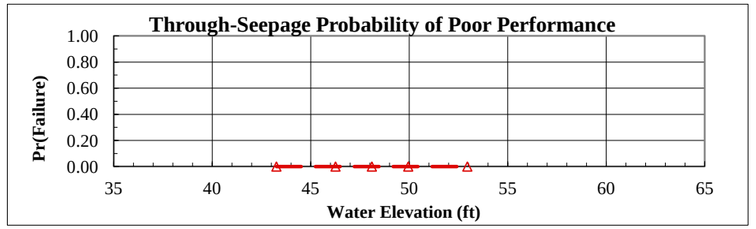
Levee Mile: 1.32
River Mile: 7.82
Analysis Case Without Project Cutoff Wall

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables - Silty Sand (SM) Levee			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Tractive Stress (Tc)	1	0.1	10.00
Initial Porosity (n)	0.5	0.05	10.00
Intrinsic Permeability (Ko)	1.00E-07	3.00E-08	30.00

Pr(f)=0
YES



Analysis Case	**Head**	**Elevation**	**Pr(f)**
Toe	0.00	43.26	0.0000
Toe+3ft	3.00	46.26	0.000000
Half Height	4.85	48.11	0.000000
Crest-3ft	6.69	49.95	0.000000
Crest	9.69	52.95	0.000000

Crest — **Head =** 9.69 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.00	0.50	1.00E-07	0.81			
2	0.90	0.50	1.00E-07	0.73			
3	1.10	0.50	1.00E-07	0.89			
4	1.00	0.45	1.00E-07	0.76			
5	1.00	0.55	1.00E-07	0.85			
6	1.00	0.50	7.00E-08	0.96			
7	1.00	0.50	1.30E-07	0.71			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]= **β =**
V(FS) = **F(z) =**
FS req'd = 1.00 ln(FS req'd) = 0.000000 **Pr(f) % =** 0.000000

Half Height — **Head =** 4.85 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.00	0.50	1.00E-07	0.81			
2	0.90	0.50	1.00E-07	0.73			
3	1.10	0.50	1.00E-07	0.89			
4	1.00	0.45	1.00E-07	0.76			
5	1.00	0.55	1.00E-07	0.85			
6	1.00	0.50	7.00E-08	0.96			
7	1.00	0.50	1.30E-07	0.71			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]= **β =**
V(FS) = **F(z) =**
FS req'd = 1.00 ln(FS req'd) = 0.000000 **Pr(f) % =** 0.000000

Crest-3ft — **Head =** 6.69 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.00	0.50	1.00E-07	0.81			
2	0.90	0.50	1.00E-07	0.73			
3	1.10	0.50	1.00E-07	0.89			
4	1.00	0.45	1.00E-07	0.76			
5	1.00	0.55	1.00E-07	0.85			
6	1.00	0.50	7.00E-08	0.96			
7	1.00	0.50	1.30E-07	0.71			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]= **β =**
V(FS) = **F(z) =**
FS req'd = 1.00 ln(FS req'd) = 0.000000 **Pr(f) % =** 0.000000

Toe+3ft — **Head =** 3.00 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.00	0.50	1.00E-07	0.81			
2	0.90	0.50	1.00E-07	0.73			
3	1.10	0.50	1.00E-07	0.89			
4	1.00	0.45	1.00E-07	0.76			
5	1.00	0.55	1.00E-07	0.85			
6	1.00	0.50	7.00E-08	0.96			
7	1.00	0.50	1.30E-07	0.71			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]= **β =**
V(FS) = **F(z) =**
FS req'd = 1.00 ln(FS req'd) = 0.000000 **Pr(f) % =** 0.000000

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Landside Long-Term Stability Analysis With UTEXAS4

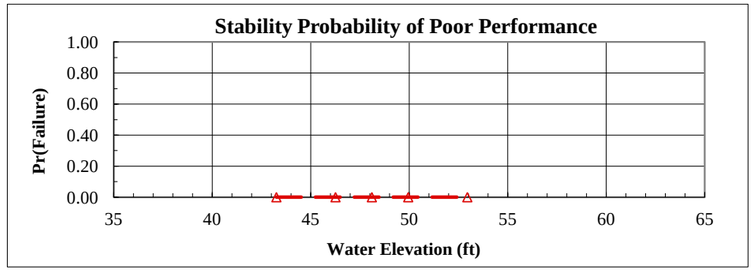
Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

Levee Mile: 1.32
River Mile: 7.82
Analysis Case Without Project Cutoff Wall

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Levee Φ	33	4	13.00
Levee Cohesion	0	0	40.00
Levee γ	125	9	7.00
Foundation Φ	33	4	13.00
Foundation Cohesion	0	0	40.00



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	43.26	0.0000
Toe+3ft	3.00	46.26	0.000000
Half Height	4.85	48.11	0.000000
Crest-3ft	6.69	49.95	0.000000
Crest	9.69	52.95	0.000000

Crest | **Head =** 9.69 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	33	0	1.76		
2	29	0	125	33	0			
3	37	0	125	33	0			
4	33	0	125	33	0			
5	33	0	125	33	0			
6	33	0	116	33	0			
7	33	0	134	33	0			
8	33	0	125	29	0			
9	33	0	125	37	0			
10	33	0	125	33	0			
11	33	0	125	33	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Crest-3ft | **Head =** 6.69 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	33	0	1.79		
2	29	0	125	33	0			
3	37	0	125	33	0			
4	33	0	125	33	0			
5	33	0	125	33	0			
6	33	0	116	33	0			
7	33	0	134	33	0			
8	33	0	125	29	0			
9	33	0	125	37	0			
10	33	0	125	33	0			
11	33	0	125	33	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Half Height | **Head =** 4.85 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	33	0	1.80		
2	29	0	125	33	0			
3	37	0	125	33	0			
4	33	0	125	33	0			
5	33	0	125	33	0			
6	33	0	116	33	0			
7	33	0	134	33	0			
8	33	0	125	29	0			
9	33	0	125	37	0			
10	33	0	125	33	0			
11	33	0	125	33	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Toe+3ft | **Head =** 3.00 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	33	0	1.81		
2	29	0	125	33	0			
3	37	0	125	33	0			
4	33	0	125	33	0			
5	33	0	125	33	0			
6	33	0	116	33	0			
7	33	0	134	33	0			
8	33	0	125	29	0			
9	33	0	125	37	0			
10	33	0	125	33	0			
11	33	0	125	33	0			

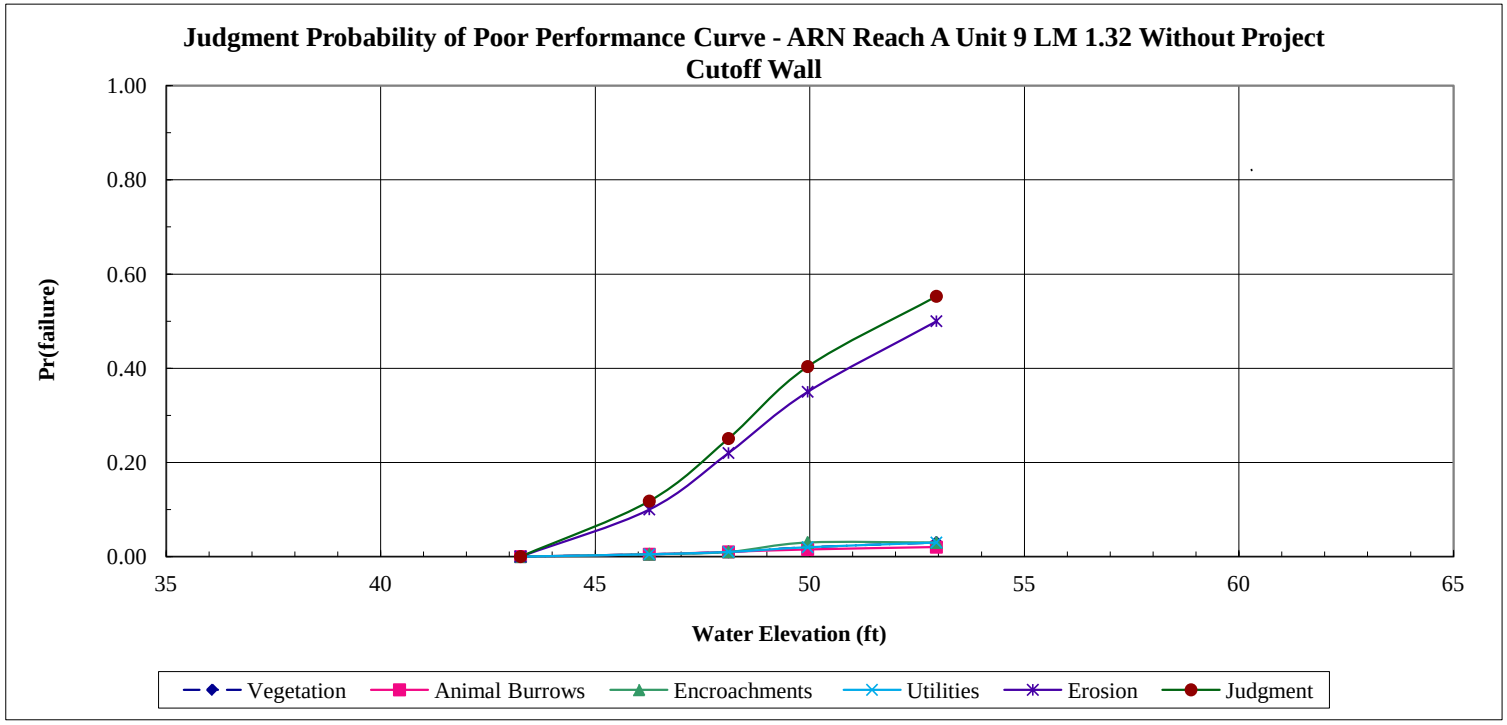
E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Judgment Probability of Poor Performance Curve

Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9
Levee Mile: 1.32
River Mile: 7.82
Analysis Case: Without Project Cutoff Wall
Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62
Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Vegetation		Animal Burrows		Encroachments		Utilities		Erosion		Judgment	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
43.26	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.0000	1.0000
46.26	0.00500	0.9950	0.00500	0.9950	0.00500	0.9950	0.00500	0.9950	0.10000	0.9000	0.1179	0.8821
48.11	0.01000	0.9900	0.01000	0.9900	0.01000	0.9900	0.01000	0.9900	0.22000	0.7800	0.2507	0.7493
49.95	0.02000	0.9800	0.01500	0.9850	0.03000	0.9700	0.02000	0.9800	0.35000	0.6500	0.4036	0.5964
52.95	0.03000	0.9700	0.02000	0.9800	0.03000	0.9700	0.03000	0.9700	0.50000	0.5000	0.5528	0.4472



Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

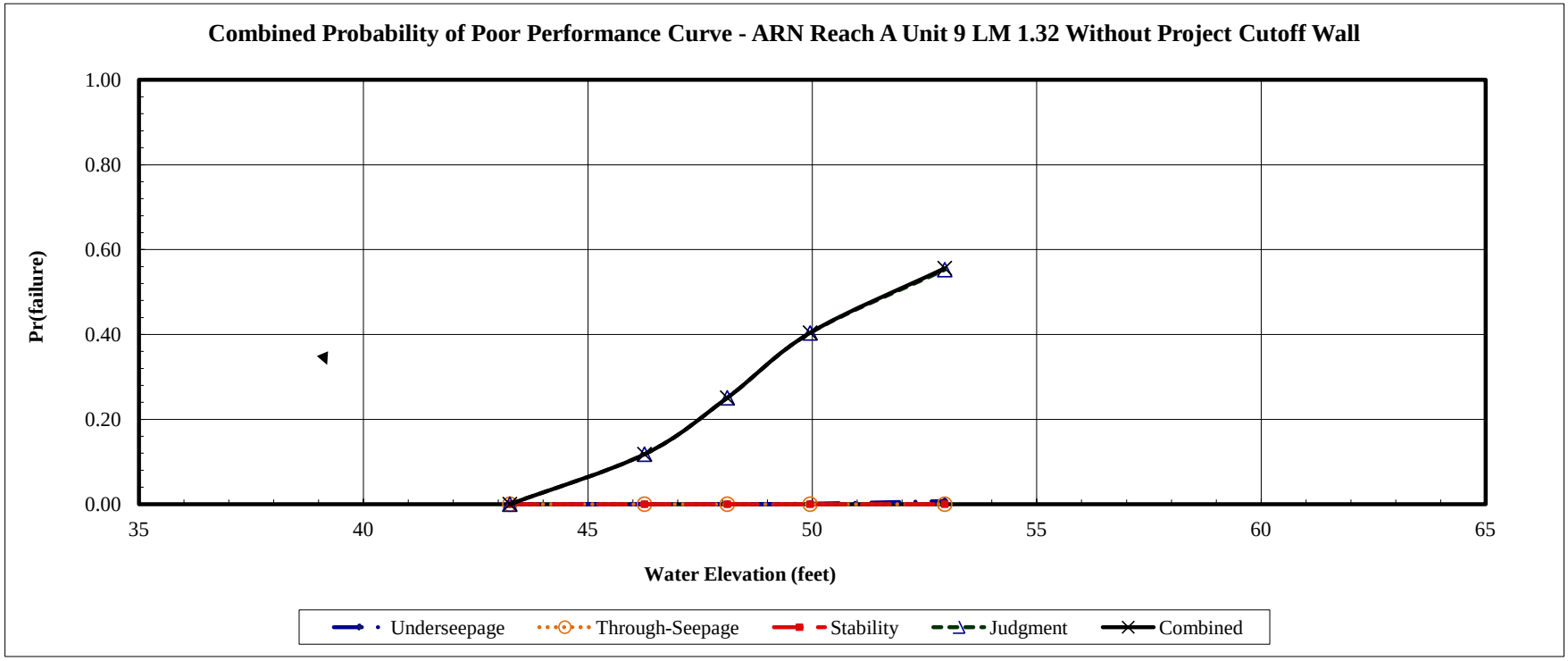
Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

Levee Mile: 1.32
River Mile: 7.82
Analysis Case: Without Project Cutoff Wall

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
43.26	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
46.26	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.1179	0.8821	0.1179	0.8821
48.11	0.0002	0.9998	0.0000	1.0000	0.0000	1.0000	0.2507	0.7493	0.2509	0.7491
49.95	0.0010	0.9990	0.0000	1.0000	0.0000	1.0000	0.4036	0.5964	0.4042	0.5958
52.95	0.0076	0.9924	0.0000	1.0000	0.0000	1.0000	0.5528	0.4472	0.5562	0.4438



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Determination of Random Variables For Underseepage Reliability Analysis

Project: American River Common Features GRR
Channel: American River
Basin and Reach: ARN Reach A Unit 9

Levee Mile: 1.32
River Mile: 7.82
Analysis Case With Project Erosion Protection

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Boring #	Blanket Thickness Variable (z)					Aquifer Thickness Variable (d)					Hydraulic Conductivity Vairables (Kb and Kf)								
	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Blanket		Aquifer Material		Kf/Kb	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation
											Material	Kb (ft/day)	Material	Kf (ft/day)					
WCNBAR_03B	20					15					SM	0.709	GM	34	48				
2F-97-06	22.7					30					SM	0.709	SP-SM/GM	24.8	35				
2F-99-08A	24					10					SM	0.709	SP-SM/GM	28	39				
2F-99-15A	6					39					SM	0.709	SP-SM/GM	30.92	44				
2F-02-17	10	15	8	96	53	24	24	10	214	42	SM	0.709	SP-SM/GM	27.33	39	41	4	456	10
2F-07-18A	10					26					SM	0.709	SP/GP	28.62	40				

Boring #	Blanket Material 1 (lowest permeability)			Blanket Material 2			Transformed Blanket Thickness (z)	Aquifer Material 1			Aquifer Material 2			Aquifer Material 3			Transformed Aquifer Horizontal Permeability (kf)
	Material Type	Thickness (z)	Permeability (Kb)	Material Type	Thickness (z)	Permeability (Kb)		Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	
WCNBAR_03B	SM	20	0.709				20	GM	15	34							34
2F-97-06	SM	22.7	0.709				22.7	SP-SM	13.8	14	GM	16.2	34				24.8
2F-99-08A	SM	24	0.709				24	SP-SM	3	14	GM	7	34				28
2F-99-15A	SM	6	0.709				6	SP-SM	6	14	GM	33	34				30.92
2F-02-17	SM	10	0.709				10	SP-SM	8	14	GM	16	34				27.33
2F-07-18A	SM	10	0.709				10	SP	7	14	GP	19	34				28.62

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Underseepage Reliability Analysis With Blanket Theory Analysis

Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

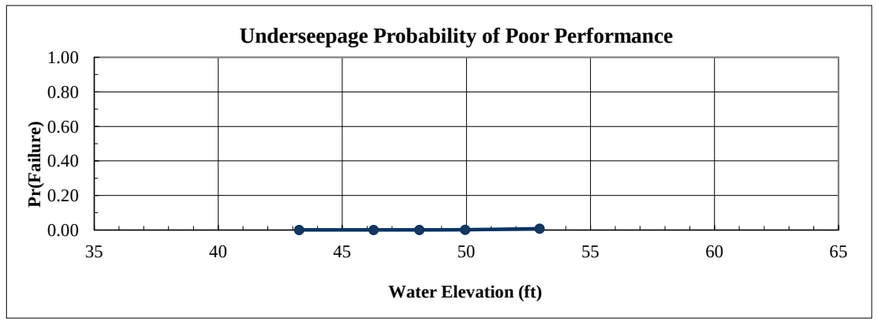
Levee Mile: 1.32
River Mile: 7.82
Analysis Case With Project Erosion Protection

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Permaebility Ratio	41	4	10
Blanket Thickness (z)	15	8	53
Aquifer Thickness (d)	24	10	42

Blanket Theory Analysis Inputs					
Pr(f)=0	**BTA Case No.**	**L1**	**L2**	**L3**	**γ Blanket**
NO	7A	265	85	∞	112



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	43.26	0.0000
Toe+3ft	3.00	46.26	0.0000
Half Height	4.85	48.11	0.0002
Crest-3ft	6.69	49.95	0.0010
Crest	9.69	52.95	0.0076

Crest		Rh
Head =	9.69	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	41	15.00	24.00	118.43	121.49	0.0739	3.62	0.24		
2	45	15.00	24.00	123.38	127.28	0.0715	3.67	0.24	0.000000	0.00
3	37	15.00	24.00	113.10	115.41	0.0766	3.57	0.24		
4	41	23.00	24.00	141.81	150.44	0.0636	3.86	0.17	0.021025	98.94
5	41	7.00	24.00	82.71	82.99	0.0957	3.21	0.46		
6	41	15.00	34.00	137.38	144.60	0.0926	3.82	0.25	0.000225	1.06
7	41	15.00	14.00	92.18	92.79	0.0519	3.33	0.22		
								Total	0.021250	100.00

E[I] = 0.240000 E[ln I] = -1.584129
Var[I]= 0.021250
σ[I]= 0.145774 σ [ln I] = 0.560379
V(I) = 0.607391

β = -2.826888
F(z) = 0.992423
Pr(f) % = 0.757681

Ic= 0.80 ln(I crit) = -0.223144

Crest-3ft		Rh
Head =	6.69	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	41	15.00	24.00	118.43	121.49	0.0739	2.50	0.17		
2	45	15.00	24.00	123.38	127.28	0.0715	2.54	0.17	0.000025	0.24
3	37	15.00	24.00	113.10	115.41	0.0766	2.46	0.16		
4	41	23.00	24.00	141.81	150.44	0.0636	2.67	0.12	0.010000	97.56
5	41	7.00	24.00	82.71	82.99	0.0957	2.21	0.32		
6	41	15.00	34.00	137.38	144.60	0.0926	2.64	0.18	0.000225	2.20
7	41	15.00	14.00	92.18	92.79	0.0519	2.30	0.15		
								Total	0.010250	100.00

E[I] = 0.170000 E[ln I] = -1.923736
Var[I]= 0.010250
σ[I]= 0.101242 σ [ln I] = 0.550962
V(I) = 0.595543

β = -3.491597
F(z) = 0.998988
Pr(f) % = 0.101233

Ic= 0.80 ln(I crit) = -0.223144

Half Height		Rh
Head =	4.85	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	41	15.00	24.00	118.43	121.49	0.0739	1.81	0.12		
2	45	15.00	24.00	123.38	127.28	0.0715	1.84	0.12	0.000000	0.00
3	37	15.00	24.00	113.10	115.41	0.0766	1.78	0.12		
4	41	23.00	24.00	141.81	150.44	0.0636	1.93	0.08	0.005625	98.25
5	41	7.00	24.00	82.71	82.99	0.0957	1.60	0.23		
6	41	15.00	34.00	137.38	144.60	0.0926	1.91	0.13	0.000100	1.75
7	41	15.00	14.00	92.18	92.79	0.0519	1.67	0.11		
								Total	0.005725	100.00

E[I] = 0.120000 E[ln I] = -2.287631
Var[I]= 0.005725
σ[I]= 0.075664 σ [ln I] = 0.578563
V(I) = 0.630531

β = -3.953991
F(z) = 0.999820
Pr(f) % = 0.017965

Ic= 0.80 ln(I crit) = -0.223144

Toe+3ft		Rh
Head =	3.00	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	41	15.00	24.00	118.43	121.49	0.0739	1.12	0.07		
2	45	15.00	24.00	123.38	127.28	0.0715	1.14	0.08	0.000025	1.20
3	37	15.00	24.00	113.10	115.41	0.0766	1.10	0.07		
4	41	23.00	24.00	141.81	150.44	0.0636	1.20	0.05	0.002025	97.59
5	41	7.00	24.00	82.71	82.99	0.0957	0.99	0.14		
6	41	15.00	34.00	137.38	144.60	0.0926	1.18	0.08	0.000025	1.20
7	41	15.00	14.00	92.18	92.79	0.0519	1.03	0.07		
								Total	0.002075	100.00

E[I] = 0.070000 E[ln I] = -2.835809
Var[I]= 0.002075
σ[I]= 0.045552 σ [ln I] = 0.594220
V(I) = 0.650745

β = -4.772323
F(z) = 0.999995
Pr(f) % = 0.000549

Ic= 0.80 ln(I crit) = -0.223144

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Through-Seepage Reliability Analysis With Khilar's Extended Model

Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

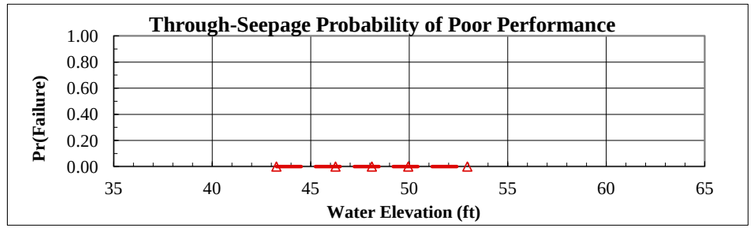
Levee Mile: 1.32
River Mile: 7.82
Analysis Case With Project Erosion Protection

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Random Variables - Silty Sand (SM) Levee			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Tractive Stress (Tc)	1	0.1	10.00
Initial Porosity (n)	0.5	0.05	10.00
Intrinsic Permeability (Ko)	1.00E-07	3.00E-08	30.00

Pr(f)=0
YES



Analysis Case	**Head**	**Elevation**	**Pr(f)**
Toe	0.00	43.26	0.0000
Toe+3ft	3.00	46.26	0.000000
Half Height	4.85	48.11	0.000000
Crest-3ft	6.69	49.95	0.000000
Crest	9.69	52.95	0.000000

Crest — **Head =** 9.69 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.00	0.50	1.00E-07	0.81			
2	0.90	0.50	1.00E-07	0.73			
3	1.10	0.50	1.00E-07	0.89			
4	1.00	0.45	1.00E-07	0.76			
5	1.00	0.55	1.00E-07	0.85			
6	1.00	0.50	7.00E-08	0.96			
7	1.00	0.50	1.30E-07	0.71			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]= **β =**
V(FS) = **F(z) =**
FS req'd = 1.00 ln(FS req'd) = 0.000000 **Pr(f) % =** 0.000000

Half Height — **Head =** 4.85 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.00	0.50	1.00E-07	0.81			
2	0.90	0.50	1.00E-07	0.73			
3	1.10	0.50	1.00E-07	0.89			
4	1.00	0.45	1.00E-07	0.76			
5	1.00	0.55	1.00E-07	0.85			
6	1.00	0.50	7.00E-08	0.96			
7	1.00	0.50	1.30E-07	0.71			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]= **β =**
V(FS) = **F(z) =**
FS req'd = 1.00 ln(FS req'd) = 0.000000 **Pr(f) % =** 0.000000

Crest-3ft — **Head =** 6.69 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.00	0.50	1.00E-07	0.81			
2	0.90	0.50	1.00E-07	0.73			
3	1.10	0.50	1.00E-07	0.89			
4	1.00	0.45	1.00E-07	0.76			
5	1.00	0.55	1.00E-07	0.85			
6	1.00	0.50	7.00E-08	0.96			
7	1.00	0.50	1.30E-07	0.71			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]= **β =**
V(FS) = **F(z) =**
FS req'd = 1.00 ln(FS req'd) = 0.000000 **Pr(f) % =** 0.000000

Toe+3ft — **Head =** 3.00 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.00	0.50	1.00E-07	0.81			
2	0.90	0.50	1.00E-07	0.73			
3	1.10	0.50	1.00E-07	0.89			
4	1.00	0.45	1.00E-07	0.76			
5	1.00	0.55	1.00E-07	0.85			
6	1.00	0.50	7.00E-08	0.96			
7	1.00	0.50	1.30E-07	0.71			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]= **β =**
V(FS) = **F(z) =**
FS req'd = 1.00 ln(FS req'd) = 0.000000 **Pr(f) % =** 0.000000

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Landside Long-Term Stability Analysis With UTEXAS4

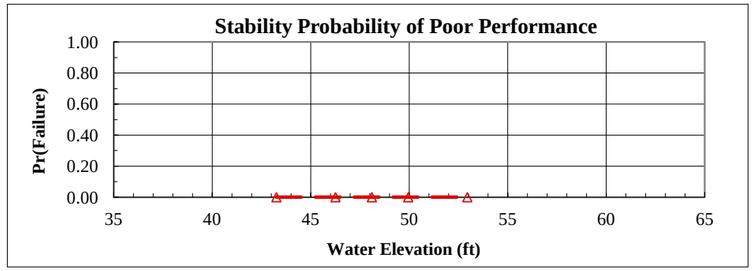
Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

Levee Mile: 1.32
River Mile: 7.82
Analysis Case With Project Erosion Protection

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Levee Φ	33	4	13.00
Levee Cohesion	0	0	40.00
Levee γ	125	9	7.00
Foundation Φ	33	4	13.00
Foundation Cohesion	0	0	40.00



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	43.26	0.0000
Toe+3ft	3.00	46.26	0.000000
Half Height	4.85	48.11	0.000000
Crest-3ft	6.69	49.95	0.000000
Crest	9.69	52.95	0.000000

Crest | **Head =** 9.69 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	33	0	1.76		
2	29	0	125	33	0			
3	37	0	125	33	0			
4	33	0	125	33	0			
5	33	0	125	33	0			
6	33	0	116	33	0			
7	33	0	134	33	0			
8	33	0	125	29	0			
9	33	0	125	37	0			
10	33	0	125	33	0			
11	33	0	125	33	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Crest-3ft | **Head =** 6.69 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	33	0	1.79		
2	29	0	125	33	0			
3	37	0	125	33	0			
4	33	0	125	33	0			
5	33	0	125	33	0			
6	33	0	116	33	0			
7	33	0	134	33	0			
8	33	0	125	29	0			
9	33	0	125	37	0			
10	33	0	125	33	0			
11	33	0	125	33	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Half Height | **Head =** 4.85 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	33	0	1.80		
2	29	0	125	33	0			
3	37	0	125	33	0			
4	33	0	125	33	0			
5	33	0	125	33	0			
6	33	0	116	33	0			
7	33	0	134	33	0			
8	33	0	125	29	0			
9	33	0	125	37	0			
10	33	0	125	33	0			
11	33	0	125	33	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Toe+3ft | **Head =** 3.00 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	33	0	1.81		
2	29	0	125	33	0			
3	37	0	125	33	0			
4	33	0	125	33	0			
5	33	0	125	33	0			
6	33	0	116	33	0			
7	33	0	134	33	0			
8	33	0	125	29	0			
9	33	0	125	37	0			
10	33	0	125	33	0			
11	33	0	125	33	0			

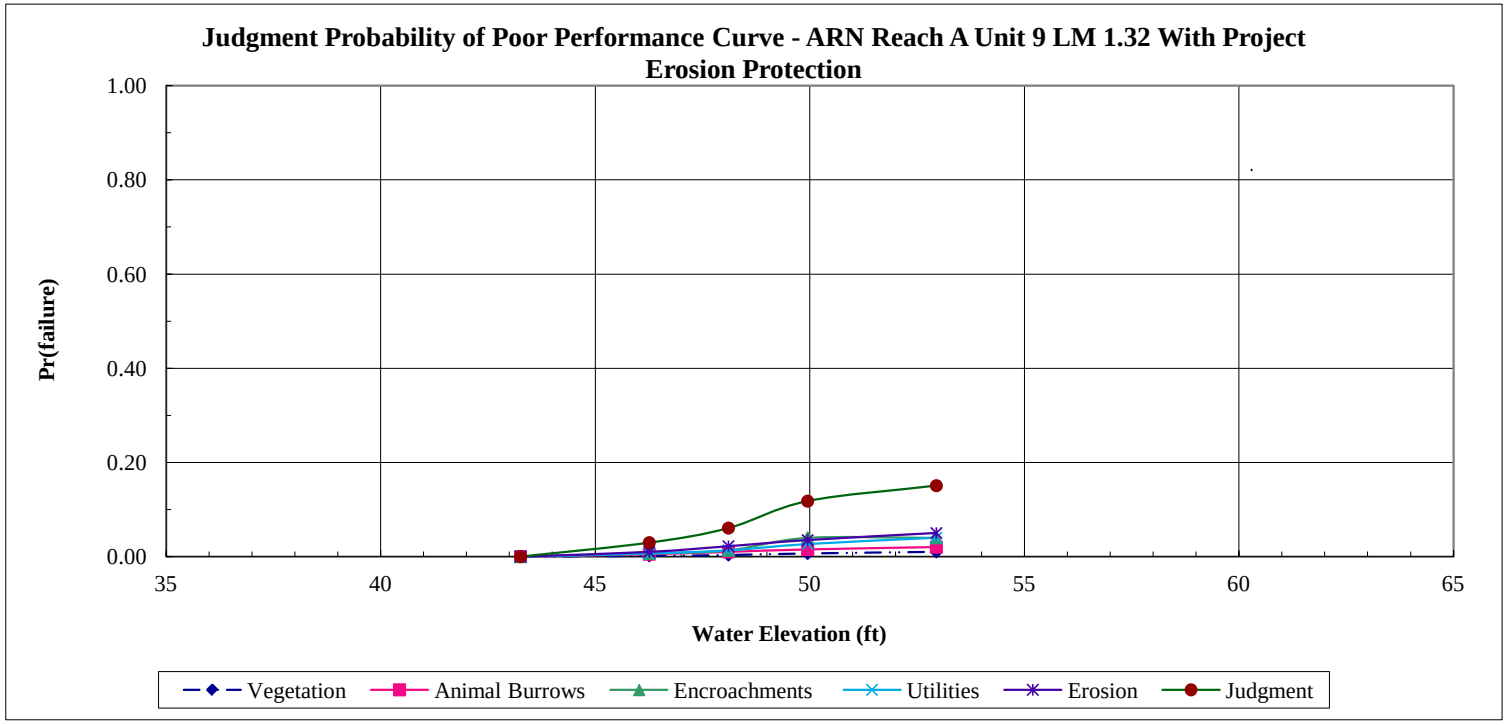
E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Judgment Probability of Poor Performance Curve

Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9
Levee Mile: 1.32
River Mile: 7.82
Analysis Case: With Project Erosion Protect
Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62
Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Water Surface Elevation	Vegetation		Animal Burrows		Encroachments		Utilities		Erosion		Judgment	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
43.26	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.0000	1.0000
46.26	0.00167	0.9983	0.00500	0.9950	0.00667	0.9933	0.00667	0.9933	0.01000	0.9900	0.0297	0.9703
48.11	0.00333	0.9967	0.01000	0.9900	0.01333	0.9867	0.01333	0.9867	0.02200	0.9780	0.0606	0.9394
49.95	0.00667	0.9933	0.01500	0.9850	0.04000	0.9600	0.02667	0.9733	0.03500	0.9650	0.1178	0.8822
52.95	0.01000	0.9900	0.02000	0.9800	0.04000	0.9600	0.04000	0.9600	0.05000	0.9500	0.1506	0.8494



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

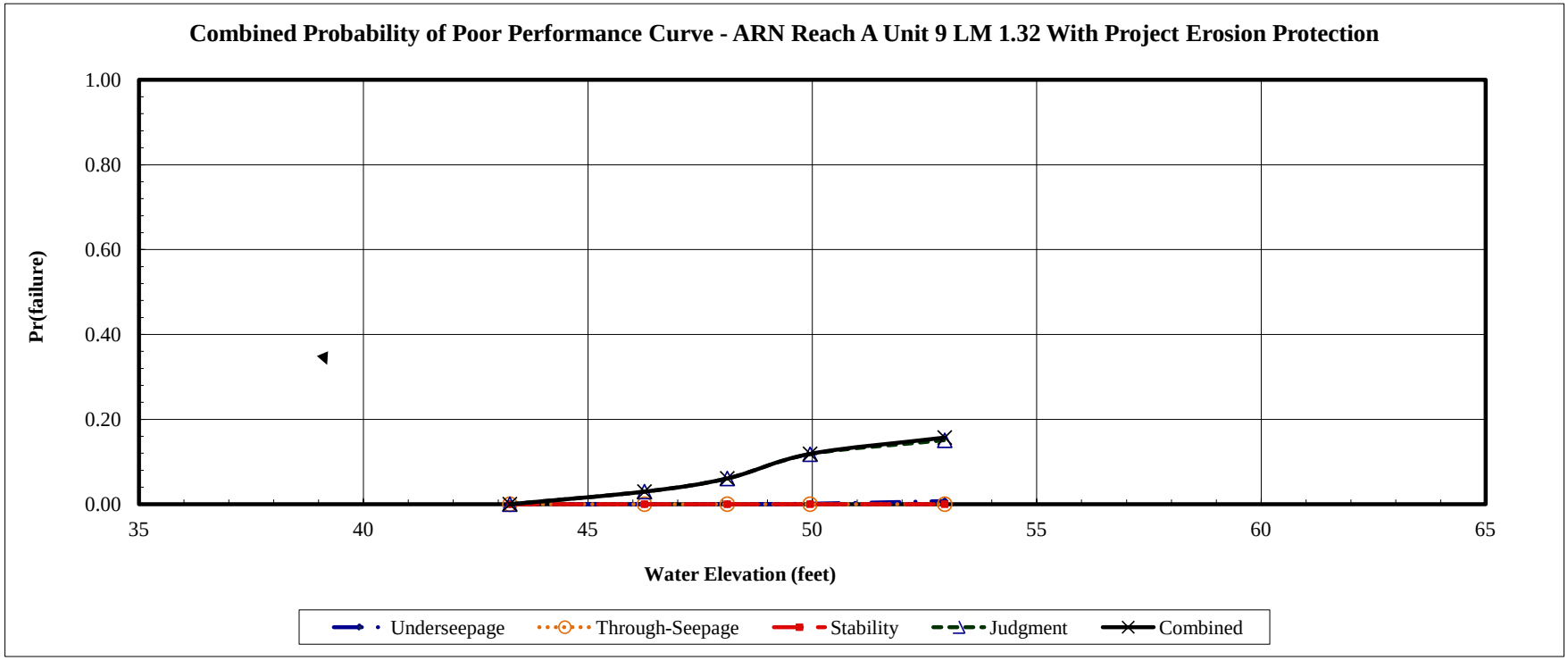
Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

Levee Mile: 1.32
River Mile: 7.82
Analysis Case: With Project Erosion Protection

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
43.26	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
46.26	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0297	0.9703	0.0297	0.9703
48.11	0.0002	0.9998	0.0000	1.0000	0.0000	1.0000	0.0606	0.9394	0.0607	0.9393
49.95	0.0010	0.9990	0.0000	1.0000	0.0000	1.0000	0.1178	0.8822	0.1186	0.8814
52.95	0.0076	0.9924	0.0000	1.0000	0.0000	1.0000	0.1506	0.8494	0.1570	0.8430



Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Determination of Random Variables For Underseepage Reliability Analysis

Project: American River Common Features GRR
Channel: Arcade Creek North
Basin and Reach: ARN Reach E Unit 7

Levee Mile: 0.90
River Mile: 0.88
Analysis Case Without Project No Improvements

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Boring #	Blanket Thickness Variable (z)					Aquifer Thickness Variable (d)					Hydraulic Conductivity Vairables (Kb and Kf)								
	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Blanket		Aquifer Material		Kf/Kb	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation
											Material	Kb (ft/day)	Material	Kf (ft/day)					
WRARFC_024S	5					27.5					CL	0.28	SM/ML	1.54	6				
WRARFC_003B	9					15.45					CL	0.028	SP	28	1000				
K94a_BA4	4					33.5					CL	0.28	ML/SM/SP	3.05	11				
		6	3	10	50		25	9	170	36						339	573	99649	98

Boring #	Blanket Material 1 (lowest permeability)			Blanket Material 2			Transformed Blanket Thickness (z)	Aquifer Material 1			Aquifer Material 2			Aquifer Material 3			Transformed Aquifer Horizontal Permeability (kf)
	Material Type	Thickness (z)	Permeability (Kb)	Material Type	Thickness (z)	Permeability (Kb)		Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	
WRARFC_024S	CL	5	0.28				5	SM	12	2.8	ML	15.5	0.57				1.54
WRARFC_003B	CL	9	0.028				9	SP	15.45	28							28
K94a_BA4	CL	4	0.28				4	ML	7.5	0.57	SM	25	2.8	SP	1	28	3.05

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Underseepage Reliability Analysis With Blanket Theory Analysis

Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

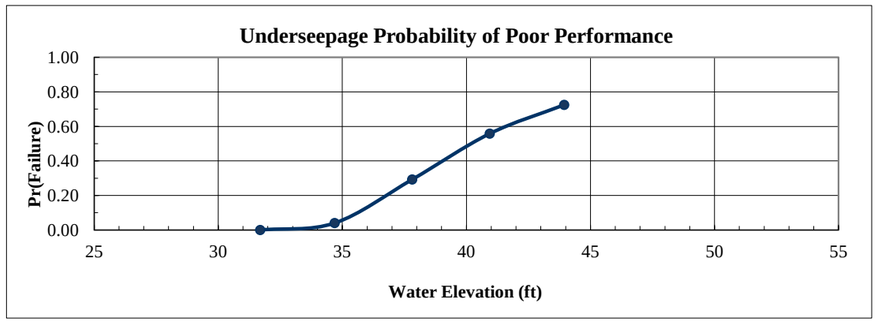
Levee Mile: 0.90
River Mile: 0.88
Analysis Case Without Project No Improvements

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Permaebility Ratio	339	332	98
Blanket Thickness (z)	6	3	50
Aquifer Thickness (d)	25	9	36

Blanket Theory Analysis Inputs					
Pr(f)=0	**BTA Case No.**	**L1**	**L2**	**L3**	**γ Blanket**
NO	7A	10	100	∞	112



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	31.69	0.0000
Toe+3ft	3.00	34.69	0.0403
Half Height	6.13	37.82	0.2925
Crest-3ft	9.25	40.94	0.5580
Crest	12.25	43.94	0.7245

Crest		Rh
Head =	12.25	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	339	6.00	25.00	9.99	225.50	0.0745	8.23	1.37		
2	671	6.00	25.00	10.00	317.31	0.0585	9.10	1.52	0.280900	34.52
3	7	6.00	25.00	9.68	31.89	0.1766	2.76	0.46		
4	339	9.00	25.00	10.00	276.18	0.0647	8.76	0.97	0.525625	64.59
5	339	3.00	25.00	9.99	159.45	0.0928	7.25	2.42		
6	339	6.00	34.00	10.00	262.98	0.0912	8.64	1.44	0.007225	0.89
7	339	6.00	16.00	9.99	180.40	0.0551	7.61	1.27		
								Total	0.813750	100.00

E[I] = 1.370000
Var[I]= 0.813750
σ[I]= 0.902081
V(I) = 0.658453

E[ln I] = 0.134730
σ [ln I] = 0.600134

Ic= 0.80

ln(I crit) = -0.223144

β = 0.224500
F(z) = 0.275480
Pr(f) % = 72.452008

Half Height		Rh
Head =	6.13	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	339	6.00	25.00	9.99	225.50	0.0745	4.12	0.69		
2	671	6.00	25.00	10.00	317.31	0.0585	4.55	0.76	0.070225	34.86
3	7	6.00	25.00	9.68	31.89	0.1766	1.38	0.23		
4	339	9.00	25.00	10.00	276.18	0.0647	4.38	0.49	0.129600	64.34
5	339	3.00	25.00	9.99	159.45	0.0928	3.62	1.21		
6	339	6.00	34.00	10.00	262.98	0.0912	4.32	0.72	0.001600	0.79
7	339	6.00	16.00	9.99	180.40	0.0551	3.81	0.64		
								Total	0.201425	100.00

E[I] = 0.690000
Var[I]= 0.201425
σ[I]= 0.448804
V(I) = 0.650441

E[ln I] = -0.547473
σ [ln I] = 0.593985

Ic= 0.80

ln(I crit) = -0.223144

β = -0.921694
F(z) = 0.707475
Pr(f) % = 29.252520

Crest-3ft		Rh
Head =	9.25	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	339	6.00	25.00	9.99	225.50	0.0745	6.22	1.04		
2	671	6.00	25.00	10.00	317.31	0.0585	6.87	1.15	0.160000	35.10
3	7	6.00	25.00	9.68	31.89	0.1766	2.08	0.35		
4	339	9.00	25.00	10.00	276.18	0.0647	6.62	0.74	0.291600	63.97
5	339	3.00	25.00	9.99	159.45	0.0928	5.47	1.82		
6	339	6.00	34.00	10.00	262.98	0.0912	6.52	1.09	0.004225	0.93
7	339	6.00	16.00	9.99	180.40	0.0551	5.75	0.96		
								Total	0.455825	100.00

E[I] = 1.040000
Var[I]= 0.455825
σ[I]= 0.675148
V(I) = 0.649181

E[ln I] = -0.136613
σ [ln I] = 0.593016

Ic= 0.80

ln(I crit) = -0.223144

β = -0.230370
F(z) = 0.441994
Pr(f) % = 55.800618

Toe+3ft		Rh
Head =	3.00	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	339	6.00	25.00	9.99	225.50	0.0745	2.02	0.34		
2	671	6.00	25.00	10.00	317.31	0.0585	2.23	0.37	0.016900	35.26
3	7	6.00	25.00	9.68	31.89	0.1766	0.68	0.11		
4	339	9.00	25.00	10.00	276.18	0.0647	2.15	0.24	0.030625	63.90
5	339	3.00	25.00	9.99	159.45	0.0928	1.78	0.59		
6	339	6.00	34.00	10.00	262.98	0.0912	2.12	0.35	0.000400	0.83
7	339	6.00	16.00	9.99	180.40	0.0551	1.86	0.31		
								Total	0.047925	100.00

E[I] = 0.340000
Var[I]= 0.047925
σ[I]= 0.218918
V(I) = 0.643876

E[ln I] = -1.252225
σ [ln I] = 0.588923

Ic= 0.80

ln(I crit) = -0.223144

β = -2.126297
F(z) = 0.959716
Pr(f) % = 4.028435

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Through-Seepage Reliability Analysis With Khilar's Extended Model

Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

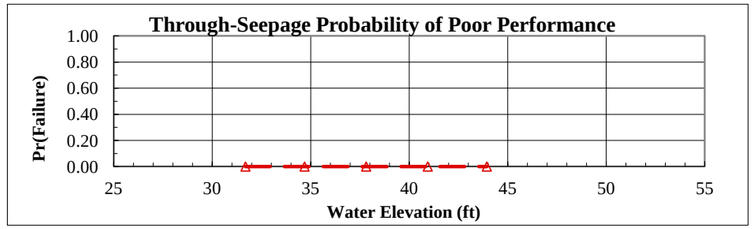
Levee Mile: 0.90
River Mile: 0.88
Analysis Case Without Project No Improvements

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables - Clay (CL) and Clayey Sand (SC) Levee			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Tractive Stress (Tc)	0.4	0.0	10.00
Initial Porosity (n)	0.7	0.07	10.00
Intrinsic Permeability (Ko)	1.00E-10	3.00E-11	30.00

Pr(f)=0
NO



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	31.69	0.0000
Toe+3ft	3.00	34.69	0.000000
Half Height	6.13	37.82	0.000000
Crest-3ft	9.25	40.94	0.000000
Crest	12.25	43.94	0.000000

Crest — **Head =** 12.25 — **Horizontal Gradient (Ix) =** 0.500

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.40	0.70	1.00E-10	12.07	24.13		
2	0.36	0.70	1.00E-10	10.86	21.72	5.824342	26.44
3	0.44	0.70	1.00E-10	13.27	26.55		
4	0.40	0.63	1.00E-10	11.45	22.90	1.459744	6.63
5	0.40	0.77	1.00E-10	12.66	25.31		
6	0.40	0.70	7.00E-11	14.42	28.85	14.740321	66.93
7	0.40	0.70	1.30E-10	10.58	21.17		
E[FS] =	24.133673		E[ln FS] =	3.165050	Total	22.024406	100.00
Var[FS]=	22.024406						
σ[FS]=	4.693017		σ[ln FS]=	0.192658		**β =**	16.428361
V(FS) =	0.194459					**F(z) =**	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Half Height — **Head =** 6.13 — **Horizontal Gradient (Ix) =** 0.400

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.40	0.70	1.00E-10	12.07	30.17		
2	0.36	0.70	1.00E-10	10.86	27.15	9.100534	26.44
3	0.44	0.70	1.00E-10	13.27	33.18		
4	0.40	0.63	1.00E-10	11.45	28.62	2.280850	6.63
5	0.40	0.77	1.00E-10	12.66	31.64		
6	0.40	0.70	7.00E-11	14.42	36.06	23.031751	66.93
7	0.40	0.70	1.30E-10	10.58	26.46		
E[FS] =	30.167091		E[ln FS] =	3.388193	Total	34.413135	100.00
Var[FS]=	34.413135						
σ[FS]=	5.866271		σ[ln FS]=	0.192658		**β =**	17.586599
V(FS) =	0.194459					**F(z) =**	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Crest-3ft — **Head =** 9.25 — **Horizontal Gradient (Ix) =** 0.470

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.40	0.70	1.00E-10	12.07	25.67		
2	0.36	0.70	1.00E-10	10.86	23.11	6.591605	26.44
3	0.44	0.70	1.00E-10	13.27	28.24		
4	0.40	0.63	1.00E-10	11.45	24.36	1.652042	6.63
5	0.40	0.77	1.00E-10	12.66	26.93		
6	0.40	0.70	7.00E-11	14.42	30.69	16.682119	66.93
7	0.40	0.70	1.30E-10	10.58	22.52		
E[FS] =	25.674120		E[ln FS] =	3.226925	Total	24.925765	100.00
Var[FS]=	24.925765						
σ[FS]=	4.992571		σ[ln FS]=	0.192658		**β =**	16.749528
V(FS) =	0.194459					**F(z) =**	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Toe+3ft — **Head =** 3.00 — **Horizontal Gradient (Ix) =** 0.230

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.40	0.70	1.00E-10	12.07	52.46		
2	0.36	0.70	1.00E-10	10.86	47.22	27.525245	26.44
3	0.44	0.70	1.00E-10	13.27	57.71		
4	0.40	0.63	1.00E-10	11.45	49.77	6.898601	6.63
5	0.40	0.77	1.00E-10	12.66	55.03		
6	0.40	0.70	7.00E-11	14.42	62.71	69.661250	66.93
7	0.40	0.70	1.30E-10	10.58	46.01		
E[FS] =	52.464507		E[ln FS] =	3.941578	Total	104.085096	100.00
Var[FS]=	104.085096						
σ[FS]=	10.202210		σ[ln FS]=	0.192658		**β =**	20.458975
V(FS) =	0.194459					**F(z) =**	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Landside Long-Term Stability Analysis With UTEXAS4

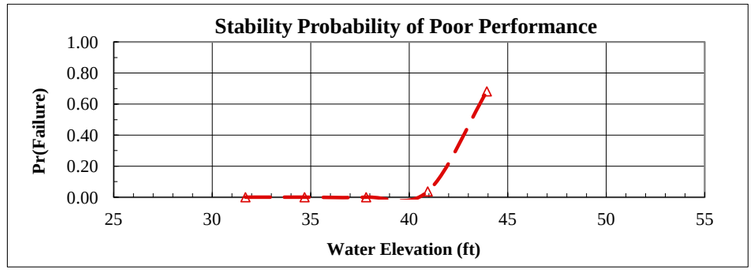
Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

Levee Mile: 0.90
River Mile: 0.88
Analysis Case Without Project No Improvements

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Levee Φ	28	4	13.00
Levee Cohesion	50	20	40.00
Levee γ	115	8	7.00
Foundation Φ	28	4	13.00
Foundation Cohesion	50	20	40.00



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	31.69	0.0000
Toe+3ft	3.00	34.69	0.000000
Half Height	6.13	37.82	0.000000
Crest-3ft	9.25	40.94	0.037401
Crest	12.25	43.94	0.681442

Crest	**Head =**	12.25	**Pr(f)=0**	NO

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	28	50	115	28	50	0.92		
2	24	50	115	28	50	0.73	0.018225	37.73
3	32	50	115	28	50	1.00		
4	28	30	115	28	50	0.85	0.000025	0.05
5	28	70	115	28	50	0.86		
6	28	50	107	28	50	0.75	0.011025	22.83
7	28	50	123	28	50	0.96		
8	28	50	115	24	50	0.76	0.009025	18.69
9	28	50	115	32	50	0.95		
10	28	50	115	28	30	0.75	0.010000	20.70
11	28	50	115	28	70	0.95		

E[FS] =	0.920000	E[ln FS] =	-0.111130	Total	0.048300	100.00
Var[FS]=	0.048300					
σ[FS]=	0.219773	σ[ln FS]=	0.235577		**β =**	-0.471735
V(FS) =	0.238883				**F(z) =**	0.681442
FS req'd =	1.00	ln(FS req'd) =	0.000000		**Pr(f) % =**	68.144204

Crest-3ft	**Head =**	9.25	**Pr(f)=0**	NO

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	28	50	115	28	50	1.18		
2	24	50	115	28	50	1.08	0.005625	49.02
3	32	50	115	28	50	1.23		
4	28	30	115	28	50	1.12	0.002025	17.65
5	28	70	115	28	50	1.21		
6	28	50	107	28	50	1.12	0.000100	0.87
7	28	50	123	28	50	1.14		
8	28	50	115	24	50	1.11	0.002500	21.79
9	28	50	115	32	50	1.21		
10	28	50	115	28	30	1.15	0.001225	10.68
11	28	50	115	28	70	1.22		

E[FS] =	1.180000	E[ln FS] =	0.161411	Total	0.011475	100.00
Var[FS]=	0.011475					
σ[FS]=	0.107121	σ[ln FS]=	0.090595		**β =**	1.781680
V(FS) =	0.090781				**F(z) =**	0.037401
FS req'd =	1.00	ln(FS req'd) =	0.000000		**Pr(f) % =**	3.740068

Half Height	**Head =**	6.13	**Pr(f)=0**	YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	28	50	115	28	50	1.40		
2	24	50	115	28	50			
3	32	50	115	28	50			
4	28	30	115	28	50			
5	28	70	115	28	50			
6	28	50	107	28	50			
7	28	50	123	28	50			
8	28	50	115	24	50			
9	28	50	115	32	50			
10	28	50	115	28	30			
11	28	50	115	28	70			

E[FS] =		E[ln FS] =		Total		
Var[FS]=						
σ[FS]=		σ[ln FS]=			**β =**	
V(FS) =					**F(z) =**	
FS req'd =	1.00	ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Toe+3ft	**Head =**	3.00	**Pr(f)=0**	YES

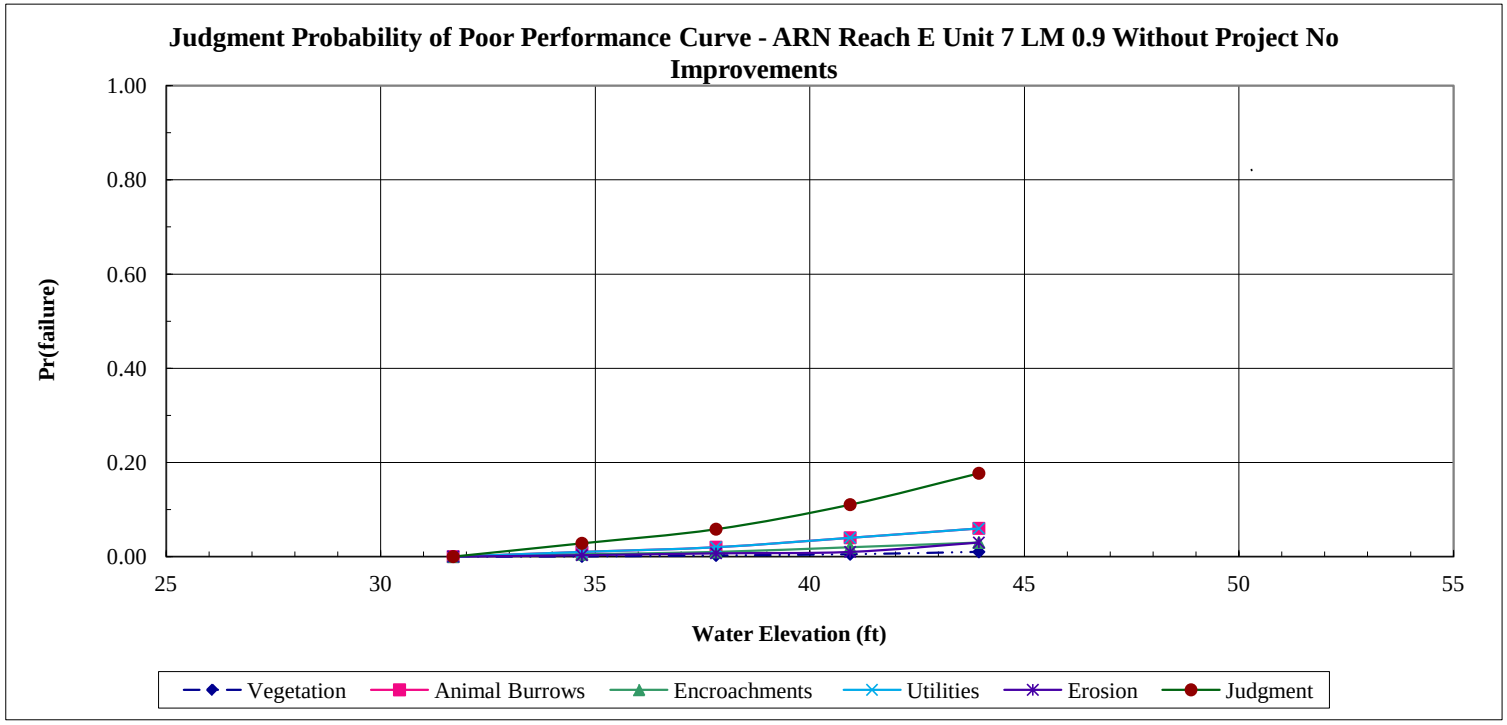
Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	28	50	115	28	50	1.52		
2	24	50	115	28	50			
3	32	50	115	28	50			
4	28	30	115	28	50			
5	28	70	115	28	50			
6	28	50	107	28	50			
7	28	50	123	28	50			
8	28	50	115	24	50			
9	28	50	115	32	50			
10	28	50	115	28	30			
11	28	50	115	28	70			

E[FS] =		E[ln FS] =		Total		
Var[FS]=						
σ[FS]=		σ[ln FS]=			**β =**	
V(FS) =					**F(z) =**	
FS req'd =	1.00	ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Judgment Probability of Poor Performance Curve

Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7
Levee Mile: 0.90
River Mile: 0.88
Analysis Case: Without Project No Improver
Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77
Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

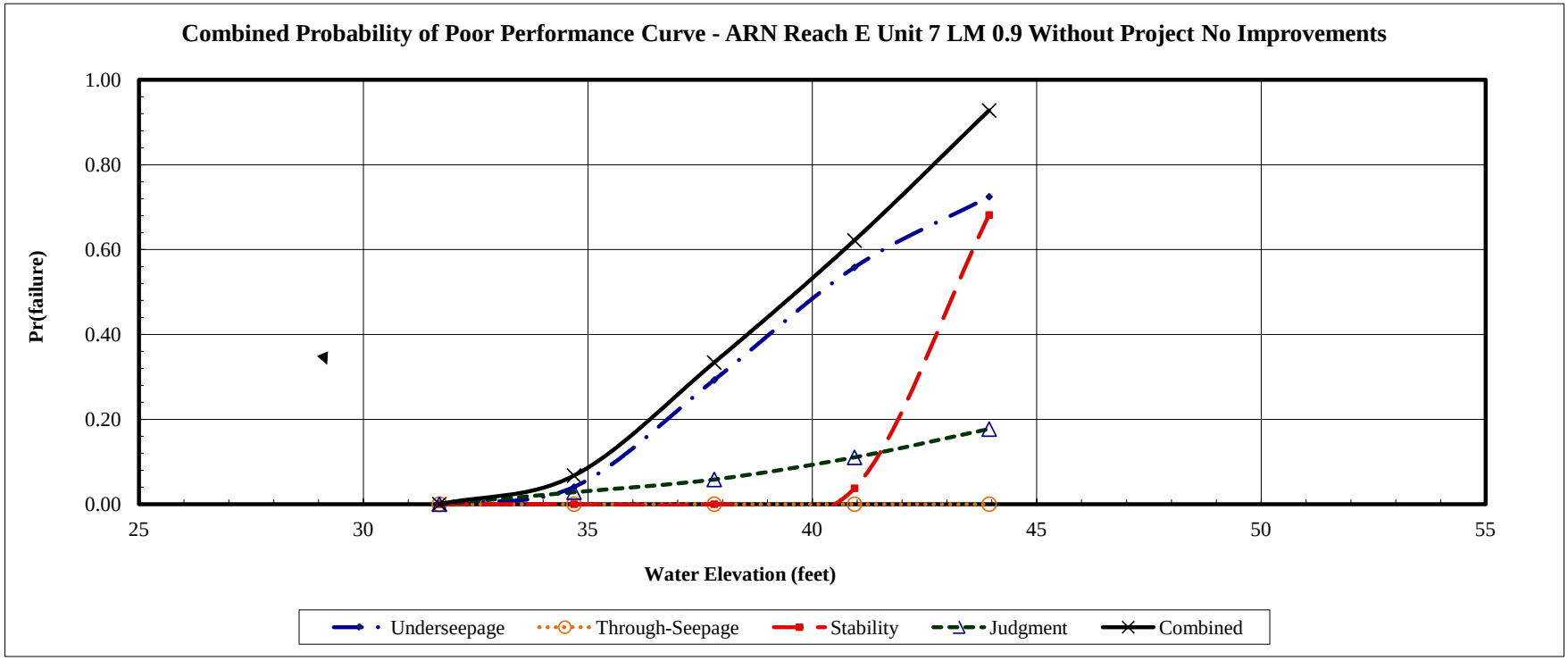
Water Surface Elevation	Vegetation		Animal Burrows		Encroachments		Utilities		Erosion		Judgment	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
31.69	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
34.69	0.0005	0.9995	0.0100	0.9900	0.0050	0.9950	0.0100	0.9900	0.0030	0.9970	0.0282	0.9718
37.82	0.0025	0.9975	0.0200	0.9800	0.0100	0.9900	0.0200	0.9800	0.0070	0.9930	0.0582	0.9418
40.94	0.0050	0.9950	0.0400	0.9600	0.0200	0.9800	0.0400	0.9600	0.0100	0.9900	0.1103	0.8897
43.94	0.0100	0.9900	0.0600	0.9400	0.0300	0.9700	0.0600	0.9400	0.0300	0.9700	0.1769	0.8231



Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7
Levee Mile: 0.90
River Mile: 0.88
Analysis Case: Without Project No Improvements
Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77
Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
31.69	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
34.69	0.0403	0.9597	0.0000	1.0000	0.0000	1.0000	0.0282	0.9718	0.0674	0.9326
37.82	0.2925	0.7075	0.0000	1.0000	0.0000	1.0000	0.0582	0.9418	0.3337	0.6663
40.94	0.5580	0.4420	0.0000	1.0000	0.0374	0.9626	0.1103	0.8897	0.6215	0.3785
43.94	0.7245	0.2755	0.0000	1.0000	0.6814	0.3186	0.1769	0.8231	0.9278	0.0722



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Determination of Random Variables For Underseepage Reliability Analysis

Project: American River Common Features GRR
Channel: Arcade Creek North
Basin and Reach: ARN Reach E Unit 7

Levee Mile: 0.90
River Mile: 0.88
Analysis Case With Project Cutoff Wall

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Boring #	Blanket Thickness Variable (z)					Aquifer Thickness Variable (d)					Hydraulic Conductivity Vairables (Kb and Kf)								
	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Blanket		Aquifer Material		Kf/Kb	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation
											Material	Kb (ft/day)	Material	Kf (ft/day)					
WRARFC_024S	5					27.5					CL	0.28	SM/ML	1.54	6				
WRARFC_003B	9					15.45					CL	0.028	SP	28	1000				
K94a_BA4	4					33.5					CL	0.28	ML/SM/SP	3.05	11				
		6	3	10	50		25	9	170	36						339	573	99649	98

Boring #	Blanket Material 1 (lowest permeability)			Blanket Material 2			Transformed Blanket Thickness (z)	Aquifer Material 1			Aquifer Material 2			Aquifer Material 3			Transformed Aquifer Horizontal Permeability (kf)
	Material Type	Thickness (z)	Permeability (Kb)	Material Type	Thickness (z)	Permeability (Kb)		Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	
WRARFC_024S	CL	5	0.28				5	SM	12	2.8	ML	15.5	0.57				1.54
WRARFC_003B	CL	9	0.028				9	SP	15.45	28							28
K94a_BA4	CL	4	0.28				4	ML	7.5	0.57	SM	25	2.8	SP	1	28	3.05

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Underseepage Reliability Analysis With Blanket Theory Analysis

Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

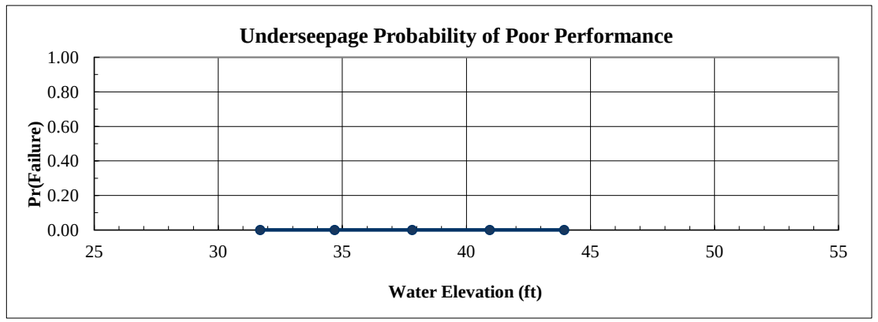
Levee Mile: 0.90
River Mile: 0.88
Analysis Case With Project Cutoff Wall

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Permaebility Ratio	339	332	98
Blanket Thickness (z)	6	3	50
Aquifer Thickness (d)	25	9	36

Blanket Theory Analysis Inputs					
Pr(f)=0	**BTA Case No.**	**L1**	**L2**	**L3**	**γ Blanket**
YES	7A	10	100	∞	112



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	31.69	0.0000
Toe+3ft	3.00	34.69	0.0000
Half Height	6.13	37.82	0.0000
Crest-3ft	9.25	40.94	0.0000
Crest	12.25	43.94	0.0000

Crest		Rh
Head =	12.25	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	339	6.00	25.00	9.99	225.50	0.0745	8.23			
2	671	6.00	25.00	10.00	317.31	0.0585	9.10			
3	7	6.00	25.00	9.68	31.89	0.1766	2.76			
4	339	9.00	25.00	10.00	276.18	0.0647	8.76			
5	339	3.00	25.00	9.99	159.45	0.0928	7.25			
6	339	6.00	34.00	10.00	262.98	0.0912	8.64			
7	339	6.00	16.00	9.99	180.40	0.0551	7.61			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Crest-3ft		Rh
Head =	9.25	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	339	6.00	25.00	9.99	225.50	0.0745	6.22			
2	671	6.00	25.00	10.00	317.31	0.0585	6.87			
3	7	6.00	25.00	9.68	31.89	0.1766	2.08			
4	339	9.00	25.00	10.00	276.18	0.0647	6.62			
5	339	3.00	25.00	9.99	159.45	0.0928	5.47			
6	339	6.00	34.00	10.00	262.98	0.0912	6.52			
7	339	6.00	16.00	9.99	180.40	0.0551	5.75			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Half Height		Rh
Head =	6.13	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	339	6.00	25.00	9.99	225.50	0.0745	4.12			
2	671	6.00	25.00	10.00	317.31	0.0585	4.55			
3	7	6.00	25.00	9.68	31.89	0.1766	1.38			
4	339	9.00	25.00	10.00	276.18	0.0647	4.38			
5	339	3.00	25.00	9.99	159.45	0.0928	3.62			
6	339	6.00	34.00	10.00	262.98	0.0912	4.32			
7	339	6.00	16.00	9.99	180.40	0.0551	3.81			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Toe+3ft		Rh
Head =	3.00	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	339	6.00	25.00	9.99	225.50	0.0745	2.02			
2	671	6.00	25.00	10.00	317.31	0.0585	2.23			
3	7	6.00	25.00	9.68	31.89	0.1766	0.68			
4	339	9.00	25.00	10.00	276.18	0.0647	2.15			
5	339	3.00	25.00	9.99	159.45	0.0928	1.78			
6	339	6.00	34.00	10.00	262.98	0.0912	2.12			
7	339	6.00	16.00	9.99	180.40	0.0551	1.86			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Through-Seepage Reliability Analysis With Khilar's Extended Model

Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

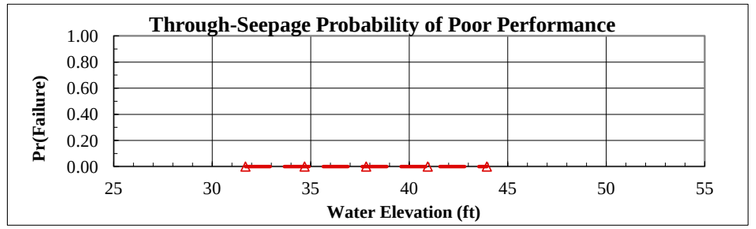
Levee Mile: 0.90
River Mile: 0.88
Analysis Case With Project Cutoff Wall

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables - Clay (CL) and Clayey Sand (SC) Levee			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Tractive Stress (Tc)	0.4	0.0	10.00
Initial Porosity (n)	0.7	0.07	10.00
Intrinsic Permeability (Ko)	1.00E-10	3.00E-11	30.00

Pr(f)=0
YES



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	31.69	0.0000
Toe+3ft	3.00	34.69	0.000000
Half Height	6.13	37.82	0.000000
Crest-3ft	9.25	40.94	0.000000
Crest	12.25	43.94	0.000000

Crest — **Head =** 12.25 — **Horizontal Gradient (Ix) =** 0.500

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.40	0.70	1.00E-10	12.07			
2	0.36	0.70	1.00E-10	10.86			
3	0.44	0.70	1.00E-10	13.27			
4	0.40	0.63	1.00E-10	11.45			
5	0.40	0.77	1.00E-10	12.66			
6	0.40	0.70	7.00E-11	14.42			
7	0.40	0.70	1.30E-10	10.58			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Half Height — **Head =** 6.13 — **Horizontal Gradient (Ix) =** 0.400

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.40	0.70	1.00E-10	12.07			
2	0.36	0.70	1.00E-10	10.86			
3	0.44	0.70	1.00E-10	13.27			
4	0.40	0.63	1.00E-10	11.45			
5	0.40	0.77	1.00E-10	12.66			
6	0.40	0.70	7.00E-11	14.42			
7	0.40	0.70	1.30E-10	10.58			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Crest-3ft — **Head =** 9.25 — **Horizontal Gradient (Ix) =** 0.470

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.40	0.70	1.00E-10	12.07			
2	0.36	0.70	1.00E-10	10.86			
3	0.44	0.70	1.00E-10	13.27			
4	0.40	0.63	1.00E-10	11.45			
5	0.40	0.77	1.00E-10	12.66			
6	0.40	0.70	7.00E-11	14.42			
7	0.40	0.70	1.30E-10	10.58			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Toe+3ft — **Head =** 3.00 — **Horizontal Gradient (Ix) =** 0.230

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.40	0.70	1.00E-10	12.07			
2	0.36	0.70	1.00E-10	10.86			
3	0.44	0.70	1.00E-10	13.27			
4	0.40	0.63	1.00E-10	11.45			
5	0.40	0.77	1.00E-10	12.66			
6	0.40	0.70	7.00E-11	14.42			
7	0.40	0.70	1.30E-10	10.58			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Landside Long-Term Stability Analysis With UTEXAS4

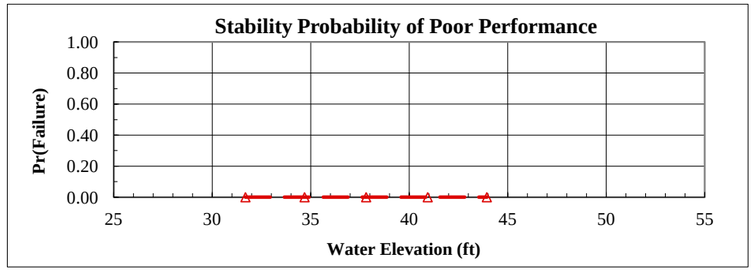
Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

Levee Mile: 0.90
River Mile: 0.88
Analysis Case With Project Cutoff Wall

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Levee Φ	24	3	13.00
Levee Cohesion	50	20	40.00
Levee γ	115	8	7.00
Foundation Φ	28	4	13.00
Foundation Cohesion	50	20	40.00



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	31.69	0.0000
Toe+3ft	3.00	34.69	0.000000
Half Height	6.13	37.82	0.000000
Crest-3ft	9.25	40.94	0.000000
Crest	12.25	43.94	0.000000

Crest | **Head =** 12.25 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	24	50	115	28	50	1.37		
2	21	50	115	28	50			
3	27	50	115	28	50			
4	24	30	115	28	50			
5	24	70	115	28	50			
6	24	50	107	28	50			
7	24	50	123	28	50			
8	24	50	115	24	50			
9	24	50	115	32	50			
10	24	50	115	28	30			
11	24	50	115	28	70			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Crest-3ft | **Head =** 9.25 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	24	50	115	28	50	1.51		
2	21	50	115	28	50			
3	27	50	115	28	50			
4	24	30	115	28	50			
5	24	70	115	28	50			
6	24	50	107	28	50			
7	24	50	123	28	50			
8	24	50	115	24	50			
9	24	50	115	32	50			
10	24	50	115	28	30			
11	24	50	115	28	70			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Half Height | **Head =** 6.13 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	24	50	115	28	50	1.54		
2	21	50	115	28	50			
3	27	50	115	28	50			
4	24	30	115	28	50			
5	24	70	115	28	50			
6	24	50	107	28	50			
7	24	50	123	28	50			
8	24	50	115	24	50			
9	24	50	115	32	50			
10	24	50	115	28	30			
11	24	50	115	28	70			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Toe+3ft | **Head =** 3.00 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	24	50	115	28	50	1.61		
2	21	50	115	28	50			
3	27	50	115	28	50			
4	24	30	115	28	50			
5	24	70	115	28	50			
6	24	50	107	28	50			
7	24	50	123	28	50			
8	24	50	115	24	50			
9	24	50	115	32	50			
10	24	50	115	28	30			
11	24	50	115	28	70			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Judgment Probability of Poor Performance Curve

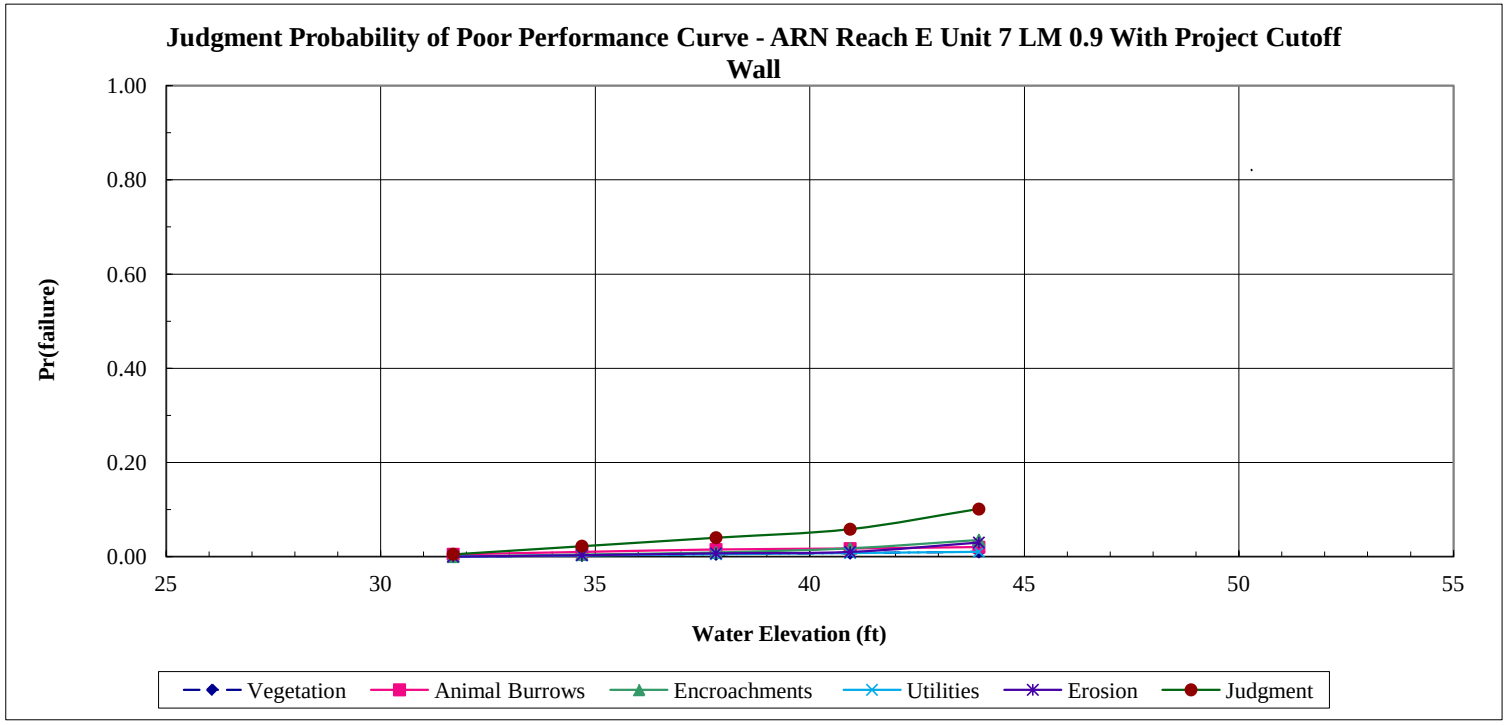
Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

Levee Mile: 0.90
River Mile: 0.88
Analysis Case: With Project Cutoff Wall

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Vegetation		Animal Burrows		Encroachments		Utilities		Erosion		Judgment	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
31.69	0.0000	1.0000	0.0050	0.9950	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0050	0.9950
34.69	0.0025	0.9975	0.0100	0.9900	0.0044	0.9956	0.0025	0.9975	0.0030	0.9970	0.0222	0.9778
37.82	0.0050	0.9950	0.0150	0.9850	0.0088	0.9913	0.0050	0.9950	0.0070	0.9930	0.0401	0.9599
40.94	0.0075	0.9925	0.0170	0.9830	0.0175	0.9825	0.0075	0.9925	0.0100	0.9900	0.0581	0.9419
43.94	0.0100	0.9900	0.0200	0.9800	0.0350	0.9650	0.0100	0.9900	0.0300	0.9700	0.1009	0.8991



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

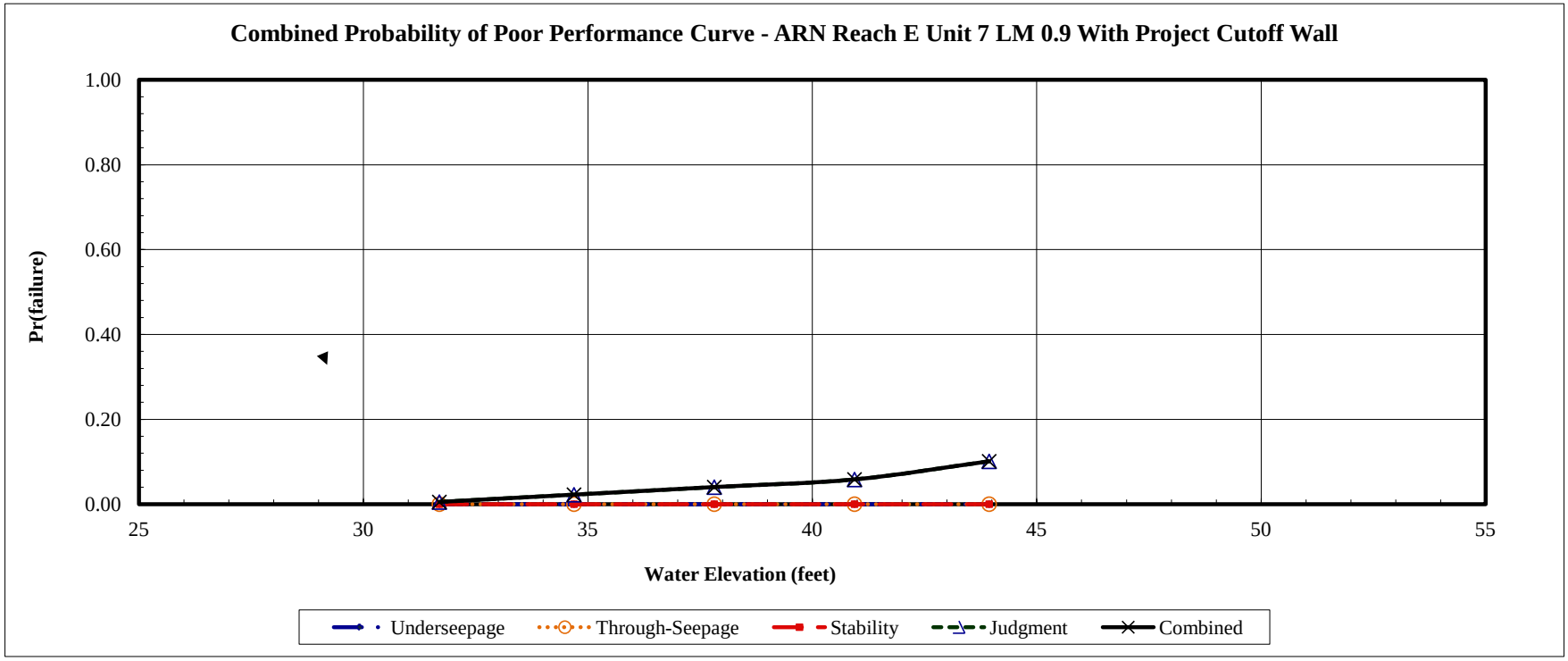
Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

Levee Mile: 0.90
River Mile: 0.88
Analysis Case: With Project Cutoff Wall

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
31.69	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0050	0.9950	0.0050	0.9950
34.69	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0222	0.9778	0.0222	0.9778
37.82	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0401	0.9599	0.0401	0.9599
40.94	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0581	0.9419	0.0581	0.9419
43.94	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.1009	0.8991	0.1009	0.8991



Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Determination of Random Variables For Underseepage Reliability Analysis

Project: American River Common Features GRR
Channel: American River
Basin and Reach: ARS Reach B Unit 4

Levee Mile: 3.90
River Mile: 3.94
Analysis Case Without Project Cutoff Wall

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Boring #	Blanket Thickness Variable (z)					Aquifer Thickness Variable (d)					Hydraulic Conductivity Vairables (Kb and Kf)								
	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Blanket		Aquifer Material		Kf/Kb	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation
											Material	Kb (ft/day)	Material	Kf (ft/day)					
WCSBAR-003B	9.5					45.5					ML	0.14	SM/SP-SM/GW	19.58	140				
2F-00-9W	7.96					30					ML/SM	0.14	SM/SP-SM/GW	16.89	121				
2F-97-23	9					31.2					CL/ML/SM	0.028	SM/SP-SM/GW	20.08	717				
2F-00-114	10.5					53					CL/SC/ML	0.035	SM/SP-SM/GW	20.84	595				
2F-99-17	20	12	4	44	33	34	40	9	427	23	SM	0.709	SW-SM/GW	25.18	36	661	1000	769160	98
2F-08-03	14.5					43					ML	0.14	SP/GP	23.77	170				
2F-07-03A	10.51					45					CL/ML	0.00709	SP/GP	20.22	2852				

Boring #	Blanket Material 1 (lowest permeability)			Blanket Material 2			Transformed Blanket Thickness (z)	Aquifer Material 1			Aquifer Material 2			Aquifer Material 3			Transformed Aquifer Horizontal Permeability (kf)
	Material Type	Thickness (z)	Permeability (Kb)	Material Type	Thickness (z)	Permeability (Kb)		Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	
WCSBAR-003B	ML	9.5	0.14				9.5	SM	17.5	2.8	SP-SM	5.5	14	GW	22.5	34	19.58
2F-00-9W	ML	4.5	0.14	SM	17.5	0.709	7.96	SM	11	2.8	SP-SM	8.5	14	GW	10.5	34	16.89
2F-97-23	CL	7	0.028	ML/SM	10	0.14	9	SM	9.85	2.8	SP-SM	6.35	14	GW	15	34	20.08
2F-00-114	CL/SC	9	0.035	ML	6	0.14	10.5	SM	10.5	2.8	SP-SM	18.5	14	GW	24	34	20.84
2F-99-17	SM	20	0.709				20	SW-SM	15	14	GW	19	34				25.18
2F-08-03	ML	14.5	0.14				14.5	SP	22	14	GP	21	34				23.77
2F-07-03A	CL	10	0.00709	ML	10	0.14	10.51	SP	31	14	GP	14	34				20.22

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Underseepage Reliability Analysis With Blanket Theory Analysis

Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4

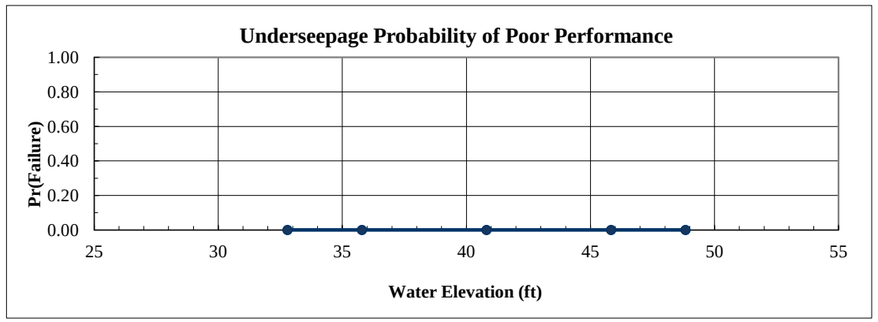
Levee Mile: 3.90
River Mile: 3.94
Analysis Case Without Project Cutoff Wall

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Permaebility Ratio	661	648	98
Blanket Thickness (z)	12	4	33
Aquifer Thickness (d)	40	9	23

Blanket Theory Analysis Inputs					
Pr(f)=0	**BTA Case No.**	**L1**	**L2**	**L3**	**γ Blanket**
YES	7A	0	125	∞	112



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	32.79	0.0000
Toe+3ft	3.00	35.79	0.0000
Half Height	8.02	40.81	0.0000
Crest-3ft	13.04	45.83	0.0000
Crest	16.04	48.83	0.0000

Crest		Rh
Head =	16.04	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	661	12.00	40.00	0.00	563.28	0.0581	13.13			
2	1309	12.00	40.00	0.00	792.60	0.0436	13.85			
3	13	12.00	40.00	0.00	79.66	0.1954	6.24			
4	661	16.00	40.00	0.00	650.42	0.0516	13.45			
5	661	8.00	40.00	0.00	459.91	0.0684	12.61			
6	661	12.00	49.00	0.00	623.43	0.0655	13.36			
7	661	12.00	31.00	0.00	495.87	0.0499	12.81			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Crest-3ft		Rh
Head =	13.04	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	661	12.00	40.00	0.00	563.28	0.0581	10.67			
2	1309	12.00	40.00	0.00	792.60	0.0436	11.26			
3	13	12.00	40.00	0.00	79.66	0.1954	5.08			
4	661	16.00	40.00	0.00	650.42	0.0516	10.94			
5	661	8.00	40.00	0.00	459.91	0.0684	10.25			
6	661	12.00	49.00	0.00	623.43	0.0655	10.86			
7	661	12.00	31.00	0.00	495.87	0.0499	10.41			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Half Height		Rh
Head =	8.02	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	661	12.00	40.00	0.00	563.28	0.0581	6.56			
2	1309	12.00	40.00	0.00	792.60	0.0436	6.93			
3	13	12.00	40.00	0.00	79.66	0.1954	3.12			
4	661	16.00	40.00	0.00	650.42	0.0516	6.73			
5	661	8.00	40.00	0.00	459.91	0.0684	6.31			
6	661	12.00	49.00	0.00	623.43	0.0655	6.68			
7	661	12.00	31.00	0.00	495.87	0.0499	6.41			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Toe+3ft		Rh
Head =	3.00	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	661	12.00	40.00	0.00	563.28	0.0581	2.46			
2	1309	12.00	40.00	0.00	792.60	0.0436	2.59			
3	13	12.00	40.00	0.00	79.66	0.1954	1.17			
4	661	16.00	40.00	0.00	650.42	0.0516	2.52			
5	661	8.00	40.00	0.00	459.91	0.0684	2.36			
6	661	12.00	49.00	0.00	623.43	0.0655	2.50			
7	661	12.00	31.00	0.00	495.87	0.0499	2.40			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Through-Seepage Reliability Analysis With Khilar's Extended Model

Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4

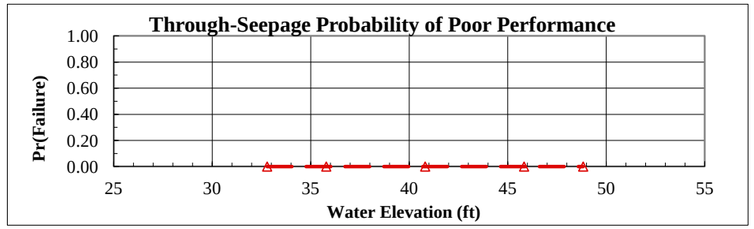
Levee Mile: 3.90
River Mile: 3.94
Analysis Case Without Project Cutoff Wall

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables - Silty Sand (SM) and Sand (SP) Levee			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Tractive Stress (Tc)	1.2	0.1	10.00
Initial Porosity (n)	0.25	0.03	10.00
Intrinsic Permeability (Ko)	1.50E-07	4.50E-08	30.00

Pr(f)=0
NO



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	32.79	0.0000
Toe+3ft	3.00	35.79	0.000000
Half Height	8.02	40.81	0.000000
Crest-3ft	13.04	45.83	0.000000
Crest	16.04	48.83	0.000000

Crest — **Head =** 16.04 — **Horizontal Gradient (Ix) =** 0.120

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.20	0.25	1.50E-07	0.56	4.65		
2	1.08	0.25	1.50E-07	0.50	4.19	0.216679	26.44
3	1.32	0.25	1.50E-07	0.61	5.12		
4	1.20	0.23	1.50E-07	0.53	4.42	0.054306	6.63
5	1.20	0.28	1.50E-07	0.59	4.88		
6	1.20	0.25	1.05E-07	0.67	5.56	0.548375	66.93
7	1.20	0.25	1.95E-07	0.49	4.08		
E[FS] =	4.654883		E[ln FS] =	1.519358	Total	0.819360	100.00
Var[FS]=	0.819360						
σ[FS]=	0.905185		σ[ln FS]=	0.192658		β =	7.886311
V(FS) =	0.194459					F(z) =	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		Pr(f) % =	0.000000

Half Height — **Head =** 8.02 — **Horizontal Gradient (Ix) =** 0.040

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.20	0.25	1.50E-07	0.56	13.96		
2	1.08	0.25	1.50E-07	0.50	12.57	1.950114	26.44
3	1.32	0.25	1.50E-07	0.61	15.36		
4	1.20	0.23	1.50E-07	0.53	13.25	0.488754	6.63
5	1.20	0.28	1.50E-07	0.59	14.65		
6	1.20	0.25	1.05E-07	0.67	16.69	4.935375	66.93
7	1.20	0.25	1.95E-07	0.49	12.25		
E[FS] =	13.964650		E[ln FS] =	2.617971	Total	7.374243	100.00
Var[FS]=	7.374243						
σ[FS]=	2.715556		σ[ln FS]=	0.192658		β =	13.588718
V(FS) =	0.194459					F(z) =	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		Pr(f) % =	0.000000

Crest-3ft — **Head =** 13.04 — **Horizontal Gradient (Ix) =** 0.090

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.20	0.25	1.50E-07	0.56	6.21		
2	1.08	0.25	1.50E-07	0.50	5.59	0.385208	26.44
3	1.32	0.25	1.50E-07	0.61	6.83		
4	1.20	0.23	1.50E-07	0.53	5.89	0.096544	6.63
5	1.20	0.28	1.50E-07	0.59	6.51		
6	1.20	0.25	1.05E-07	0.67	7.42	0.974889	66.93
7	1.20	0.25	1.95E-07	0.49	5.44		
E[FS] =	6.206511		E[ln FS] =	1.807040	Total	1.456641	100.00
Var[FS]=	1.456641						
σ[FS]=	1.206914		σ[ln FS]=	0.192658		β =	9.379541
V(FS) =	0.194459					F(z) =	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		Pr(f) % =	0.000000

Toe+3ft — **Head =** 3.00 — **Horizontal Gradient (Ix) =** 0.010

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.20	0.25	1.50E-07	0.56	55.86		
2	1.08	0.25	1.50E-07	0.50	50.27	31.201831	26.44
3	1.32	0.25	1.50E-07	0.61	61.44		
4	1.20	0.23	1.50E-07	0.53	52.99	7.820057	6.63
5	1.20	0.28	1.50E-07	0.59	58.58		
6	1.20	0.25	1.05E-07	0.67	66.76	78.966003	66.93
7	1.20	0.25	1.95E-07	0.49	48.99		
E[FS] =	55.858599		E[ln FS] =	4.004265	Total	117.987891	100.00
Var[FS]=	117.987891						
σ[FS]=	10.862223		σ[ln FS]=	0.192658		β =	20.784354
V(FS) =	0.194459					F(z) =	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		Pr(f) % =	0.000000

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Landside Long-Term Stability Analysis With UTEXAS4

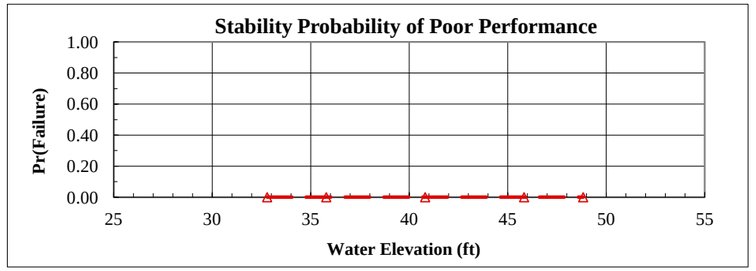
Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4

Levee Mile: 3.90
River Mile: 3.94
Analysis Case Without Project Cutoff Wall

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Levee Φ	33	4	13.00
Levee Cohesion	0	0	40.00
Levee γ	125	9	7.00
Foundation Φ	30	4	13.00
Foundation Cohesion	0	0	40.00



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	32.79	0.0000
Toe+3ft	3.00	35.79	0.000000
Half Height	8.02	40.81	0.000000
Crest-3ft	13.04	45.83	0.000000
Crest	16.04	48.83	0.000000

Crest | **Head =** 16.04 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.58		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Crest-3ft | **Head =** 13.04 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.59		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Half Height | **Head =** 8.02 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.61		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Toe+3ft | **Head =** 3.00 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.67		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

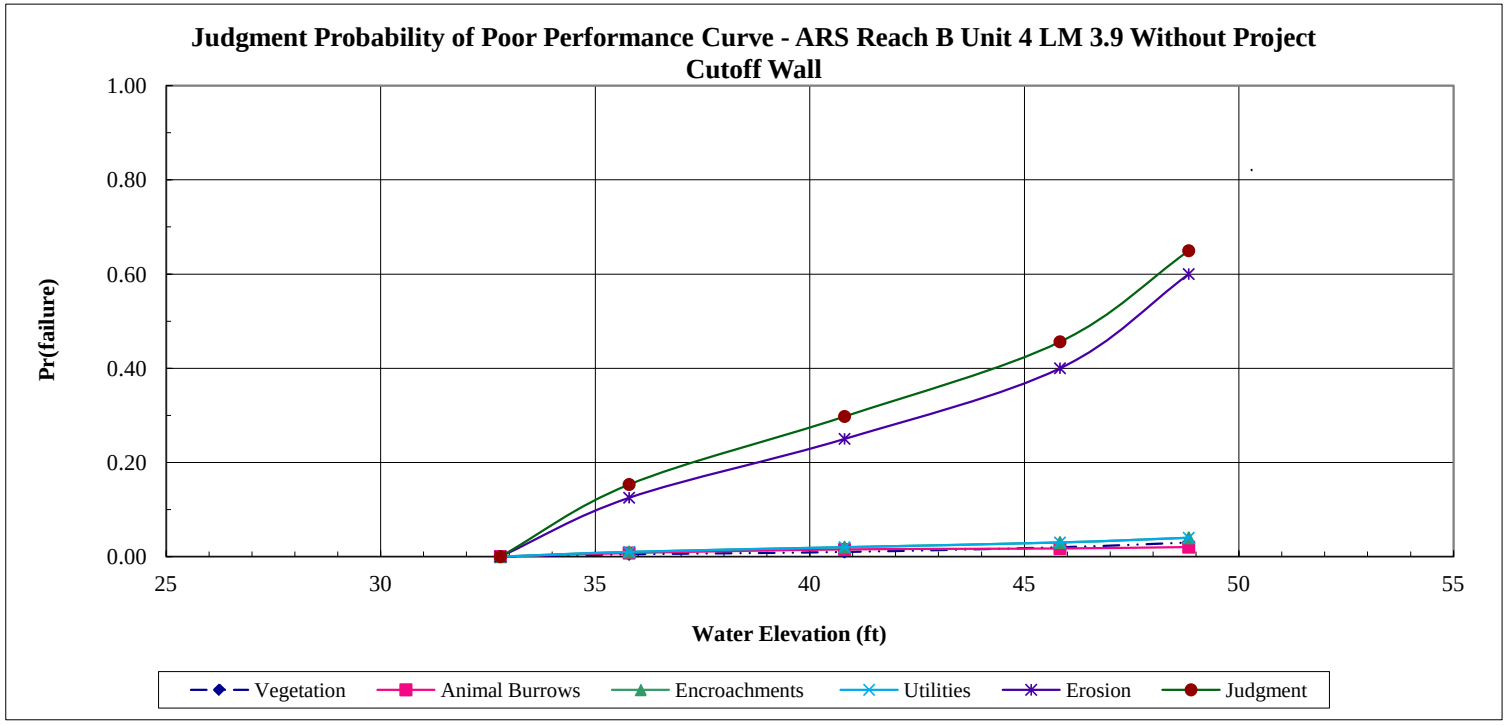
E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Judgment Probability of Poor Performance Curve

Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4
Levee Mile: 3.90
River Mile: 3.94
Analysis Case: Without Project Cutoff Wall
Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64
Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Vegetation		Animal Burrows		Encroachments		Utilities		Erosion		Judgment	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
32.79	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
35.79	0.0050	0.9950	0.0075	0.9925	0.0100	0.9900	0.0100	0.9900	0.1250	0.8750	0.1531	0.8469
40.81	0.0100	0.9900	0.0150	0.9850	0.0200	0.9800	0.0200	0.9800	0.2500	0.7500	0.2976	0.7024
45.83	0.0200	0.9800	0.0170	0.9830	0.0300	0.9700	0.0300	0.9700	0.4000	0.6000	0.4562	0.5438
48.83	0.0300	0.9700	0.0200	0.9800	0.0400	0.9600	0.0400	0.9600	0.6000	0.4000	0.6496	0.3504



Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

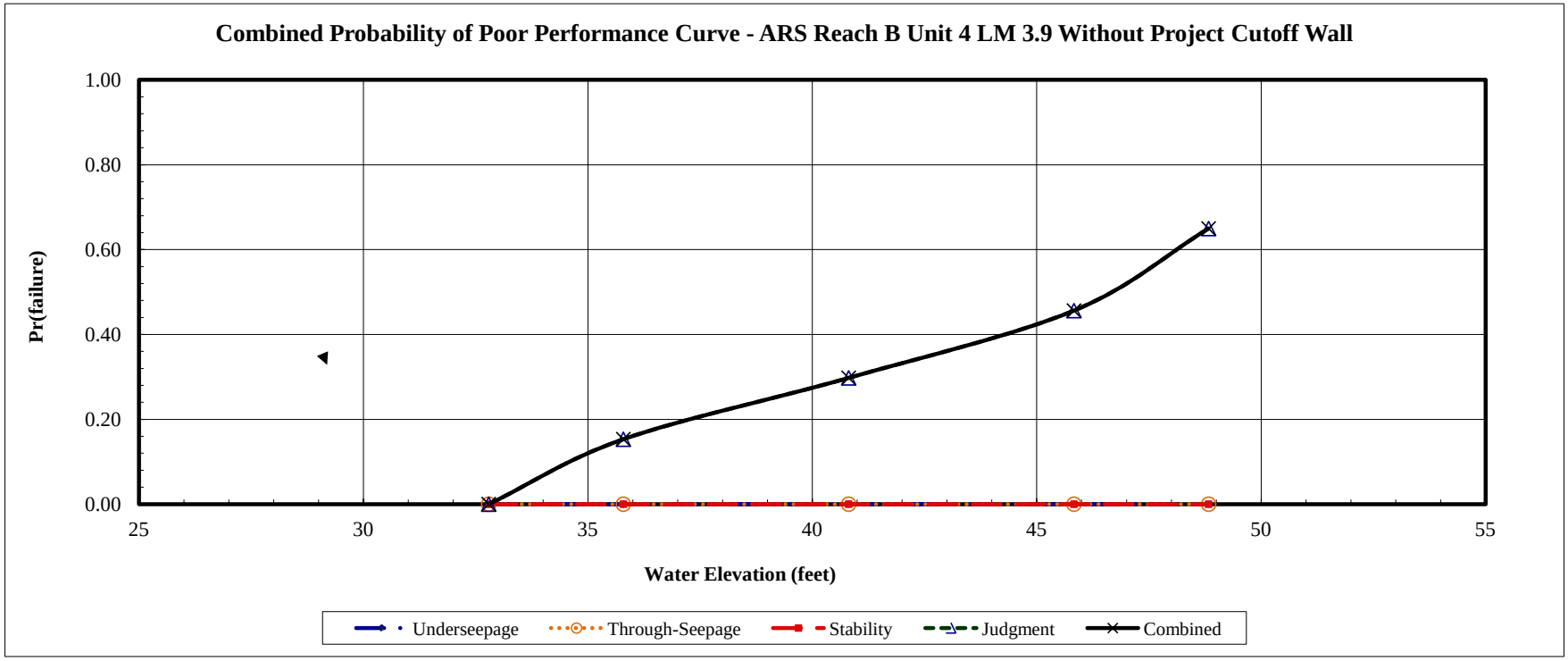
Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4

Levee Mile: 3.90
River Mile: 3.94
Analysis Case: Without Project Cutoff Wall

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
32.79	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
35.79	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.1531	0.8469	0.1531	0.8469
40.81	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.2976	0.7024	0.2976	0.7024
45.83	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.4562	0.5438	0.4562	0.5438
48.83	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.6496	0.3504	0.6496	0.3504



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Determination of Random Variables For Underseepage Reliability Analysis

Project: American River Common Features GRR
Channel: American River
Basin and Reach: ARS Reach B Unit 4

Levee Mile: 3.90
River Mile: 3.94
Analysis Case With Project Erosion Protection

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Boring #	Blanket Thickness Variable (z)					Aquifer Thickness Variable (d)					Hydraulic Conductivity Vairables (Kb and Kf)								
	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Blanket		Aquifer Material		Kf/Kb	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation
											Material	Kb (ft/day)	Material	Kf (ft/day)					
WCSBAR-003B	9.5					45.5					ML	0.14	SM/SP-SM/GW	19.58	140				
2F-00-9W	7.96					30					ML/SM	0.14	SM/SP-SM/GW	16.89	121				
2F-97-23	9					31.2					CL/ML/SM	0.028	SM/SP-SM/GW	20.08	717				
2F-00-114	10.5					53					CL/SC/ML	0.035	SM/SP-SM/GW	20.84	595				
2F-08-03	14.5	10	3	32	30	43	41	10	499	24	ML	0.14	SP/GP	23.77	170	349	285	69780	82

Boring #	Blanket Material 1 (lowest permeability)			Blanket Material 2			Transformed Blanket Thickness (z)	Aquifer Material 1			Aquifer Material 2			Aquifer Material 3			Transformed Aquifer Horizontal Permeability (kf)
	Material Type	Thickness (z)	Permeability (Kb)	Material Type	Thickness (z)	Permeability (Kb)		Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	
WCSBAR-003B	ML	9.5	0.14				9.5	SM	17.5	2.8	SP-SM	5.5	14	GW	22.5	34	19.58
2F-00-9W	ML	4.5	0.14	SM	17.5	0.709	7.96	SM	11	2.8	SP-SM	8.5	14	GW	10.5	34	16.89
2F-97-23	CL	7	0.028	ML/SM	10	0.14	9	SM	9.85	2.8	SP-SM	6.35	14	GW	15	34	20.08
2F-00-114	CL/SC	9	0.035	ML	6	0.14	10.5	SM	10.5	2.8	SP-SM	18.5	14	GW	24	34	20.84
2F-08-03	ML	14.5	0.14				14.5	SP	22	14	GP	21	34				23.77

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Underseepage Reliability Analysis With Blanket Theory Analysis

Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4

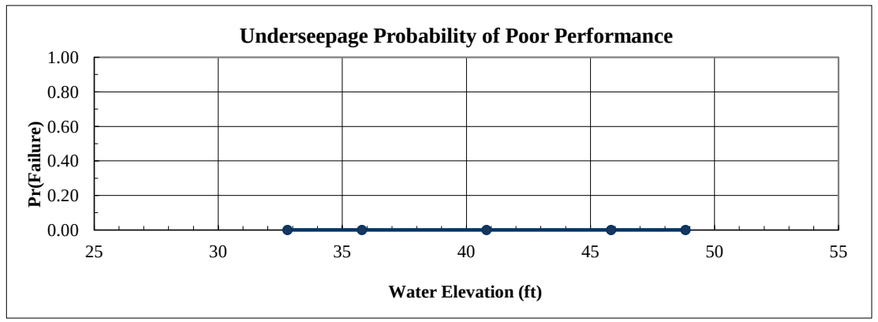
Levee Mile: 3.90
River Mile: 3.94
Analysis Case With Project Erosion Protection

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Permaebility Ratio	349	285	82
Blanket Thickness (z)	10	3	30
Aquifer Thickness (d)	41	10	24

Blanket Theory Analysis Inputs					
Pr(f)=0	**BTA Case No.**	**L1**	**L2**	**L3**	**γ Blanket**
YES	7A	0	125	∞	112



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	32.79	0.0000
Toe+3ft	3.00	35.79	0.0000
Half Height	8.02	40.81	0.0000
Crest-3ft	13.04	45.83	0.0000
Crest	16.04	48.83	0.0000

Crest		Rh
Head =	16.04	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	349	10.00	41.00	0.00	378.27	0.0815	12.06			
2	634	10.00	41.00	0.00	509.84	0.0646	12.88			
3	64	10.00	41.00	0.00	161.99	0.1429	9.05			
4	349	13.00	41.00	0.00	431.30	0.0737	12.44			
5	349	7.00	41.00	0.00	316.49	0.0929	11.50			
6	349	10.00	51.00	0.00	421.89	0.0933	12.37			
7	349	10.00	31.00	0.00	328.92	0.0683	11.62			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Crest-3ft		Rh
Head =	13.04	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	349	10.00	41.00	0.00	378.27	0.0815	9.80			
2	634	10.00	41.00	0.00	509.84	0.0646	10.47			
3	64	10.00	41.00	0.00	161.99	0.1429	7.36			
4	349	13.00	41.00	0.00	431.30	0.0737	10.11			
5	349	7.00	41.00	0.00	316.49	0.0929	9.35			
6	349	10.00	51.00	0.00	421.89	0.0933	10.06			
7	349	10.00	31.00	0.00	328.92	0.0683	9.45			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Half Height		Rh
Head =	8.02	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	349	10.00	41.00	0.00	378.27	0.0815	6.03			
2	634	10.00	41.00	0.00	509.84	0.0646	6.44			
3	64	10.00	41.00	0.00	161.99	0.1429	4.53			
4	349	13.00	41.00	0.00	431.30	0.0737	6.22			
5	349	7.00	41.00	0.00	316.49	0.0929	5.75			
6	349	10.00	51.00	0.00	421.89	0.0933	6.19			
7	349	10.00	31.00	0.00	328.92	0.0683	5.81			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Toe+3ft		Rh
Head =	3.00	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	349	10.00	41.00	0.00	378.27	0.0815	2.25			
2	634	10.00	41.00	0.00	509.84	0.0646	2.41			
3	64	10.00	41.00	0.00	161.99	0.1429	1.69			
4	349	13.00	41.00	0.00	431.30	0.0737	2.33			
5	349	7.00	41.00	0.00	316.49	0.0929	2.15			
6	349	10.00	51.00	0.00	421.89	0.0933	2.31			
7	349	10.00	31.00	0.00	328.92	0.0683	2.17			
								Total		

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Through-Seepage Reliability Analysis With Khilar's Extended Model

Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4

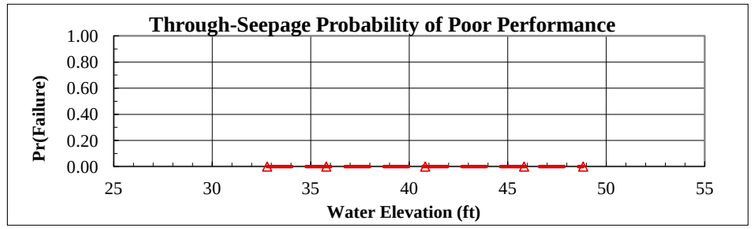
Levee Mile: 3.90
River Mile: 3.94
Analysis Case With Project Erosion Protection

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Random Variables - Silty Sand (SM) and Sand (SP) Levee			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Tractive Stress (Tc)	1.2	0.1	10.00
Initial Porosity (n)	0.25	0.03	10.00
Intrinsic Permeability (Ko)	1.50E-07	4.50E-08	30.00

Pr(f)=0
NO



Analysis Case	**Head**	**Elevation**	**Pr(f)**
Toe	0.00	32.79	0.0000
Toe+3ft	3.00	35.79	0.000000
Half Height	8.02	40.81	0.000000
Crest-3ft	13.04	45.83	0.000000
Crest	16.04	48.83	0.000000

Crest — **Head =** 16.04 — **Horizontal Gradient (Ix) =** 0.120

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.20	0.25	1.50E-07	0.56	4.65		
2	1.08	0.25	1.50E-07	0.50	4.19	0.216679	26.44
3	1.32	0.25	1.50E-07	0.61	5.12		
4	1.20	0.23	1.50E-07	0.53	4.42	0.054306	6.63
5	1.20	0.28	1.50E-07	0.59	4.88		
6	1.20	0.25	1.05E-07	0.67	5.56	0.548375	66.93
7	1.20	0.25	1.95E-07	0.49	4.08		
E[FS] =	4.654883		E[ln FS] =	1.519358	Total	0.819360	100.00
Var[FS]=	0.819360						
σ[FS]=	0.905185		σ[ln FS]=	0.192658		**β =**	7.886311
V(FS) =	0.194459					**F(z) =**	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Crest-3ft — **Head =** 13.04 — **Horizontal Gradient (Ix) =** 0.090

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.20	0.25	1.50E-07	0.56	6.21		
2	1.08	0.25	1.50E-07	0.50	5.59	0.385208	26.44
3	1.32	0.25	1.50E-07	0.61	6.83		
4	1.20	0.23	1.50E-07	0.53	5.89	0.096544	6.63
5	1.20	0.28	1.50E-07	0.59	6.51		
6	1.20	0.25	1.05E-07	0.67	7.42	0.974889	66.93
7	1.20	0.25	1.95E-07	0.49	5.44		
E[FS] =	6.206511		E[ln FS] =	1.807040	Total	1.456641	100.00
Var[FS]=	1.456641						
σ[FS]=	1.206914		σ[ln FS]=	0.192658		**β =**	9.379541
V(FS) =	0.194459					**F(z) =**	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Half Height — **Head =** 8.02 — **Horizontal Gradient (Ix) =** 0.040

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.20	0.25	1.50E-07	0.56	13.96		
2	1.08	0.25	1.50E-07	0.50	12.57	1.950114	26.44
3	1.32	0.25	1.50E-07	0.61	15.36		
4	1.20	0.23	1.50E-07	0.53	13.25	0.488754	6.63
5	1.20	0.28	1.50E-07	0.59	14.65		
6	1.20	0.25	1.05E-07	0.67	16.69	4.935375	66.93
7	1.20	0.25	1.95E-07	0.49	12.25		
E[FS] =	13.964650		E[ln FS] =	2.617971	Total	7.374243	100.00
Var[FS]=	7.374243						
σ[FS]=	2.715556		σ[ln FS]=	0.192658		**β =**	13.588718
V(FS) =	0.194459					**F(z) =**	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

Toe+3ft — **Head =** 3.00 — **Horizontal Gradient (Ix) =** 0.010

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	1.20	0.25	1.50E-07	0.56	55.86		
2	1.08	0.25	1.50E-07	0.50	50.27	31.201831	26.44
3	1.32	0.25	1.50E-07	0.61	61.44		
4	1.20	0.23	1.50E-07	0.53	52.99	7.820057	6.63
5	1.20	0.28	1.50E-07	0.59	58.58		
6	1.20	0.25	1.05E-07	0.67	66.76	78.966003	66.93
7	1.20	0.25	1.95E-07	0.49	48.99		
E[FS] =	55.858599		E[ln FS] =	4.004265	Total	117.987891	100.00
Var[FS]=	117.987891						
σ[FS]=	10.862223		σ[ln FS]=	0.192658		**β =**	20.784354
V(FS) =	0.194459					**F(z) =**	0.000000
FS req'd =	1.00		ln(FS req'd) =	0.000000		**Pr(f) % =**	0.000000

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Landside Long-Term Stability Analysis With UTEXAS4

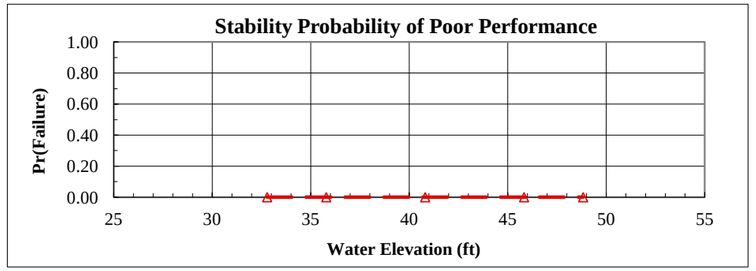
Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4

Levee Mile: 3.90
River Mile: 3.94
Analysis Case With Project Erosion Protection

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Levee Φ	33	4	13.00
Levee Cohesion	0	0	40.00
Levee γ	125	9	7.00
Foundation Φ	30	4	13.00
Foundation Cohesion	0	0	40.00



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	32.79	0.0000
Toe+3ft	3.00	35.79	0.000000
Half Height	8.02	40.81	0.000000
Crest-3ft	13.04	45.83	0.000000
Crest	16.04	48.83	0.000000

Crest | **Head =** 16.04 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.58		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = | E[ln FS] = | Total
Var[FS]=
σ[FS]= | σ[ln FS]= | **β =**
V(FS) = | **F(z) =**
FS req'd = 1.00 | ln(FS req'd) = 0.000000 | **Pr(f) % =** 0.000000

Crest-3ft | **Head =** 13.04 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.59		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = | E[ln FS] = | Total
Var[FS]=
σ[FS]= | σ[ln FS]= | **β =**
V(FS) = | **F(z) =**
FS req'd = 1.00 | ln(FS req'd) = 0.000000 | **Pr(f) % =** 0.000000

Half Height | **Head =** 8.02 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.61		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = | E[ln FS] = | Total
Var[FS]=
σ[FS]= | σ[ln FS]= | **β =**
V(FS) = | **F(z) =**
FS req'd = 1.00 | ln(FS req'd) = 0.000000 | **Pr(f) % =** 0.000000

Toe+3ft | **Head =** 3.00 | **Pr(f)=0** YES

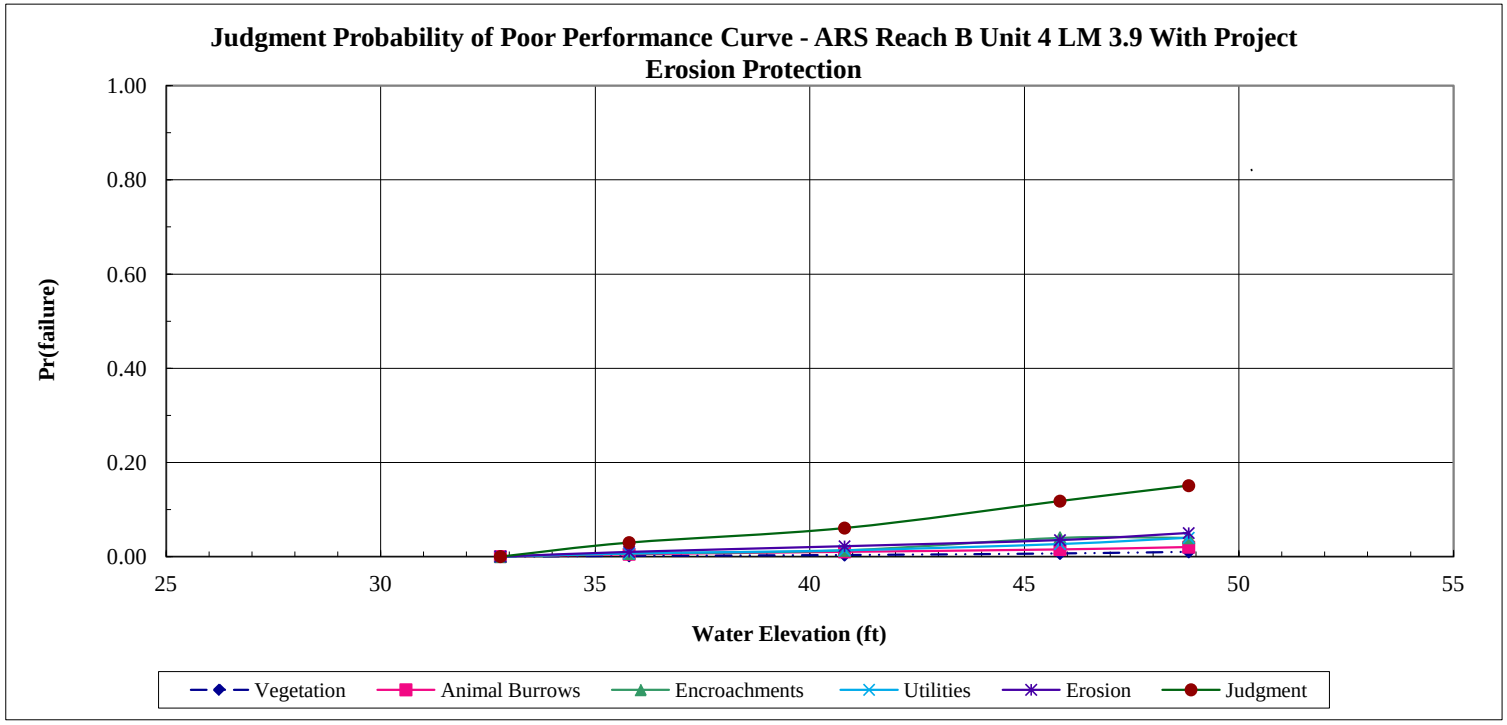
Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.67		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = | E[ln FS] = | Total
Var[FS]=
σ[FS]= | σ[ln FS]= | **β =**
V(FS) = | **F(z) =**
FS req'd = 1.00 | ln(FS req'd) = 0.000000 | **Pr(f) % =** 0.000000

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Judgment Probability of Poor Performance Curve

Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4
Levee Mile: 3.90
River Mile: 3.94
Analysis Case: With Project Erosion Protect
Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64
Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Water Surface Elevation	Vegetation		Animal Burrows		Encroachments		Utilities		Erosion		Judgment	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
32.79	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.00000	1.0000	0.0000	1.0000
35.79	0.00167	0.9983	0.00500	0.9950	0.00667	0.9933	0.00667	0.9933	0.01000	0.9900	0.0297	0.9703
40.81	0.00333	0.9967	0.01000	0.9900	0.01333	0.9867	0.01333	0.9867	0.02200	0.9780	0.0606	0.9394
45.83	0.00667	0.9933	0.01500	0.9850	0.04000	0.9600	0.02667	0.9733	0.03500	0.9650	0.1178	0.8822
48.83	0.01000	0.9900	0.02000	0.9800	0.04000	0.9600	0.04000	0.9600	0.05000	0.9500	0.1506	0.8494



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

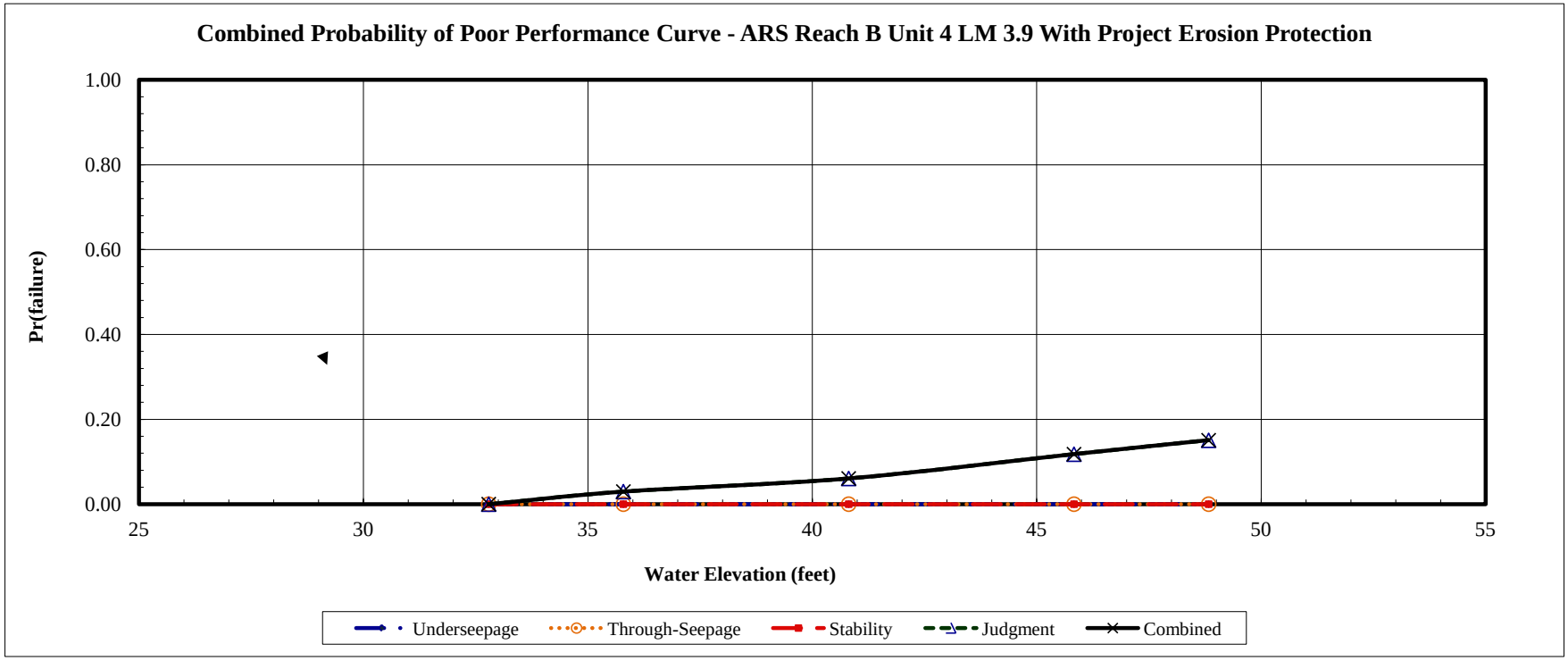
Project: American River Common Features GRR
Study Area: American River
River Section: ARS Reach B Unit 4

Levee Mile: 3.90
River Mile: 3.94
Analysis Case: With Project Erosion Protection

Crest Elev.: 48.83
L/S Toe Elev.: 32.79
W/S Toe Elev.: 28.64

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
32.79	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
35.79	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0297	0.9703	0.0297	0.9703
40.81	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0606	0.9394	0.0606	0.9394
45.83	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.1178	0.8822	0.1178	0.8822
48.83	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.1506	0.8494	0.1506	0.8494



Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Determination of Random Variables For Underseepage Reliability Analysis

Project: American River Common Features GRR
Channel: Sacramento River
Basin and Reach: ARS Reach F Unit 1

Levee Mile: 5.92
River Mile: 50.21
Analysis Case Without Project Cutoff Wall

Crest Elev.: 33.23
L/S Toe Elev.: 19.00
W/S Toe Elev.: 22.00

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Boring #	Blanket Thickness Variable (z)					Aquifer Thickness Variable (d)					Hydraulic Conductivity Vairables (Kb and Kf)								
	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Blanket		Aquifer Material		Kf/Kb	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation
											Material	Kb (ft/day)	Material	Kf (ft/day)					
2F-05-G4-1	32					57.4					ML	0.14	SP/ML	25.13	180				
2F-05-G4-1A	32					63.5					ML	0.14	L/SM/SP/GP-G	24.85	178				
2F-05-G4-2	13.11					94					ML/SM	0.14	SM/SP/GW	20.88	149				
2F-05-G4-2A	16					67.2					ML	0.14	SM/SP/GP-GM	12.47	89				
K-S-4	9.75	20	9	118	45	95.25	83	16	911	19	CL/ML/ML/SM	0.028	SP/GP	29.51	1054	289	361	124190	98
2F-05-G4-3	26					96.8					ML	0.14	SM/SP/GP	22.23	159				
2F-05-G4-3A	8.5					90					CL	0.028	SM/SP/GP-GM	20.99	750				
K-S-2	28					91					SM	0.709	SM/SP-SM/GP	15.12	21				
K-S-3	18.5					93.5					SM	0.709	SM/SP-SM/GM	13.54	19				

Boring #	Blanket Material 1 (lowest permeability)			Blanket Material 2			Transformed Blanket Thickness (z)	Aquifer Material 1			Aquifer Material 2			Aquifer Material 3			Transformed Aquifer Horizontal Permeability (kf)
	Material Type	Thickness (z)	Permeability (Kb)	Material Type	Thickness (z)	Permeability (Kb)		Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	
2F-05-G4-1	ML	32	0.14				32	SP	51.4	28	ML	6	0.57				25.13
2F-05-G4-1A	ML	32	0.14				32	ML/SM	9	2.8	SP	50	28	GP-GM	4.5	34	24.85
2F-05-G4-2	ML	10.8	0.14	SM	11.7	0.709	13.11	SM	33	2.8	SP	34	28	GW	27	34	20.88
2F-05-G4-2A	ML	16	0.14				16	SM	43.8	2.8	SP	13.4	28	GP-GM	10	34	12.47
K-S-4	CL/ML	6	0.028	ML/SM	18.75	0.14	9.75	SP	71.25	28	GP	24	34				29.51
2F-05-G4-3	ML	26	0.14				26	SM	33	2.8	SP	18.3	28	GP	45.5	34	22.23
2F-05-G4-3A	CL	8.5	0.028				8.5	SM	31	2.8	SP	34	28	GP-GM	25	34	20.99
K-S-2	SM	28	0.709				28	SM	15	2.8	SP-SM	62.5	14	GP	13.5	34	15.12
K-S-3	SM	18.5	0.709				18.5	SM	19	2.8	SP-SM	66	14	GM	8.5	34	13.54

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Underseepage Reliability Analysis With Blanket Theory Analysis

Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

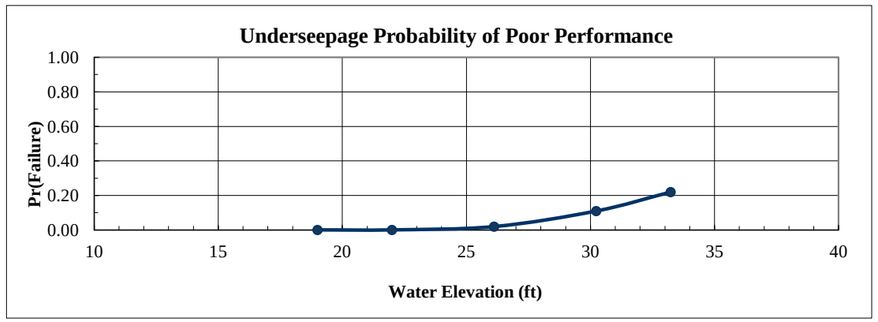
Levee Mile: 5.92
River Mile: 50.21
Analysis Case Without Project Cutoff Wall

Crest Elev.: 33.23
L/S Toe Elev.: 19.00
W/S Toe Elev.: 22.00

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Permaebility Ratio	289	283	98
Blanket Thickness (z)	20	9	45
Aquifer Thickness (d)	83	16	19

Blanket Theory Analysis Inputs					
Pr(f)=0	**BTA Case No.**	**L1**	**L2**	**L3**	**γ Blanket**
NO	7A	20	95	∞	112



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	19.00	0.0000
Toe+3ft	3.00	22.00	0.0001
Half Height	7.12	26.12	0.0193
Crest-3ft	11.23	30.23	0.1094
Crest	14.23	33.23	0.2194

Crest		Rh
Head =	14.23	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	289	20.00	83.00	19.99	692.63	0.1028	12.20	0.61		
2	572	20.00	83.00	20.00	974.62	0.0762	12.73	0.64	0.024025	19.48
3	6	20.00	83.00	19.73	97.95	0.3903	6.55	0.33		
4	289	29.00	83.00	20.00	834.04	0.0875	12.51	0.43	0.099225	80.44
5	289	11.00	83.00	19.99	513.67	0.1320	11.63	1.06		
6	289	20.00	99.00	20.00	756.45	0.1136	12.35	0.62	0.000100	0.08
7	289	20.00	67.00	19.99	622.30	0.0909	12.01	0.60		
								Total	0.123350	100.00

E[I] = 0.610000 E[ln I] = -0.637448
Var[I]= 0.123350
σ[I]= 0.351212 σ [ln I] = 0.535074
V(I) = 0.575758

β =	-1.191328
F(z) =	0.780622
Pr(f) % =	21.937828

Ic= 0.80 ln(I crit) = -0.223144

Half Height		Rh
Head =	7.12	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	289	20.00	83.00	19.99	692.63	0.1028	6.10	0.31		
2	572	20.00	83.00	20.00	974.62	0.0762	6.36	0.32	0.006400	21.02
3	6	20.00	83.00	19.73	97.95	0.3903	3.28	0.16		
4	289	29.00	83.00	20.00	834.04	0.0875	6.25	0.22	0.024025	78.90
5	289	11.00	83.00	19.99	513.67	0.1320	5.81	0.53		
6	289	20.00	99.00	20.00	756.45	0.1136	6.18	0.31	0.000025	0.08
7	289	20.00	67.00	19.99	622.30	0.0909	6.01	0.30		
								Total	0.030450	100.00

E[I] = 0.310000 E[ln I] = -1.308807
Var[I]= 0.030450
σ[I]= 0.174499 σ [ln I] = 0.524641
V(I) = 0.562901

β =	-2.494672
F(z) =	0.980743
Pr(f) % =	1.925683

Ic= 0.80 ln(I crit) = -0.223144

Crest-3ft		Rh
Head =	11.23	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	289	20.00	83.00	19.99	692.63	0.1028	9.63	0.48		
2	572	20.00	83.00	20.00	974.62	0.0762	10.04	0.50	0.014400	19.32
3	6	20.00	83.00	19.73	97.95	0.3903	5.17	0.26		
4	289	29.00	83.00	20.00	834.04	0.0875	9.87	0.34	0.060025	80.54
5	289	11.00	83.00	19.99	513.67	0.1320	9.18	0.83		
6	289	20.00	99.00	20.00	756.45	0.1136	9.75	0.49	0.000100	0.13
7	289	20.00	67.00	19.99	622.30	0.0909	9.48	0.47		
								Total	0.074525	100.00

E[I] = 0.480000 E[ln I] = -0.874094
Var[I]= 0.074525
σ[I]= 0.272993 σ [ln I] = 0.529385
V(I) = 0.568735

β =	-1.651148
F(z) =	0.890583
Pr(f) % =	10.941717

Ic= 0.80 ln(I crit) = -0.223144

Toe+3ft		Rh
Head =	3.00	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	289	20.00	83.00	19.99	692.63	0.1028	2.57	0.13		
2	572	20.00	83.00	20.00	974.62	0.0762	2.68	0.13	0.000900	17.56
3	6	20.00	83.00	19.73	97.95	0.3903	1.38	0.07		
4	289	29.00	83.00	20.00	834.04	0.0875	2.64	0.09	0.004225	82.44
5	289	11.00	83.00	19.99	513.67	0.1320	2.45	0.22		
6	289	20.00	99.00	20.00	756.45	0.1136	2.60	0.13	0.000000	0.00
7	289	20.00	67.00	19.99	622.30	0.0909	2.53	0.13		
								Total	0.005125	100.00

E[I] = 0.130000 E[ln I] = -2.172653
Var[I]= 0.005125
σ[I]= 0.071589 σ [ln I] = 0.514650
V(I) = 0.550685

β =	-4.221614
F(z) =	0.999924
Pr(f) % =	0.007592

Ic= 0.80 ln(I crit) = -0.223144

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Through-Seepage Reliability Analysis With Khilar's Extended Model

Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

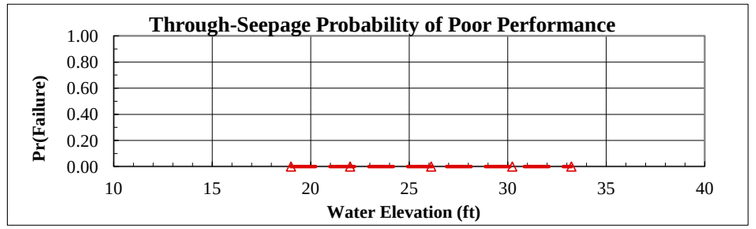
Levee Mile: 5.92
River Mile: 50.21
Analysis Case Without Project Cutoff Wall

Crest Elev.: 33.23
L/S Toe Elev.: 19.00
W/S Toe Elev.: 22.00

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables - Silty Sand (SM) and Sand (SP) Levee			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Tractive Stress (Tc)	0.8	0.1	10.00
Initial Porosity (n)	0.35	0.04	10.00
Intrinsic Permeability (Ko)	5.00E-07	1.50E-07	30.00

Pr(f)=0
YES



Analysis Case	**Head**	**Elevation**	**Pr(f)**
Toe	0.00	19.00	0.0000
Toe+3ft	3.00	22.00	0.000000
Half Height	7.12	26.12	0.000000
Crest-3ft	11.23	30.23	0.000000
Crest	14.23	33.23	0.000000

Crest — **Head =** 14.23 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.80	0.35	5.00E-07	0.24			
2	0.72	0.35	5.00E-07	0.22			
3	0.88	0.35	5.00E-07	0.27			
4	0.80	0.32	5.00E-07	0.23			
5	0.80	0.39	5.00E-07	0.25			
6	0.80	0.35	3.50E-07	0.29			
7	0.80	0.35	6.50E-07	0.21			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Crest-3ft — **Head =** 11.23 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.80	0.35	5.00E-07	0.24			
2	0.72	0.35	5.00E-07	0.22			
3	0.88	0.35	5.00E-07	0.27			
4	0.80	0.32	5.00E-07	0.23			
5	0.80	0.39	5.00E-07	0.25			
6	0.80	0.35	3.50E-07	0.29			
7	0.80	0.35	6.50E-07	0.21			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Half Height — **Head =** 7.12 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.80	0.35	5.00E-07	0.24			
2	0.72	0.35	5.00E-07	0.22			
3	0.88	0.35	5.00E-07	0.27			
4	0.80	0.32	5.00E-07	0.23			
5	0.80	0.39	5.00E-07	0.25			
6	0.80	0.35	3.50E-07	0.29			
7	0.80	0.35	6.50E-07	0.21			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Toe+3ft — **Head =** 3.00 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.80	0.35	5.00E-07	0.24			
2	0.72	0.35	5.00E-07	0.22			
3	0.88	0.35	5.00E-07	0.27			
4	0.80	0.32	5.00E-07	0.23			
5	0.80	0.39	5.00E-07	0.25			
6	0.80	0.35	3.50E-07	0.29			
7	0.80	0.35	6.50E-07	0.21			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Landside Long-Term Stability Analysis With UTEXAS4

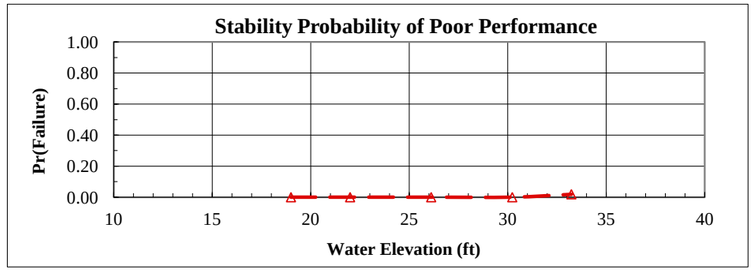
Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

Levee Mile: 5.92
River Mile: 50.21
Analysis Case Without Project Cutoff Wall

Crest Elev.: 33.23
L/S Toe Elev.: 19.00
W/S Toe Elev.: 22.00

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Levee Φ	33	4	13.00
Levee Cohesion	0	0	40.00
Levee γ	125	9	7.00
Foundation Φ	30	4	13.00
Foundation Cohesion	0	0	40.00



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	19.00	0.0000
Toe+3ft	3.00	22.00	0.000000
Half Height	7.12	26.12	0.000000
Crest-3ft	11.23	30.23	0.000000
Crest	14.23	33.23	0.019060

Crest	**Head =**	14.23	**Pr(f)=0**	NO

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.28		
2	29	0	125	30	0	1.21	0.010000	45.20
3	37	0	125	30	0	1.41		
4	33	0	125	30	0	1.28	0.000000	0.00
5	33	0	125	30	0	1.28		
6	33	0	116	30	0	1.33	0.000025	0.11
7	33	0	134	30	0	1.32		
8	33	0	125	26	0	1.21	0.012100	54.69
9	33	0	125	34	0	1.43		
10	33	0	125	30	0	1.28	0.000000	0.00
11	33	0	125	30	0	1.28		

E[FS] = 1.280000 E[ln FS] = 0.240153 Total 0.022125 100.00
Var[FS]= 0.022125
σ[FS]= 0.148745 σ[ln FS]= 0.115817
V(FS) = 0.116207

β =	2.073551
F(z) =	0.019060
Pr(f) % =	1.906050

FS req'd =	1.00	ln(FS req'd) =	0.000000

Crest-3ft	**Head =**	11.23	**Pr(f)=0**	YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.32		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =

β =	
F(z) =	
Pr(f) % =	

FS req'd =	1.00	ln(FS req'd) =	0.000000

Half Height	**Head =**	7.12	**Pr(f)=0**	YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.40		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =

β =	
F(z) =	
Pr(f) % =	

FS req'd =	1.00	ln(FS req'd) =	0.000000

Toe+3ft	**Head =**	3.00	**Pr(f)=0**	YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	33	0	125	30	0	1.46		
2	29	0	125	30	0			
3	37	0	125	30	0			
4	33	0	125	30	0			
5	33	0	125	30	0			
6	33	0	116	30	0			
7	33	0	134	30	0			
8	33	0	125	26	0			
9	33	0	125	34	0			
10	33	0	125	30	0			
11	33	0	125	30	0			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =

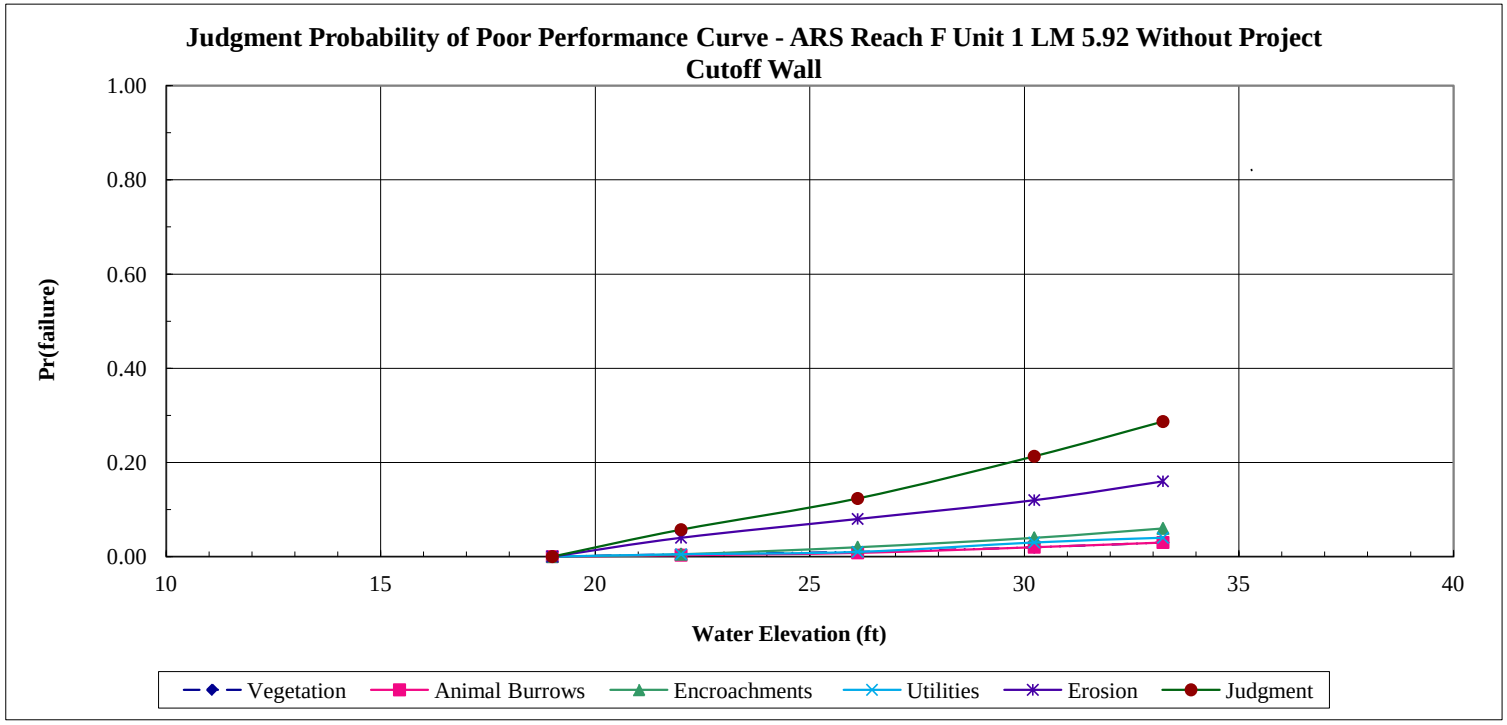
β =	
F(z) =	
Pr(f) % =	0.000000

FS req'd =	1.00	ln(FS req'd) =	0.000000

Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Judgment Probability of Poor Performance Curve

Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1
Levee Mile: 5.92
River Mile: 50.21
Analysis Case: Without Project Cutoff Wall
Crest Elev.: 33.23
L/S Toe Elev.: 19.00
W/S Toe Elev.: 22.00
Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Vegetation		Animal Burrows		Encroachments		Utilities		Erosion		Judgment	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
19.00	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
22.00	0.0050	0.9950	0.0030	0.9970	0.0050	0.9950	0.0050	0.9950	0.0400	0.9600	0.0572	0.9428
26.12	0.0100	0.9900	0.0080	0.9920	0.0200	0.9800	0.0100	0.9900	0.0800	0.9200	0.1234	0.8766
30.23	0.0200	0.9800	0.0200	0.9800	0.0400	0.9600	0.0300	0.9700	0.1200	0.8800	0.2130	0.7870
33.23	0.0300	0.9700	0.0300	0.9700	0.0600	0.9400	0.0400	0.9600	0.1600	0.8400	0.2868	0.7132



Without Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

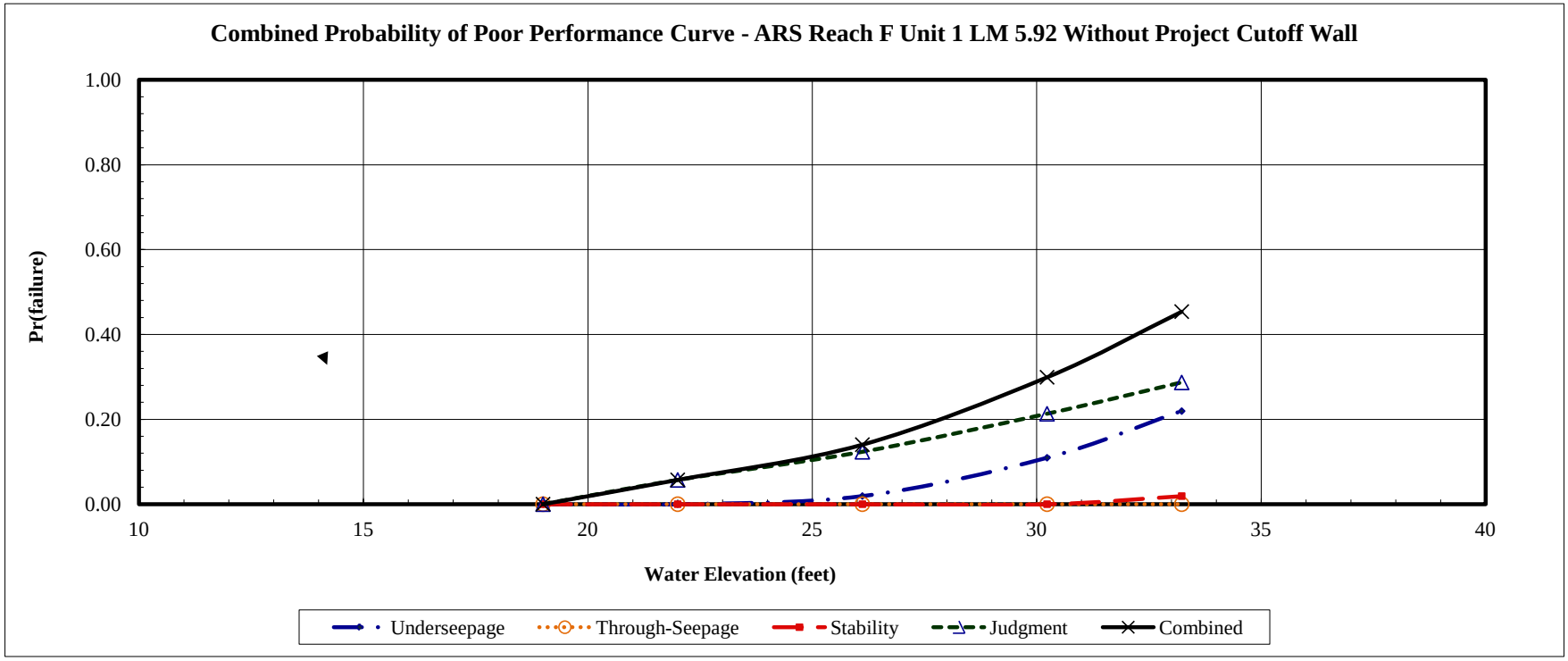
Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

Levee Mile: 5.92
River Mile: 50.21
Analysis Case: Without Project Cutoff Wall

Crest Elev.: 33.23
L/S Toe Elev.: 19.00
W/S Toe Elev.: 22.00

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
19.00	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
22.00	0.0001	0.9999	0.0000	1.0000	0.0000	1.0000	0.0572	0.9428	0.0572	0.9428
26.12	0.0193	0.9807	0.0000	1.0000	0.0000	1.0000	0.1234	0.8766	0.1403	0.8597
30.23	0.1094	0.8906	0.0000	1.0000	0.0000	1.0000	0.2130	0.7870	0.2991	0.7009
33.23	0.2194	0.7806	0.0000	1.0000	0.0191	0.9809	0.2868	0.7132	0.4539	0.5461



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Determination of Random Variables For Underseepage Reliability Analysis

Project: American River Common Features GRR
Channel: Sacramento River
Basin and Reach: ARS Reach F Unit 1

Levee Mile: 5.92
River Mile: 50.21
Analysis Case With Project Cutoff Wall

Crest Elev.: 35.05
L/S Toe Elev.: 15.45
W/S Toe Elev.: 21.05

Analysis By: A. Deus
Checked By: H. Mulder
Date: 6/28/2012

Boring #	Blanket Thickness Variable (z)					Aquifer Thickness Variable (d)					Hydraulic Conductivity Vairables (Kb and Kf)								
	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Layer Thickness (ft)	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation	Blanket Material	Blanket Kb (ft/day)	Aquifer Material	Aquifer Material Kf (ft/day)	Kf/Kb	Mean (MLV)	Standard Deviation	Variation	Coefficient of Variation
2F-05-G4-1	32					57.4					ML	0.14	SP/ML	25.13	180				
2F-05-G4-1A	32					63.5					ML	0.14	L/SM/SP/GP-G	24.85	178				
2F-05-G4-2	13.11					94					ML/SM	0.14	SM/SP/GW	20.88	149				
2F-05-G4-2A	16					67.2					ML	0.14	SM/SP/GP-GM	12.47	89				
K-S-4	9.75	19	9	111	47	95.25	83	16	911	19	CL/ML/ML/SM	0.028	SP/GP	29.51	1054	359	393	150273	98
2F-05-G4-3	16					96.8					CL/ML	0.028	SM/SP/GP	22.23	794				
2F-05-G4-3A	8.5					90					CL	0.028	SM/SP/GP-GM	20.99	750				
K-S-2	28					91					SM	0.709	SM/SP-SM/GP	15.12	21				
K-S-3	18.5					93.5					SM	0.709	SM/SP-SM/GM	13.54	19				

Boring #	Blanket Material 1 (lowest permeability)			Blanket Material 2			Transformed Blanket Thickness (z)	Aquifer Material 1			Aquifer Material 2			Aquifer Material 3			Transformed Aquifer Horizontal Permeability (kf)
	Material Type	Thickness (z)	Permeability (Kb)	Material Type	Thickness (z)	Permeability (Kb)		Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	Material Type	Thickness (d)	Permeability (Kf)	
2F-05-G4-1	ML	32	0.14				32	SP	51.4	28	ML	6	0.57				25.13
2F-05-G4-1A	ML	32	0.14				32	ML/SM	9	2.8	SP	50	28	GP-GM	4.5	34	24.85
2F-05-G4-2	ML	10.8	0.14	SM	11.7	0.709	13.11	SM	33	2.8	SP	34	28	GW	27	34	20.88
2F-05-G4-2A	ML	16	0.14				16	SM	43.8	2.8	SP	13.4	28	GP-GM	10	34	12.47
K-S-4	CL/ML	6	0.028	ML/SM	18.75	0.14	9.75	SP	71.25	28	GP	24	34				29.51
2F-05-G4-3	CL	10	0.028	ML	30	0.14	16	SM	33	2.8	SP	18.3	28	GP	45.5	34	22.23
2F-05-G4-3A	CL	8.5	0.028				8.5	SM	31	2.8	SP	34	28	GP-GM	25	34	20.99
K-S-2	SM	28	0.709				28	SM	15	2.8	SP-SM	62.5	14	GP	13.5	34	15.12
K-S-3	SM	18.5	0.709				18.5	SM	19	2.8	SP-SM	66	14	GM	8.5	34	13.54

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Underseepage Reliability Analysis With Blanket Theory Analysis

Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

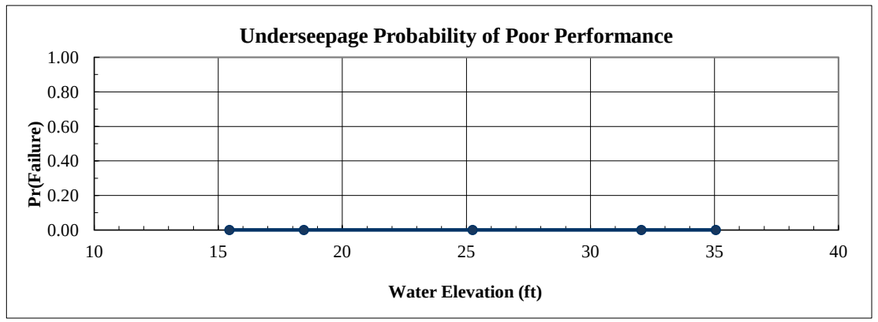
Levee Mile: 5.92
River Mile: 50.21
Analysis Case With Project Cutoff Wall

Crest Elev.: 35.05
L/S Toe Elev.: 15.45
W/S Toe Elev.: 21.05

Analysis By: A. Deus
Checked By: H. Mulder
Date: 6/28/2012

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Permaebility Ratio	359	352	98
Blanket Thickness (z)	19	9	47
Aquifer Thickness (d)	83	16	19

Blanket Theory Analysis Inputs					
Pr(f)=0	**BTA Case No.**	**L1**	**L2**	**L3**	**γ Blanket**
YES	7A	20	95	∞	112



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	15.45	0.0000
Toe+3ft	3.00	18.45	0.0000
Half Height	9.80	25.25	0.0000
Crest-3ft	16.60	32.05	0.0000
Crest	19.60	35.05	0.0000

Crest		Rh
Head =	19.60	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	359	19.00	83.00	20.00	752.42	0.0957	17.00			
2	711	19.00	83.00	20.00	1058.76	0.0707	17.68			
3	7	19.00	83.00	19.77	106.41	0.3753	9.43			
4	359	28.00	83.00	20.00	913.41	0.0807	17.41			
5	359	10.00	83.00	19.99	545.87	0.1256	16.19			
6	359	19.00	99.00	20.00	821.75	0.1057	17.19			
7	359	19.00	67.00	19.99	676.02	0.0847	16.75			
							Total			

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Crest-3ft		Rh
Head =	16.60	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	359	19.00	83.00	20.00	752.42	0.0957	14.40			
2	711	19.00	83.00	20.00	1058.76	0.0707	14.97			
3	7	19.00	83.00	19.77	106.41	0.3753	7.99			
4	359	28.00	83.00	20.00	913.41	0.0807	14.74			
5	359	10.00	83.00	19.99	545.87	0.1256	13.71			
6	359	19.00	99.00	20.00	821.75	0.1057	14.56			
7	359	19.00	67.00	19.99	676.02	0.0847	14.19			
							Total			

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Half Height		Rh
Head =	9.80	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	359	19.00	83.00	20.00	752.42	0.0957	8.50			
2	711	19.00	83.00	20.00	1058.76	0.0707	8.84			
3	7	19.00	83.00	19.77	106.41	0.3753	4.71			
4	359	28.00	83.00	20.00	913.41	0.0807	8.70			
5	359	10.00	83.00	19.99	545.87	0.1256	8.09			
6	359	19.00	99.00	20.00	821.75	0.1057	8.60			
7	359	19.00	67.00	19.99	676.02	0.0847	8.38			
							Total			

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

Toe+3ft		Rh
Head =	3.00	

Run	Kf/Kb	z	d	x1	x3	$	hx	I	Variance Component	% Variance
1 (Mean)	359	19.00	83.00	20.00	752.42	0.0957	2.60			
2	711	19.00	83.00	20.00	1058.76	0.0707	2.71			
3	7	19.00	83.00	19.77	106.41	0.3753	1.44			
4	359	28.00	83.00	20.00	913.41	0.0807	2.66			
5	359	10.00	83.00	19.99	545.87	0.1256	2.48			
6	359	19.00	99.00	20.00	821.75	0.1057	2.63			
7	359	19.00	67.00	19.99	676.02	0.0847	2.56			
							Total			

E[I] =
Var[I]=
σ[I]=
V(I) =

E[ln I] =
σ [ln I] =

β =	
F(z) =	
Pr(f) % =	0.000000

Ic=	0.80

ln(I crit) = -0.223144

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Through-Seepage Reliability Analysis With Khilar's Extended Model

Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

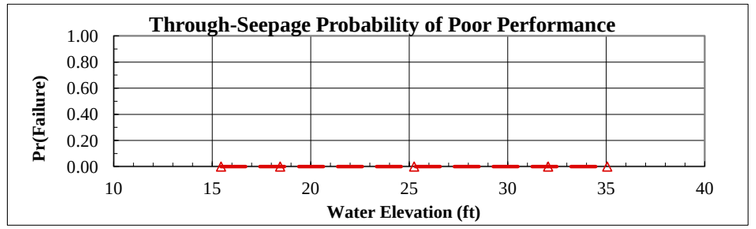
Levee Mile: 5.92
River Mile: 50.21
Analysis Case With Project Cutoff Wall

Crest Elev.: 35.05
L/S Toe Elev.: 15.45
W/S Toe Elev.: 21.05

Analysis By: A. Deus
Checked By: H. Mulder
Date: 6/28/2012

Random Variables - Silty Sand (SM) and Sand (SP) Levee			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Tractive Stress (Tc)	0.8	0.1	10.00
Initial Porosity (n)	0.35	0.04	10.00
Intrinsic Permeability (Ko)	5.00E-07	1.50E-07	30.00

Pr(f)=0
YES



Analysis Case	**Head**	**Elevation**	**Pr(f)**
Toe	0.00	15.45	0.0000
Toe+3ft	3.00	18.45	0.000000
Half Height	9.80	25.25	0.000000
Crest-3ft	16.60	32.05	0.000000
Crest	19.60	35.05	0.000000

Crest — **Head =** 19.60 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.80	0.35	5.00E-07	0.24			
2	0.72	0.35	5.00E-07	0.22			
3	0.88	0.35	5.00E-07	0.27			
4	0.80	0.32	5.00E-07	0.23			
5	0.80	0.39	5.00E-07	0.25			
6	0.80	0.35	3.50E-07	0.29			
7	0.80	0.35	6.50E-07	0.21			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Crest-3ft — **Head =** 16.60 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.80	0.35	5.00E-07	0.24			
2	0.72	0.35	5.00E-07	0.22			
3	0.88	0.35	5.00E-07	0.27			
4	0.80	0.32	5.00E-07	0.23			
5	0.80	0.39	5.00E-07	0.25			
6	0.80	0.35	3.50E-07	0.29			
7	0.80	0.35	6.50E-07	0.21			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Half Height — **Head =** 9.80 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.80	0.35	5.00E-07	0.24			
2	0.72	0.35	5.00E-07	0.22			
3	0.88	0.35	5.00E-07	0.27			
4	0.80	0.32	5.00E-07	0.23			
5	0.80	0.39	5.00E-07	0.25			
6	0.80	0.35	3.50E-07	0.29			
7	0.80	0.35	6.50E-07	0.21			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

Toe+3ft — **Head =** 3.00 — **Horizontal Gradient (Ix) =** 0.000

Run	Tractive Stress (Tc)	Initial Porosity (n)	Intrinsic Permeability (Ko)	Critical Gradient (Ic)	FS	Variance Component	% Variance
1 (Mean)	0.80	0.35	5.00E-07	0.24			
2	0.72	0.35	5.00E-07	0.22			
3	0.88	0.35	5.00E-07	0.27			
4	0.80	0.32	5.00E-07	0.23			
5	0.80	0.39	5.00E-07	0.25			
6	0.80	0.35	3.50E-07	0.29			
7	0.80	0.35	6.50E-07	0.21			

E[FS] = E[ln FS] = Total
Var[FS]=
σ[FS]= σ[ln FS]=
V(FS) =
FS req'd = 1.00 ln(FS req'd) = 0.000000

β =
F(z) =
Pr(f) % = 0.000000

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Landside Long-Term Stability Analysis With UTEXAS4

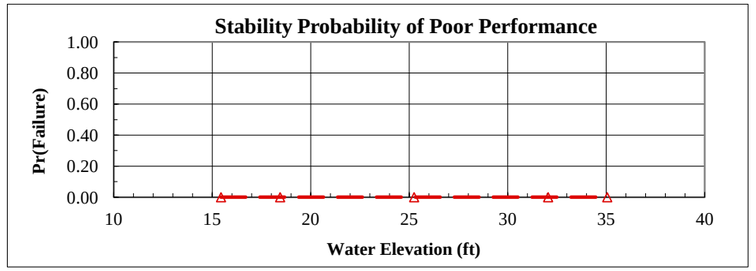
Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

Levee Mile: 5.92
River Mile: 50.21
Analysis Case With Project Cutoff Wall

Crest Elev.: 35.05
L/S Toe Elev.: 15.45
W/S Toe Elev.: 21.05

Analysis By: A. Deus
Checked By: H. Mulder
Date: 6/28/2012

Random Variables			
Parameter	**Expected Value**	**Standard Deviation**	**Coefficient of Variation, %**
Levee Φ	34	4	13.00
Levee Cohesion	0	0	40.00
Levee γ	125	9	7.00
Foundation Φ	28	4	13.00
Foundation Cohesion	0	0	40.00



Analysis Case	Head	Elevation	Pr(f)
Toe	0.00	15.45	0.0000
Toe+3ft	3.00	18.45	0.000000
Half Height	9.80	25.25	0.000000
Crest-3ft	16.60	32.05	0.000000
Crest	19.60	35.05	0.000001

Crest | **Head =** 19.60 | **Pr(f)=0** NO

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	34	0	125	28	0	1.37		
2	30	0	125	28	0	1.28	0.005625	71.62
3	38	0	125	28	0	1.43		
4	34	0	125	28	0	1.37	0.000000	0.00
5	34	0	125	28	0	1.37		
6	34	0	116	28	0	1.39	0.000380	4.84
7	34	0	134	28	0	1.35		
8	34	0	125	24	0	1.43	0.001849	23.54
9	34	0	125	32	0	1.52		
10	34	0	125	28	0	1.37	0.000000	0.00
11	34	0	125	28	0	1.37		

E[FS] = 1.370000 | E[ln FS] = 0.312723 | Total | 0.007854 | 100.00
Var[FS]= 0.007854
σ[FS]= 0.088624 | σ[ln FS]= 0.064622 | **β =** 4.839286
V(FS) = 0.064689 | **F(z) =** 0.000001
FS req'd = 1.00 | ln(FS req'd) = 0.000000 | **Pr(f) % =** 0.000065

Crest-3ft | **Head =** 16.60 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	34	0	125	28	0			
2	30	0	125	28	0			
3	38	0	125	28	0			
4	34	0	125	28	0			
5	34	0	125	28	0			
6	34	0	116	28	0			
7	34	0	134	28	0			
8	34	0	125	24	0			
9	34	0	125	32	0			
10	34	0	125	28	0			
11	34	0	125	28	0			

E[FS] = | E[ln FS] = | Total
Var[FS]=
σ[FS]= | σ[ln FS]= | **β =**
V(FS) = | **F(z) =**
FS req'd = 1.00 | ln(FS req'd) = 0.000000 | **Pr(f) % =** 0.000000

Half Height | **Head =** 9.80 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	34	0	125	28	0			
2	30	0	125	28	0			
3	38	0	125	28	0			
4	34	0	125	28	0			
5	34	0	125	28	0			
6	34	0	116	28	0			
7	34	0	134	28	0			
8	34	0	125	24	0			
9	34	0	125	32	0			
10	34	0	125	28	0			
11	34	0	125	28	0			

E[FS] = | E[ln FS] = | Total
Var[FS]=
σ[FS]= | σ[ln FS]= | **β =**
V(FS) = | **F(z) =**
FS req'd = 1.00 | ln(FS req'd) = 0.000000 | **Pr(f) % =** 0.000000

Toe+3ft | **Head =** 3.00 | **Pr(f)=0** YES

Run	Levee Φ	Levee Cohesion	Levee γ	Foundation Φ	Foundation Cohesion	FS	Variance Component	% Variance
1 (Mean)	34	0	125	28	0			
2	30	0	125	28	0			
3	38	0	125	28	0			
4	34	0	125	28	0			
5	34	0	125	28	0			
6	34	0	116	28	0			
7	34	0	134	28	0			
8	34	0	125	24	0			
9	34	0	125	32	0			
10	34	0	125	28	0			
11	34	0	125	28	0			

E[FS] = | E[ln FS] = | Total
Var[FS]=
σ[FS]= | σ[ln FS]= | **β =**
V(FS) = | **F(z) =**
FS req'd = 1.00 | ln(FS req'd) = 0.000000 | **Pr(f) % =** 0.000000

With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Judgment Probability of Poor Performance Curve

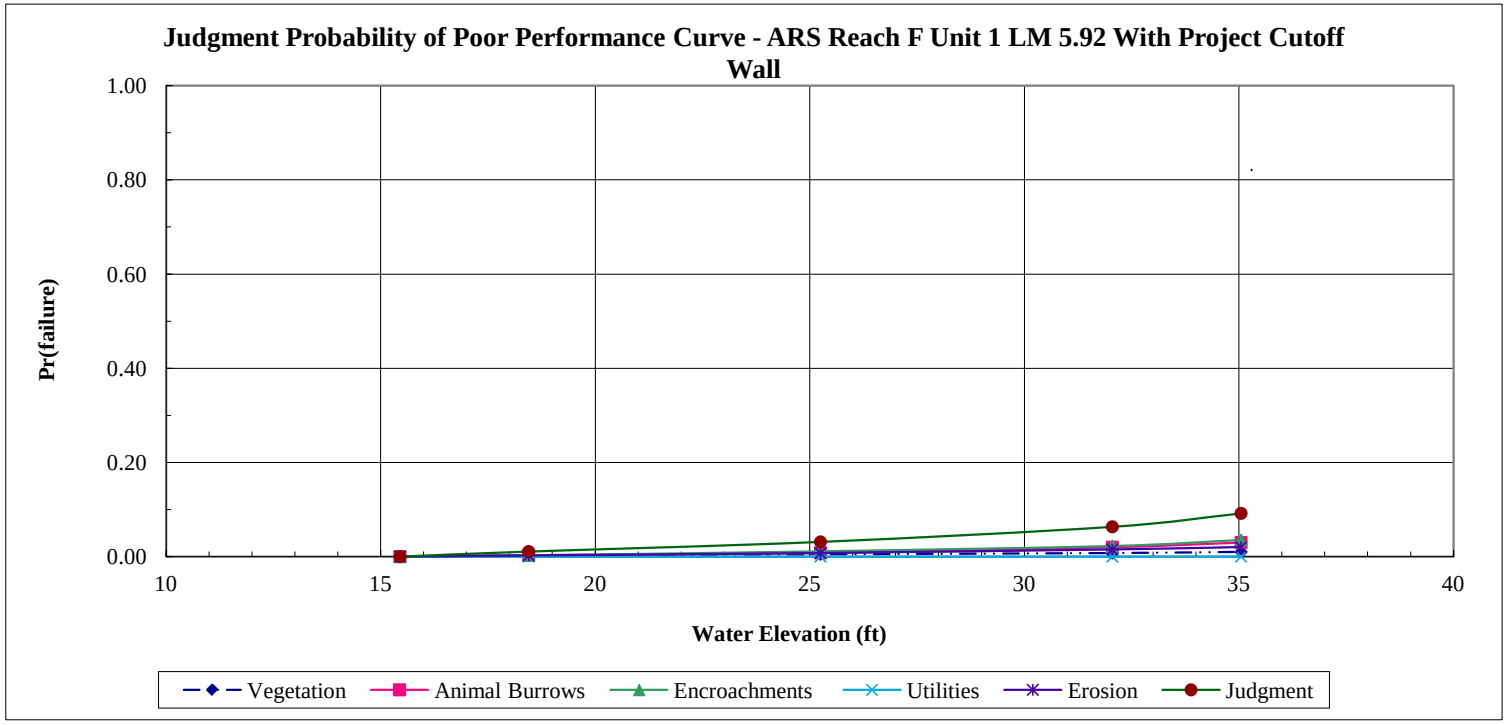
Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

Levee Mile: 5.92
River Mile: 50.21
Analysis Case: With Project Cutoff Wall

Crest Elev.: 35.05
L/S Toe Elev.: 15.45
W/S Toe Elev.: 21.05

Analysis By: A. Deus
Checked By: H. Mulder
Date: 6/28/2012

Water Surface Elevation	Vegetation		Animal Burrows		Encroachments		Utilities		Erosion		Judgment	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
15.45	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
18.45	0.0025	0.9975	0.0030	0.9970	0.0028	0.9972	0.0000	1.0000	0.0025	0.9975	0.0107	0.9893
25.25	0.0050	0.9950	0.0080	0.9920	0.0112	0.9889	0.0000	1.0000	0.0075	0.9925	0.0313	0.9687
32.05	0.0075	0.9925	0.0200	0.9800	0.0223	0.9777	0.0000	1.0000	0.0150	0.9850	0.0633	0.9367
35.05	0.0100	0.9900	0.0300	0.9700	0.0350	0.9650	0.0000	1.0000	0.0200	0.9800	0.0918	0.9082



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

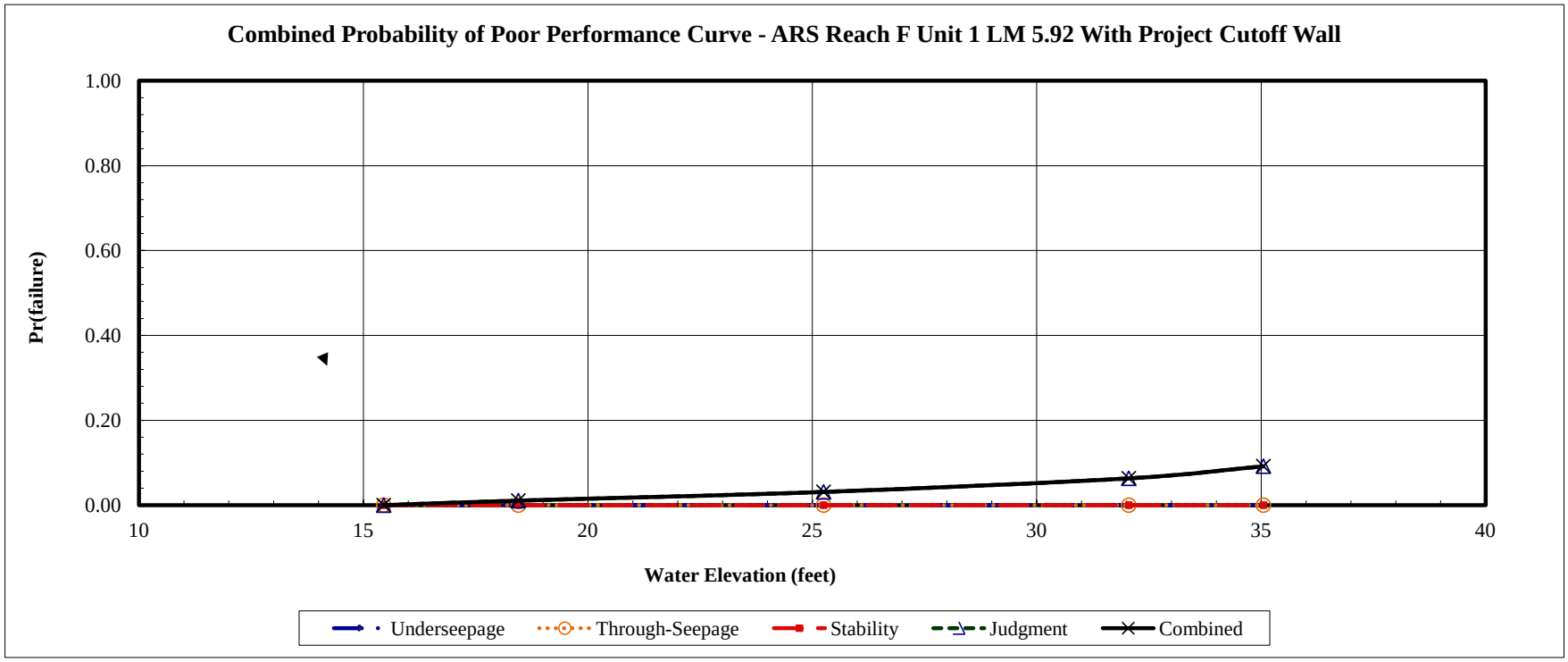
Project: American River Common Features GRR
Study Area: Sacramento River
River Section: ARS Reach F Unit 1

Levee Mile: 5.92
River Mile: 50.21
Analysis Case: With Project Cutoff Wall

Crest Elev.: 35.05
L/S Toe Elev.: 15.45
W/S Toe Elev.: 21.05

Analysis By: A. Deus
Checked By: H. Mulder
Date: 6/28/2012

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
15.45	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
18.45	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0107	0.9893	0.0107	0.9893
25.25	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0313	0.9687	0.0313	0.9687
32.05	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0633	0.9367	0.0633	0.9367
35.05	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0918	0.9082	0.0918	0.9082



With Project Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

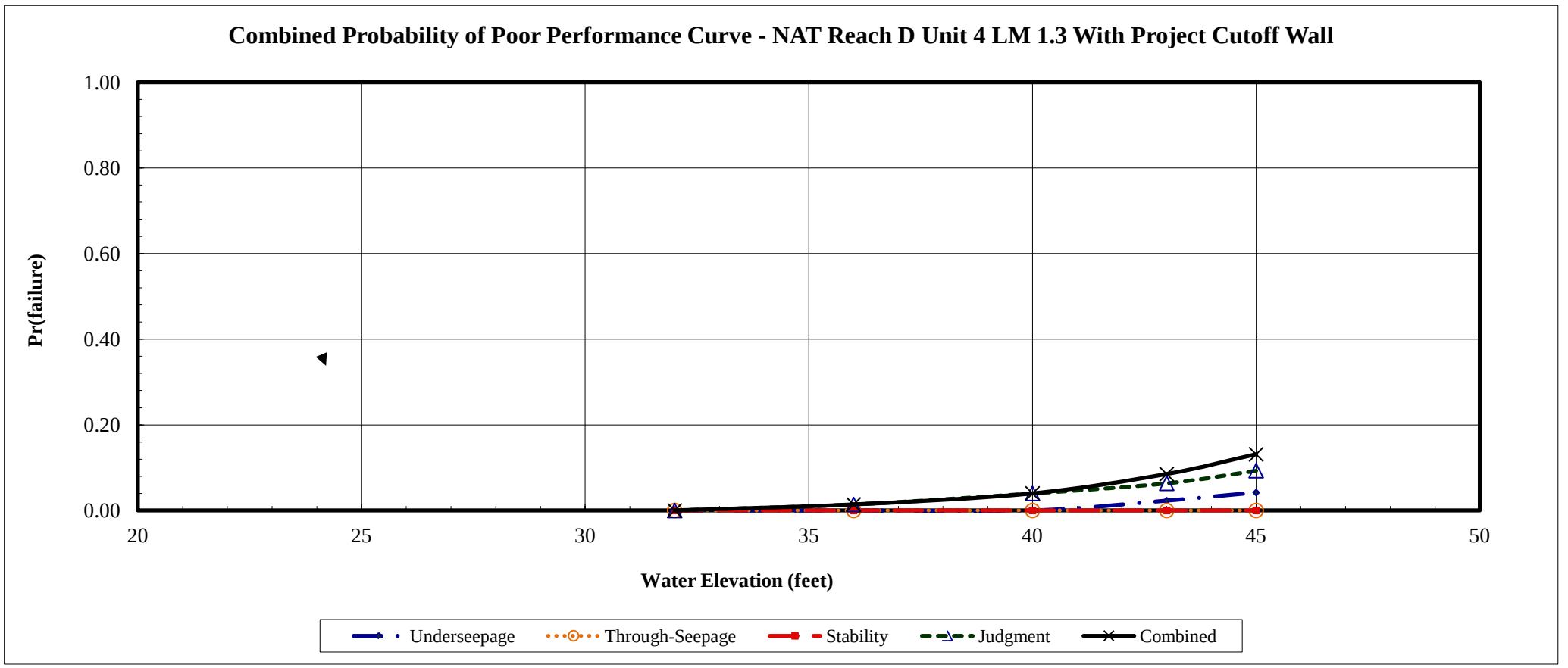
Project: American River Common Features GRR
Study Area: Sacramento River
River Section: NAT Reach D Unit 4

Levee Mile: 1.30
River Mile: 3.10
Analysis Case: With Project Cutoff Wall

Crest Elev.: 45.00
L/S Toe Elev.: 29.00
W/S Toe Elev.:

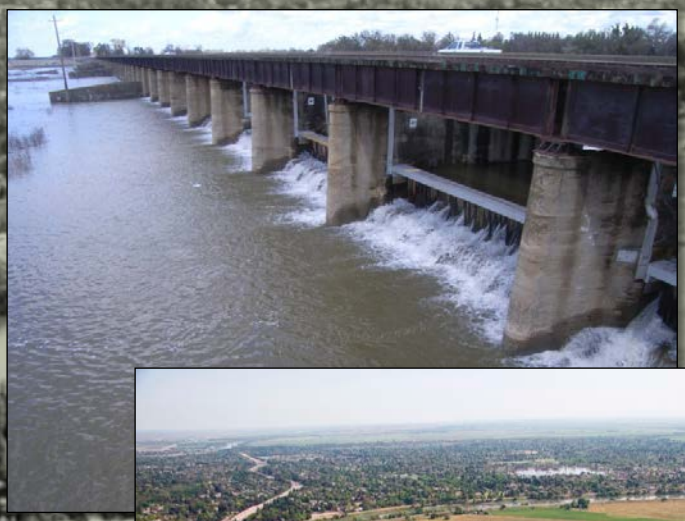
Analysis By: M. Perlea
Checked By: M. Kynett
Date:

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
32.00	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
36.00	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0140	0.9860	0.0140	0.9860
40.00	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0398	0.9602	0.0398	0.9602
43.00	0.0230	0.9770	0.0000	1.0000	0.0000	1.0000	0.0635	0.9365	0.0850	0.9150
45.00	0.0420	0.9580	0.0000	1.0000	0.0000	1.0000	0.0931	0.9069	0.1312	0.8688



American River Watershed

Common Features
General Reevaluation Report



Attachment D
Cost Engineering

December 2015

Sacramento Area Flood Control Agency

CENTRAL VALLEY FLOOD PROTECTION BOARD
PUBLIC SAFETY
WITH FLOOD PROTECTION
STATE OF CALIFORNIA

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:
Sacramento Weir during operation
Sacramento River facing south near the Pocket and Little Pocket neighborhoods
High flows on the American River at the Highway 160 overcrossing
Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Attachment D
Cost Engineering

U.S. Army Corps of Engineers
Sacramento District

December 2015

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COST ENGINEERING APPENDIX

1. BASIS OF ESTIMATE

This estimate is based on the Final Feasibility Report:
American River Watershed
Common Features
General Reevaluation Report
Final Report
December 2015

Cost Engineering Data for both an NED plan (Alternative 1) and the locally preferred plan (LPP, Alternative 2) has been developed.

The baseline feasibility cost estimates for the alternatives were developed from quantity take-off calculations provided by the Sacramento District's Civil Design section and Structural Design Section (for the new Sacramento Weir). Levee alignments and stationing were provided to Cost Engineering as Google Earth files (no detailed drawings were developed or printed).

Due to the large scope, the project is broken into construction contracts by reach. Each reach is assumed to be a separate contract. The type of solicitation is expected to be unrestricted IFB.

2. PROJECT SCOPE/DESCRIPTION

Both plans/alternatives typically involve the construction of in-place levee improvement measures to address erosion protection and slope stability, seepage, and overtopping (height) concerns identified for the American and Sacramento River levees, the Natomas East Main Drain Channel (NEMDC), and Arcade, Dry/Robla, and Magpie Creeks. Below are brief descriptions of the design remediation methods. Further detail can be found in the Engineering Appendix.

For both the NED and the LPP, the project area contains two main subareas (basins):

- American River North Basin (ARN) – This area is located north of the American River and east of the Natomas Basin. The basin is bordered by the NEMDC to the west and the American River to the south. This basin is composed of nine reaches, designated A through I for economic evaluation and construction sequencing purposes. The basin consists of two economic areas for economic evaluations (ARNA and ARNB constitute one area; ARNC thru ARNI constitute a second area, the Tributaries). Note that project features for this area are the same for both

the NED and the LPP. Note also that Reach H, while part of the project study area, has no construction associated with it.

- American River South Basin (ARS) – This area is located south of the American River. It is bounded on the north by the American River and on the west by the Sacramento River. This basin includes downtown Sacramento and surrounding neighborhoods. This basin is composed of seven reaches, designated A through G for economic evaluation and construction sequencing purposes. Note that project features for this area are the same for both the NED and the LPP, except that for the LPP, there is much less work associated with raising levees (overtopping concern) for reaches D-G.

In addition, the LPP also includes a third area. The Sacramento Weir and Bypass, North of the city of West Sacramento, will be widened by about 1500 feet and a new (second) weir built just upstream of the existing Sacramento Weir. The Sacramento Weir has both a road and railroad atop it and these will be preserved through the new weir.

Two measures for erosion protection and slope stability are utilized. One is a Bank Protection fix that includes placing revetment on the existing levee waterside and project the revetment to a finished surface slope of 2H:1V or 3H:1V. The second is a Launchable Rock Trench fix that provides protection to the levee by utilizing sacrificial rock berms. For reaches D-G of ARS, it is assumed that rock placement will be from the water side. Other reaches requiring erosion protection are too shallow for barges and placement will be from the land side.

The levee remediation to address seepage is provided through cutoff walls, by degrading the levee and then constructing a cutoff wall either using deep-soil-mixing (DSM) or as a soil-cement-bentonite (SCB) slurry wall, typically through the centerline of the levee, finally rebuilding the levee to pre-project geometry. At some locations, jet grout cutoff walls, seepage berms, or relief wells are used.

Height improvements to address overtopping concerns include levee raising and new floodwalls or height improvements to existing floodwalls.

Along the levees, there are utilities that need to be relocated or removed. Active utilities such as pressure pipes, irrigation pipes, drainage pipes, electrical, sewer, gas, cable and water lines are to be removed and replaced in order to construct the cutoff walls. Temporary utilities service is to be provided during the service outages. Roads on the levee crowns that must be removed in order to demolish or relocate utilities will be replaced.

Reaches D and G of ARS have a railroad atop the levee in some areas. The railroad line in Reach D is currently used for recreational purposes and it is assumed agreements will be made between the local sponsor and the

Recreation Company for shutdown during construction. The railroad in Reach G terminates south of the project (near Hood-Franklin Road) and is currently not in use. It is assumed that it may be reactivated in the future and is thus removed and replaced in the project area.

3. MII COST ESTIMATE - NOTES & ASSUMPTIONS (SEE ATTACHED)

The MII (MCACES, 2nd generation) Cost Estimate is divided by reach and each reach is assumed to be a separate construction contract.

ARS & ARN

Prepared By: Sacramento District, Cost Engineering Section

PROJECT SCOPE/DESCRIPTION
ARS is comprised of seven reaches, designated A through G for economic evaluation and construction sequencing purposes. Costs for both the NED and locally preferred plan (LPP) have been developed. For the LPP, no increase in levee height is to be done in Reaches D-G. The description of each reach, and typical work involved for each, is as follows:

ARS - Reach A: American River, LB - Between Mira Del Rio Drive & Northwest of Carlson Drive (Bank Stabilization, Planting/Fish & Wildlife Facilities)
ARS - Reach B: American River, LB - Between Carlson Drive and State Route 160 (Bank Stabilization, Planting/Fish & Wildlife Facilities)
ARS - Reach C: American and Sacramento Rivers, LB - Between State Route 160 and Richards Blvd (Bank Stabilization, Planting/Fish & Wildlife Facilities)
ARS - Reach D: Sacramento River, LB - Between Richards Blvd and Linden Road (Bank Stabilization, Planting/Fish & Wildlife Facilities, Levee Improvements, Relocations)
ARS - Reach E: Sacramento River, LB - Between Linden Road & Clipper Way (Bank Stabilization, Planting/Fish & Wildlife Facilities, Levee Improvements, Relocations)
ARS - Reach F: Sacramento River, LB - Between Clipper Way and River Garden Ct (Bank Stabilization, Planting/Fish & Wildlife Facilities, Levee Improvements, Relocations)
ARS - Reach G: Sacramento River, LB - Between River Garden Court and Beach Lake Road (Bank Stabilization, Planting/Fish & Wildlife Facilities, Levee Improvements, Relocations)

ARN is comprised of nine reaches, designated A through I for economic evaluation and construction sequencing purposes. Reach G and H require no improvements/work.

ARN - Reach A: American River, RB - Between River Oak Way and North of Northrop Ave (Bank Stabilization, Planting/Fish & Wildlife Facilities)

ARN - Reach B: American River, RB - Between Northrop Ave and State Route 160 (Bank Stabilization, Planting/Fish & Wildlife Facilities)
ARN - Reach C: NEMDC, RB (tributary of American River) - Between State Route 160 and just West of Arcade Blvd (Levee Improvements, Relocations)
ARN - Reach D: Arcade Creek, LB (tributary of NEMDC) Between Arcade Blvd and Marysville Blvd (Levee Improvements, Relocations)
ARN - Reach E: Arcade Creek, RB (tributary of NEMDC) - Between Scoles Ct and High S (Levee Improvements, Relocations)
ARN - Reach F: NEMDC, RB (tributary of American River) - Between Scoles Ct and W Ascot Ave (Levee Improvements, Relocations)
ARN - Reach G: Dry/Robla Creek, LB (tributary of NEMDC) Between Main Ave and in between W Ascot Ave and Neal Rd - (NO WORK in this reach)
ARN - Reach H: Dry/Robla Creek, RB (tributary of NEMDC) - (NO WORK in this reach)
ARN - Reach I: Magpie Creek (tributary of Dry/Robla Creek) - Magpie Creek Diversion Channel from near intersection of Santa Ana Ave & Raley Blvd(NW corner) to Magpie Creek crossing of Dry Creek Road (Levee Improvements)

ACQUISITION PLAN
Reaches of less than about $12M construction costs are assumed to be done by small businesses. For reaches of $12M or more, the type of solicitation is expected to be unrestricted IFB.

CONTRACTING PLAN
For each reach, there is a separate prime contractor expected to be an earthwork contractor responsible for the general site work, borrow site excavation, levee degrading and rebuilding to the restored or new levee height, and bank stabilization.

Service Contractors have been created for planting and plant establishment.

Miscellaneous/General Subcontractors are expected to be utilized for hydroseeding, jet grouting, railroad removal and reconstruction and vibration monitoring.

CONSTRUCTION WINDOWS
This estimate breaks construction for large reaches into seasons based on construction work windows. The construction work window for major Levee Improvement and Relocations construction activities is typically May-Oct, April and November are available for mobilization and demobilization of equipment and non-flood protection items such as hydroseeding that do not change the effectiveness of flood control and drainage system. The construction window for Bank Stabilization is assumed to be April-November, except that placement of materials IN WATER is limited to August thru November.

OVERTIME and PRODUCTIVITY

Overtime is included in this estimate. Assumption is 10 hr days, 6 days/week.

Normal Productivity/Task Durations are based on production for 50 minutes/hr to allow for meetings/breaks, accessing the working area/office trailer to get supplies, etc. Because overtime is expected to go on for months, productivity is reduced to 90% of normal.

CONSTRUCTION SCHEDULE

Design and Construction (sans planting establishment) was to be completed in 10 years if possible. Total Project Schedules including design, pre-construction, construction and post construction were developed using MS Project with construction durations based on those developed in MII. These are used to insure the project reaches could, in general, be completed within the construction windows and with the anticipated crews.

PROJECT CONSTRUCTION

The project consists of 14 reaches where construction will occur, A-G in ARS and A-F+I in ARN, with multiple utility relocations for penetrations through the levees (including several pumping plants for interior drainage).

SITE ACCESS

The project sites are accessible by paved local roads to levee access points and then along the levee. In many areas, the haul route is required to be through residential or highly developed areas. Traffic control will be required at levee access points, many of which are at local parks and hauling delays will undoubtedly occur due to shared use with local residents. Because of this limited access, it is assumed that placement will in general be about 10 loads per hour. This also may require resurfacing the roads following construction.
Locating Contractor Storage areas is problematical. The assumption on haul distances is dependent on the location, but is assumed as long as 10 miles round trip in some residential areas.

BORROW \ DISPOSAL AREAS

The geotechnical designers conducted a Soil Borrow Study to about a 25-30 mile radius of the project area. The larger land areas where there is high confidence in material to meet specs are near the outer edge of this radius and roughly 60 miles round trip from the central reaches. For the purposes of haul distance a general point in the areas of high confidence to both the north and south of Sacramento was chosen as borrow site locations. It is uncertain whether borrow will be obtained from local suppliers or by development of new borrow sites by the Contractor thru land acquisition. Land acquisition, mining, and restoration of borrow sites is not included in the estimate. Instead a royalty cost of $7/TON is assumed, based on a 2014-2015 pricelist from a local supplier.
Disposal Areas are the Yolo and Kiefer landfills. Certain companies in the Sacramento area receive such items as green waste, broken concrete, and

excavation that may not be satisfactory for reuse in levees, etc. A typical haul distance to these areas is assumed as about 30 miles round trip.

CONSTRUCTION METHODOLOGY
The construction methodologies are considered standard for most construction work. One exception is deep soil mixing (DSM) for cutoff walls deeper than 80 ft. Another exception to standard construction is jet grouting around deep utilities.

UNUSUAL CONDITIONS
No unusual conditions.

UNIQUE TECHNIQUES OF CONSTRUCTION
Deep Soil Mixing and Jet Grouting are considered unique in that relatively few contractors perform this work.

EQUIPMENT AND LABOR AVAILABILITY & DISTANCE TRAVELED
In an urban area such as Sacramento, equipment and labor is readily available within a 100 mile radius of the site. Deep Soil Mixing and Jet Grouting rigs are available, but in limited number. For this reason, it is assumed than no more than three headings for DSM are used within any construction reach. This could change over the 10 year construction period anticipated.

ENVIRONMENTAL CONCERNS
Environment protection requires consideration of air, water, and land, and involves noise, solid-waste management and management of other pollutants. In order to prevent or provide for abatement and control of any environmental pollution arising from the work activities, the Contractor and his subcontractors in the performance of this contract, shall comply with all applicable Federal, State, and local laws, and regulations concerning environmental pollution control and abatement. The Contractor shall use best management practices at all times to minimize the potential for environmental impacts.

STORM WATER POLLUTION PREVENTION (SWPP)
SWPP costs are assumed to utilize BMPs. Quantities are based on those provided by SPK Environmental (ARS_SWPPP_CostEstimate.xlsx and ARN_SWPPP_CostEstimate.xlsx). SWPP development and reporting is considered to be part of JOOH.
The primary sediment control BMP is fiber rolls placed at a maximum interval of 15 ft for slope inclinations between 4:1 and 2:1. Though there are slopes flatter than 4:1 (which would allow for a max spacing of 20 ft), the more conservative interval of 15 ft is used to provide more effective erosion control. Silt fences will be used in conjunction with fiber rolls for further sediment control.

LABOR RATES, EQUIPMENT RATES, MATERIAL & FUEL COSTS & SALES TAX

This estimate meets Davis Bacon wage rates for Davis Bacon wage determinations for the state of California, General Decision Numbers: CA1400003, CA140006, CA140009 and CA1400026 as of December 2014.

Equipment unit costs were obtained from historical Quotes or verbal/telephone conversations with Contractors performing like or similar work and the MII/MCACES Equipment Library.

Note: Gasoline and diesel fuel costs used in the estimate are the average costs in the Sacramento area as of 6/11/15.
Off-road diesel costs are not subject to state and federal excise taxes, so those taxes are removed from off-road diesel prices.

Material prices were obtained from Quotes, supply catalogs, previous similar estimates, and the MII/MCACES Cost Book.

Sales tax is applied at 8.5%.

QUOTES
Specific quotes were obtained for various large volume material items (high total cost.

Quotes obtained are as indicated below, indicating type of material, unit cost, date:

¾" Class II AB	$14.71/TON	(4/1/2015-9/30/2015)
Riprap (waterside placement)	$19/TON	(8/27/2015)
Riprap (landside placement)	$22.20/TON	(4/1/2015-9/30/2015)
Sand	$12/TON	(4/1/2014-10/31/2014)
Pumps (for Pump Stations, various sizes)	$70,000-$430,000/EA	(10/17/2014)
Geotextile	$1.65/SY	(10/24/2014)
Concrete (3000 psi)	$90/CY	(9/29/2014)
Concrete (4000 psi)	$96/CY	(9/29/2014)
Cement	$95/TON	(9/2/2015)
Fiber Rolls	$0.69/LF	(10/24/2014)
Dump Fees	$31/TON	average of two local landfills per web search (2015)
Bentonite	$98/TON	(6/17/2015)

SACRAMENTO BYPASS WIDENING

Prepared By: Walla Walla District, Cost Engineering Section

PROJECT DESCRIPTION
This estimate consists of costs to lengthen the existing Sacramento Bypass Weir and bridge by 1,500 feet. The new Railroad Bridge is the same configuration as the existing bridge. The new roadway bridge is a concrete bridge deck supported

by 5 reinforced concrete piers and 2 abutments. The piers are the same height and length as the existing piers. The existing levee will be relocated 1,500 feet to the North with a seepage berm, relief wells, drainage ditch, and 2 new pump houses.

BASIS OF DESIGN
This estimate is a feasibility level estimate based on a 10% structural conceptual design feasibility report dated August 25, 2014.

ACQUISITION PLAN
The assumption is the project will be acquired by the Bidding process. The project solicitation is for open competition, sealed bid, with award to the low bidder.

This work will not be performed by a Contractor under the Small Business Administration 8a program.

Prices are good for the period October 2014 through October 2015.

SUB-CONTRACTING PLAN
It is assumed that the Prime Contractor will do the excavation, levee, roadwork, and concrete work.
The following are subcontractor on this project:
Subcontractor Tier 1 (Bridge)
Subcontractor Tier 2 (Bridge Painting)

PROJECT CONSTRUCTION

SITE ACCESS
The project site is located 4.5 miles Northwest of Sacramento, CA.

BORROW AREAS
The borrow source is assumed to be within the widened Sacramento Bypass. Because of this, land acquisition of the borrow site is inherent with land acquisition for the widened bypass. Therefore, no royalty or reclamation costs for the borrow area are anticipated.

CONSTRUCTION METHODOLOGY
The construction methodology is standard construction. The site is situated close to the same elevation as the Sacramento River and isolated by a 28 foot elevation levee. The site elevation ranges between 15 to 31 feet in elevation, with a Sacramento River elevation of around 15 feet. Excavation will need to be scheduled for low river stage and ground water level. Minimal dewatering is assumed for the estimate and includes a single pump while constructing the foundation of the weir.

UNIQUE TECHNIQUES OF CONSTRUCTION
The estimate assumes that the existing roadway and railroad will be shutdown during the duration of construction with no accommodations for diversions, detours, or traffic control. Roadways include Old River Road, Levee Road, and E Yolo Levee Road.

CONSTRUCTION WINDOWS
SCHEDULE
The contractor shall commence work under this contract within 14 calendar days of receiving the notice to proceed, and then prosecute said work diligently, and complete the entire work ready for use, with the time frames and not later than the date contracted for. At this stage of the project the schedule is unknown but assumed to be a multi-year contract.

OVERTIME
Due to the risk of flood events, difficulty of extending the duration of the contract, and impacts for shutting down the railroad and roadway, overtime is assumed of 10 hour work days, 6 days a week.

EQUIPMENT AND LABOR AVAILABILITY & DISTANCE TRAVELED
This estimate uses Sacramento Labor rates. Equipment rates used are MII Equipment 2014 Region 07, and the Cost Book is MII English Cost Book 2012-b. Labor and equipment is assumed to be available in Sacramento, CA at a distance of approximately 4 miles.

ENVIRONMENTAL CONCERNS
During site work, the proximity of the water requires additional attention to eliminate all spills and to control / cleanup debris to prevent it from entering the water.

4. CONTRACTOR MARKUPS

As determined by: Sacramento District, Cost Engineering Section

In general, the prime contractor for projects where the construction cost is over $12M-$15M is considered large business. Profit is determined through the use of profit weighted guidelines (PWG) and is based on project cost, duration, amount of subcontracting, etc. and ranges from about 7-9.6% Home Office Overhead (HOOH) is set at 10% and Job/Field Office Overhead (JOOH) is set at 13% for all reaches based on typical values for historic projects with similar type work. Small Tools Markup is set at a running 2% of Labor costs. Bond markup is set at 1.2%.

Prime contractors for projects where construction costs are under $12-15M are considered small business. Profit is based on PWG and varies from about 6.5-9.5%. Home Office Overhead is considered to be 15% (somewhat higher than for large business). Job/Field Office Overhead (JOOH) is set at 13%, the same as

for large business. Small Tool Markup is set at a running 2% of Labor costs. Bond markup is set at 1.2%.

Miscellaneous/General Subcontractors have JOOH set at 15% and HOOH set at 10%. Profit is determined using PWG and ranges from about 8.5-11.25%. Bond is set at 1.2%.

Service Contractors for Plantings & Plant Establishment should have relatively little JOOH and so it is set at 2%. The work is typically by landscape contractors with low HOOH (set at 6%). Profit is determined using PWG and varies from about 9.5-11%. Bond is again assumed to be 1.2%.

5. TOTAL PROJECT SCHEDULE, INCLUDING CONSTRUCTION (SEE ATTACHED)

Total Project Schedules including design, pre-construction, construction and post construction were developed using MS Project with construction durations based on those developed in MII. These were used to insure the project reaches could be completed within the construction windows and with the anticipated crews.

6. COST AND SCHEDULE RISK ANALYSIS (SEE ATTACHED)

The scope of the risk analysis was to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The study does not include consideration for operation and maintenance or life cycle costs.

7. TOTAL PROJECT COST SUMMARIES (SEE ATTACHED)

First Costs are based on 1 Oct 2014 price levels. Fully funded costs are first costs escalated to the midpoint of design or construction (as per the anticipated construction schedule).

REAL ESTATE (01 Account)
The Real Estate cost estimate (01 Account Lands & Damages and Administrative costs) is performed by the SPK Real Estate Division and provided to the Cost Engineering section. The 01 Account Lands and Damages, Relocation Assistance Payment, and New Utility Easements cost estimates were appraised (please refer to the Real Estate Appendix/Report for more detail). These technical Real Estate increments estimated by the appraiser are independent of the contingency derived though the Cost and Schedule Risk Analysis (CSRA). The contingencies were provided by the Real Estate Division.

RELOCATIONS (02 Account)
Construction costs for relocation of utilities, roads and railroads were developed primarily through the use of MII and the local 'database' of construction methods (labor, equipment, and materials cost data, construction crews and anticipated production rate, anticipated borrow and disposal sites, etc). These are relatively up-to-date (2014 Davis-Bacon rates, 2014 MII equipment rates, and recent quotes for bulk materials and high cost items, such as pumps for interior drainage). Contingency applied to this account is the effective contingency derived from the Cost and Schedule Risk Analysis.

FISH & WILDLIFE FACILITIES - ENVIRONMENTAL MITIGATION (06 Account)
The Environmental Mitigation cost estimate is performed by SPK Environmental Planning and provided to Cost Engineering. Since this is a construction cost the contingency applied to this account is the effective contingency derived from the Cost and Schedule Risk Analysis.

Mitigation costs were estimated based on acreages of habitat types impacted per the requirements of the Biological Opinions. Each habitat type's costs were assessed considering onsite mitigation and offsite mitigation.
On-site mitigation is preferred because it provides higher habitat compensation values than off-site mitigation because the restoration activities occur on the same area as the area of the impact, and was used to the extent practicable. On-site mitigation costs were coordinated with the Corps' landscape architecture department and were based on past experience for implementation of these types of sites in the area. Mitigation occurs at either a 2 to 1 or a 3 to 1 ratio depending on the level of sensitivity of habitat affected, per terms and conditions in the Biological Opinion.

Off-site mitigation costs are estimated based on the acreage of area impacted by construction. Additional consideration went into the feasibility of whether or not on-site mitigation was practicable for the impacted habitat type. The cost for off-site mitigation is based on the acreage required multiplied by a standard rate for buying credits from a local mitigation bank. Mitigation occurs at either a 2 to 1 or a 3 to 1 ratio depending on the level of sensitivity of habitat affected, per terms and conditions in the Biological Opinion.

Other features required to comply with the biological opinion, such as fish monitoring, were directly negotiated with resource agencies in order to address their concerns over adverse impacts to these species and include measures to directly mitigate for the impact. Categories that this direct negotiation occurred on include the following: 1) a physical model study; 2) Pre-construction sampling and monitoring study; 3) construction fish monitoring; 4) post-construction monitoring study; 5) development and certification of the EFM model for use with Green Sturgeon; 6) Mitigation – per acre (for impacts to Green Sturgeon which differs from the off-site mitigation costs item described in the previous paragraph); 7) mitigation – rock removal; and 8) conveyance utilizing the

Sacramento River Deep Water Ship Channel. Details of the scope and budget for these features are included as Appendix B to the Mitigation Monitoring Plan.

Additionally, a cost effectiveness/incremental cost analysis was run on three different alternatives for mitigating for project impacts: maximizing on-site mitigation with no off-site mitigation included, maximizing off-site mitigation with no on-site mitigation included, and the proposed alternative, which includes a combination of on-site and off-site mitigation. This combination alternative was shown to be the best value plan for the project. The incremental cost analysis is included as Appendix A to the project's Mitigation and Monitoring Plan.

FISH & WILDLIFE FACILITIES - CONSTRUCTION (06 Account)
Construction costs for plantings and plant establishment were developed using MII. Contingency applied to this account is the effective contingency derived from the Cost and Schedule Risk Analysis.

LEVEES AND FLOODWALLS, FLOODWAY CONTROL-DIVERSION STRUCTURES, AND BANK STABILIZATION (11, 15 and 16 Accounts)
Construction costs for these accounts were developed using MII. Contingency applied is the effective contingency derived from the Cost and Schedule Risk Analysis.

CULTURAL RESOURCES PRESERVATION (18 Account)
The Cultural Resources Preservation cost is assumed as one Percent of the federal share of the Total Amount. This is the statutory level set by the Archeological and Historic Preservation Act of 1974 (Public Law 93-291) on Corps of Engineers' general authority to make expenditures for data recovery. The Department of the Interior defines "data" as "evidence about historic and prehistoric periods which are buried in the ground" and recovery as "the scientific excavation or removal and preservation of that evidence . . . when construction projects pose threats that would result in their irreparable loss or destruction."

Section 208 of the National Historic Preservation Act Amendments of 1980 authorize data recovery in excess of the one percent level when the Assistant Secretary of the Army (Civil Works) seeks the concurrence of the Secretary of the Interior (through the Departmental Consulting Archeologist) and notification of Congress.

PLANNING, ENGINEERING AND DESIGN (30 Account)
The cost for Planning, Engineering and Design (PED) is assumed as 16% of the Construction Estimate Total, based on historical estimates done by SPK. In addition, $7,778,522 is added to this account for Preconstruction Environmental Activities (physical model study, pre-construction sampling, etc). Contingency applied is the effective contingency derived from the Cost and Schedule Risk Analysis.

For this project, the assumed percentages are as follows:

Project Management	1.6%
Planning & Environmental Compliance	0.6%
Coordination w/ Other Agencies	
Mitigation Analysis Report	
Fish & Wildlife Coordination Act Report	
NPDES Permit	
Preconstruction Environmental Activities	$7,778,522
Engineering and Design	8.2%
Surveying and Mapping	
Civil Design	
Geotechnical Design	
Hydrology & Hydraulic Design	
Structural Design	
Mechanical Design	
Electrical Design	
Physical Closeout Documents	
Audit	
OMRR&R Manual	
Review, ATRs, IEPRs, VE	0.3%
Review Plans & Specs	
BCOE Review and Certification	
Life Cycle Cost Updates (costs, schedule, risks)	0.7%
Cost Estimates – Construction Contracts	
Cost Estimates – Project	
Value Engineering	
Contracting & Reprographics	1.0%
Advertise	
Reproduction	
Award Contract	
Cultural Investigations	1.0%
Engineering During Construction	2.0%
Engineering and Design During Construction	
Amendments to Plans and Specs	
Planning During Construction	0.3%
Project Operations	1.3%

CONSTRUCTION MANAGEMENT (31 Account)

The cost for Construction Management (CM) is assumed as 9% of the Construction Estimate Total, based on historical estimates done by SPK. Contingency applied is the effective contingency derived from the Cost and Schedule Risk Analysis.

For this project, the assumed percentages are as follows:

Project Management	3.1%
Project Mngt Documents	

Funds Control Documents	
Trip Reports	
Upward Reporting Documents	
Budgetary Documents	
Project Authorization Documents	
Annual Notification Letter	
Fact Sheets	
Correspondence (Congress/State)	
Schedule and Cost Changes	
Project Work Directives	
Project Closeout Documents	
Quarterly Cost Report to Local Sponsor	
Other PM Documents	
Mitigation Construction	
Construction Management	4.7%
Project Office Superv and Admin	
Area Office S&A Documents	
District Office S&A Documents	
Contract Mods & Negotiations	
Project Operations	1.2%

The purpose of this project is to improve erosion, seepage and stability concerns with portions of the levee system in the Sacramento area. Specific improvements include construction of one or more of the follow features: Seepage cutoff wall; raised levee; slope flattening; erosion protection (riprap). Additionally improvements at utilities are recommended. Some of these utilities include pipe penetrations (domestic water, interior drainage water, sewer, gas, etc.), power lines, and power poles. The recommended plan includes addressing the various utilities or encroachments so that the seepage and stability problems can be addressed. Project scope also includes: (1) right-of-way acquisition to facilitate long-term operation and maintenance activities; and (2) modifications to existing interior drainage facilities to bring the facilities in compliance with Corps criteria for penetrations through levees (upgrading discharge lines, pumps, etc. to raise the drainage over the top of levee or to provide positive closure for penetrations through levees).

ARS - Fix-in-Place Levees

Level of Estimate: Feasibility

This portion of the project is comprised of seven reaches, three along the south bank of the American River and four along the east bank of the Sacramento River, designated A through G for economic evaluation and construction sequencing purposes.

The primary methods of fixing-in-place are by construction of slurry walls using the DSM method (existing levees and foundation are primarily noncohesive soils) and providing erosion protection (primarily stone/riprap added to the waterside face and toe of the levee).

ARN - Fix-in-Place Levees

Level of Estimate: Feasibility

This portion of the project is comprised of eight reaches, three along the north bank of the American River and five along the east bank Natomas East Main Drain (NEMDC) and it's tributaries, designated A through I for economic evaluation and construction sequencing purposes. NOTE: No work planned in reach H.

The primary methods of fixing-in-place are by construction of SCB slurry walls using the conventional method (existing levees and foundation are primarily cohesive soils) and providing erosion protection along the American River (primarily stone/riprap added to the waterside face and toe of the levee).

Estimated by	CESPK-ED-SC & NWW
Designed by	USACE (Sacramento District)
Prepared by	Robert Vrchoticky (SPK), Phillip Ohnstad (NWW)
Preparation Date	9/21/2015
Effective Date of Pricing	9/21/2015
Estimated Construction Time	Days

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Description	Quantity	UOM	CostToPrime	JOOH_PRM	HOOH_PRM	Profit_PRM	Bond_PRM	ContractCost
Prime Contractor Cost or Bid Cost w/o Esc			606,769,676	47,953,704	42,715,209	54,757,946	8,201,532	760,398,068
ARS - Reach A	1.00	EA	83,205,815	9,071,044	8,040,123	8,595,205	1,185,001	110,097,188
Fish and Wildlife Facilities (Mitigation)	1.00	LS	9,182,404	0	0	0	0	9,182,404
Bank Stabilization (SP)	1.00	EA	66,655,054	8,630,391	7,501,802	7,889,625	1,088,122	91,764,994
Fish and Wildlife Facilities	1.00	EA	3,544,249	70,885	216,908	368,642	50,408	4,251,092
Relocations	1.00	EA	3,824,108	369,768	321,414	336,938	46,470	4,898,698
ARS - Reach B	1.00	EA	21,900,893	2,251,229	1,999,261	1,897,995	292,427	28,341,806
Fish and Wildlife Facilities (Mitigation)	1.00	LS	3,217,833	0	0	0	0	3,217,833
Bank Stabilization (SP)	1.00	EA	15,894,630	2,055,375	1,786,595	1,648,006	256,615	21,641,222
Fish and Wildlife Facilities	1.00	EA	968,227	19,365	59,255	109,081	13,871	1,169,800
Relocations	1.00	EA	1,820,203	176,490	153,410	140,907	21,941	2,312,951
ARS - Reach C	1.00	EA	13,437,366	1,474,813	1,324,183	1,274,790	195,401	17,706,553
Fish and Wildlife Facilities (Mitigation)	1.00	LS	1,127,833	0	0	0	0	1,127,833
Bank Stabilization (SP)	1.00	EA	10,952,599	1,417,419	1,232,064	1,135,774	176,854	14,914,709
Fish and Wildlife Facilities	1.00	EA	963,804	19,276	58,985	108,583	13,808	1,164,456
Relocations	1.00	EA	393,131	38,119	33,134	30,433	4,739	499,555
ARS - Reach D	1.00	EA	81,680,870	5,090,601	4,501,316	6,480,219	1,033,164	98,786,171
Fish and Wildlife Facilities (Mitigation) (Alt 1)	1.00	LS	6,551,333	0	0	0	0	6,551,333
Levees and Floodwalls (Alt 1)	1.00	EA	36,936,920	1,956,298	1,700,474	3,284,030	526,533	44,404,254
Relocations	1.00	EA	21,572,774	1,175,991	1,022,207	1,510,106	242,117	25,523,196
Bank Stabilization (SP)	1.00	EA	14,875,962	1,923,436	1,671,909	1,494,329	239,588	20,205,223
Fish and Wildlife Facilities	1.00	EA	1,743,882	34,878	106,726	191,754	24,927	2,102,165
ARS - Reach E	1.00	EA	55,812,865	3,006,077	2,687,888	4,324,182	714,457	66,545,470
Fish and Wildlife Facilities (Mitigation) (Alt 1)	1.00	LS	5,464,118	0	0	0	0	5,464,118
Levees and Floodwalls (Alt 1)	1.00	EA	34,286,283	1,220,735	1,061,101	2,834,029	472,826	39,874,974
Relocations	1.00	EA	3,274,791	317,976	276,395	235,626	39,312	4,144,100
Bank Stabilization (SP)	1.00	EA	11,077,910	1,433,170	1,245,756	1,066,155	177,876	15,000,866
Fish and Wildlife Facilities	1.00	EA	1,709,763	34,195	104,637	188,372	24,444	2,061,411
ARS - Reach F	1.00	EA	140,941,059	7,801,585	6,896,378	12,582,161	1,852,963	170,074,146
Fish and Wildlife Facilities (Mitigation) (Alt 1)	1.00	LS	11,523,404	0	0	0	0	11,523,404
Levees and Floodwalls (Alt 1)	1.00	EA	90,710,987	3,375,640	2,934,210	8,586,344	1,267,286	106,874,468
Relocations	1.00	EA	8,960,846	865,449	752,275	734,052	108,341	11,420,965
Bank Stabilization (SP)	1.00	EA	27,121,174	3,508,002	3,049,263	2,980,542	439,908	37,098,889
Fish and Wildlife Facilities (Construction)	1.00	EA	2,624,648	52,493	160,628	281,223	37,428	3,156,421
ARS - Reach G	1.00	EA	66,064,605	5,515,583	4,874,697	5,895,699	868,418	83,219,002
Fish and Wildlife Facilities (Mitigation) (Alt 1)	1.00	LS	4,705,833	0	0	0	0	4,705,833
Levees and Floodwalls (Alt 1)	1.00	EA	23,770,116	2,565,802	2,230,274	2,522,395	373,063	31,461,649
Relocations	1.00	EA	22,257,892	1,167,719	1,015,017	1,692,182	250,274	26,383,085
Bank Stabilization (SP)	1.00	EA	13,496,180	1,745,371	1,517,130	1,479,792	218,862	18,457,334
Fish and Wildlife Facilities	1.00	EA	1,834,584	36,692	112,277	201,331	26,219	2,211,101
ARN - Reach A	1.00	EA	59,254,030	6,794,549	5,997,737	6,220,436	879,243	79,145,994
Fish and Wildlife Facilities (Mitigation)	1.00	LS	4,602,118	0	0	0	0	4,602,118
Bank Stabilization (SP)	1.00	EA	51,016,511	6,603,452	5,739,923	5,860,789	830,648	70,051,324
Fish and Wildlife Facilities	1.00	EA	2,093,020	41,860	128,093	227,655	29,888	2,520,516
Relocations	1.00	EA	1,542,381	149,236	129,721	131,991	18,707	1,972,037
ARN - Reach B	1.00	EA	3,257,125	331,388	441,780	333,139	47,269	4,410,702
Fish and Wildlife Facilities (Mitigation)	1.00	LS	408,000	0	0	0	0	408,000
Bank Stabilization (SP)	1.00	EA	2,470,546	319,134	414,678	291,326	41,948	3,537,633
Fish and Wildlife Facilities	1.00	EA	316,707	6,334	19,382	36,434	4,546	383,404

Description	Quantity	UOM	CostToPrime	JOOH_PRM	HOOH_PRM	Profit_PRM	Bond_PRM	ContractCost
Relocations	1.00	EA	61,872	5,920	7,719	5,379	775	81,665
ARN - Reach C	1.00	EA	5,188,061	282,179	367,918	396,147	70,778	6,305,083
Fish and Wildlife Facilities (Mitigation)	1.00	LS	100,000	0	0	0	0	100,000
Levees and Floodwalls	1.00	EA	4,182,034	195,089	254,366	333,467	59,579	5,024,536
Relocations	1.00	EA	906,027	87,089	113,551	62,680	11,199	1,180,546
ARN - Reach D	1.00	EA	28,380,510	2,530,242	2,199,364	2,554,860	400,036	36,065,012
Fish and Wildlife Facilities (Mitigation)	1.00	LS	660,000	0	0	0	0	660,000
Levees and Floodwalls	1.00	EA	21,152,369	1,893,310	1,645,724	2,049,386	320,889	27,061,679
Relocations	1.00	EA	6,568,141	636,932	553,641	505,474	79,146	8,343,333
ARN - Reach E	1.00	EA	28,782,304	2,536,284	2,204,616	2,565,960	401,774	36,490,937
Fish and Wildlife Facilities (Mitigation)	1.00	LS	495,000	0	0	0	0	495,000
Levees and Floodwalls	1.00	EA	19,970,130	1,729,743	1,503,546	1,925,884	301,552	25,430,854
Relocations	1.00	EA	8,317,174	806,540	701,070	640,077	100,222	10,565,083
ARN - Reach F	1.00	EA	17,194,676	1,089,465	946,997	1,466,342	236,999	20,934,478
Fish and Wildlife Facilities (Mitigation)	1.00	EA	100,000	0	0	0	0	100,000
Levees and Floodwalls	1.00	EA	13,752,037	765,107	665,054	1,217,612	196,798	16,596,608
Relocations	1.00	EA	3,342,639	324,358	281,942	248,730	40,201	4,237,870
ARN - Reach I (Magpie Cr Div Channel)	1.00	EA	1,669,497	178,665	232,952	170,810	23,603	2,275,527
Fish and Wildlife Facilities (Mitigation)	1.00	LS	275,000	0	0	0	0	275,000
Levees and Floodwalls	1.00	EA	1,356,692	175,052	228,241	167,375	23,128	1,950,487
Relocations	1.00	EA	37,805	3,614	4,712	3,435	475	50,040

The purpose of this project is to improve erosion, seepage and stability concerns with portions of the levee system in the Sacramento area. Specific improvements include construction of one or more of the follow features: Seepage cutoff wall; raised levee; slope flattening; erosion protection (riprap). Additionally improvements at utilities are recommended. Some of these utilities include pipe penetrations (domestic water, interior drainage water, sewer, gas, etc.), power lines, and power poles. The recommended plan includes addressing the various utilities or encroachments so that the seepage and stability problems can be addressed. Project scope also includes: (1) right-of-way acquisition to facilitate long-term operation and maintenance activities; and (2) modifications to existing interior drainage facilities to bring the facilities in compliance with Corps criteria for penetrations through levees (upgrading discharge lines, pumps, etc. to raise the drainage over the top of levee or to provide positive closure for penetrations through levees).

ARS - Fix-in-Place Levees

Level of Estimate: Feasibility

This portion of the project is comprised of seven reaches, three along the south bank of the American River and four along the east bank of the Sacramento River, designated A through G for economic evaluation and construction sequencing purposes.

The primary methods of fixing-in-place are by construction of slurry walls using the DSM method (existing levees and foundation are primarily noncohesive soils) and providing erosion protection (primarily stone/riprap added to the waterside face and toe of the levee).

ARN - Fix-in-Place Levees

Level of Estimate: Feasibility

This portion of the project is comprised of eight reaches, three along the north bank of the American River and five along the east bank Natomas East Main Drain (NEMDC) and it's tributaries, designated A through I for economic evaluation and construction sequencing purposes. NOTE: No work planned in reach H.

The primary methods of fixing-in-place are by construction of SCB slurry walls using the conventional method (existing levees and foundation are primarily cohesive soils) and providing erosion protection along the American River (primarily stone/riprap added to the waterside face and toe of the levee).

Estimated by	CESPK-ED-SC & NWW
Designed by	USACE (Sacramento District)
Prepared by	Robert Vrchoticky (SPK), Phillip Ohnstad (NWW)
Preparation Date	9/21/2015
Effective Date of Pricing	9/21/2015
Estimated Construction Time	Days

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Description	Quantity	UOM	CostToPrime	JOOH_PRM	HOOH_PRM	Profit_PRM	Bond_PRM	ContractCost
Prime Contractor Cost or Bid Cost w/o Esc			728,260,475	58,683,696	52,042,048	66,186,689	9,897,410	915,070,319
ARS - Reach A	1.00	EA	83,205,815	9,071,044	8,040,123	8,595,205	1,185,001	110,097,188
Fish and Wildlife Facilities (Mitigation)	1.00	LS	9,182,404	0	0	0	0	9,182,404
Bank Stabilization (SP)	1.00	EA	66,655,054	8,630,391	7,501,802	7,889,625	1,088,122	91,764,994
Fish and Wildlife Facilities	1.00	EA	3,544,249	70,885	216,908	368,642	50,408	4,251,092
Relocations	1.00	EA	3,824,108	369,768	321,414	336,938	46,470	4,898,698
ARS - Reach B	1.00	EA	21,900,893	2,251,229	1,999,261	1,897,995	292,427	28,341,806
Fish and Wildlife Facilities (Mitigation)	1.00	LS	3,217,833	0	0	0	0	3,217,833
Bank Stabilization (SP)	1.00	EA	15,894,630	2,055,375	1,786,595	1,648,006	256,615	21,641,222
Fish and Wildlife Facilities	1.00	EA	968,227	19,365	59,255	109,081	13,871	1,169,800
Relocations	1.00	EA	1,820,203	176,490	153,410	140,907	21,941	2,312,951
ARS - Reach C	1.00	EA	13,437,366	1,474,813	1,324,183	1,274,790	195,401	17,706,553
Fish and Wildlife Facilities (Mitigation)	1.00	LS	1,127,833	0	0	0	0	1,127,833
Bank Stabilization (SP)	1.00	EA	10,952,599	1,417,419	1,232,064	1,135,774	176,854	14,914,709
Fish and Wildlife Facilities	1.00	EA	963,804	19,276	58,985	108,583	13,808	1,164,456
Relocations	1.00	EA	393,131	38,119	33,134	30,433	4,739	499,555
ARS - Reach D	1.00	EA	78,897,735	4,843,301	4,286,356	6,288,858	1,002,483	95,318,733
Relocations	1.00	EA	21,572,774	1,175,991	1,022,207	1,510,106	242,117	25,523,196
Bank Stabilization (SP)	1.00	EA	14,875,962	1,923,436	1,671,909	1,494,329	239,588	20,205,223
Fish and Wildlife Facilities	1.00	EA	1,743,882	34,878	106,726	191,754	24,927	2,102,165
Fish and Wildlife Facilities (Mitigation) (Alt 2)	1.00	EA	5,671,333	0	0	0	0	5,671,333
Levees and Floodwalls (Alt 2)	1.00	EA	35,033,784	1,708,998	1,485,513	3,092,669	495,852	41,816,816
ARS - Reach E	1.00	EA	54,840,206	2,979,860	2,665,100	4,304,678	711,203	65,501,048
Relocations	1.00	EA	3,274,791	317,976	276,395	235,626	39,312	4,144,100
Bank Stabilization (SP)	1.00	EA	11,077,910	1,433,170	1,245,756	1,066,155	177,876	15,000,866
Fish and Wildlife Facilities	1.00	EA	1,709,763	34,195	104,637	188,372	24,444	2,061,411
Fish and Wildlife Facilities (Mitigation) (Alt 2)	1.00	LS	4,694,118	0	0	0	0	4,694,118
Levees and Floodwalls (Alt 2)	1.00	EA	34,083,624	1,194,519	1,038,313	2,814,525	469,572	39,600,553
ARS - Reach F	1.00	EA	134,344,889	7,133,809	6,315,926	12,015,461	1,769,322	161,579,407
Relocations	1.00	EA	8,960,846	865,449	752,275	734,052	108,341	11,420,965
Bank Stabilization (SP)	1.00	EA	27,121,174	3,508,002	3,049,263	2,980,542	439,908	37,098,889
Fish and Wildlife Facilities (Construction)	1.00	EA	2,624,648	52,493	160,628	281,223	37,428	3,156,421
Fish and Wildlife Facilities (Mitigation) (Alt 2)	1.00	LS	10,082,404	0	0	0	0	10,082,404
Levees and Floodwalls (Alt 2)	1.00	EA	85,555,817	2,707,865	2,353,759	8,019,643	1,183,645	99,820,729
ARS - Reach G	1.00	EA	62,060,278	5,190,751	4,592,344	5,620,599	827,730	78,291,703
Relocations	1.00	EA	22,257,892	1,167,719	1,015,017	1,692,182	250,274	26,383,085
Bank Stabilization (SP)	1.00	EA	13,496,180	1,745,371	1,517,130	1,479,792	218,862	18,457,334
Fish and Wildlife Facilities	1.00	EA	1,834,584	36,692	112,277	201,331	26,219	2,211,101
Fish and Wildlife Facilities (Mitigation) (Alt 2)	1.00	LS	3,209,833	0	0	0	0	3,209,833
Levees and Floodwalls (Alt 2)	1.00	EA	21,261,789	2,240,970	1,947,920	2,247,295	332,376	28,030,350
ARN - Reach A	1.00	EA	59,254,030	6,794,549	5,997,737	6,220,436	879,243	79,145,994
Fish and Wildlife Facilities (Mitigation)	1.00	LS	4,602,118	0	0	0	0	4,602,118
Bank Stabilization (SP)	1.00	EA	51,016,511	6,603,452	5,739,923	5,860,789	830,648	70,051,324
Fish and Wildlife Facilities	1.00	EA	2,093,020	41,860	128,093	227,655	29,888	2,520,516
Relocations	1.00	EA	1,542,381	149,236	129,721	131,991	18,707	1,972,037
ARN - Reach B	1.00	EA	3,257,125	331,388	441,780	333,139	47,269	4,410,702
Fish and Wildlife Facilities (Mitigation)	1.00	LS	408,000	0	0	0	0	408,000
Bank Stabilization (SP)	1.00	EA	2,470,546	319,134	414,678	291,326	41,948	3,537,633
Fish and Wildlife Facilities	1.00	EA	316,707	6,334	19,382	36,434	4,546	383,404

Description	Quantity	UOM	CostToPrime	JOOH_PRM	HOOH_PRM	Profit_PRM	Bond_PRM	ContractCost
Relocations	1.00	EA	61,872	5,920	7,719	5,379	775	81,665
ARN - Reach C	1.00	EA	5,188,061	282,179	367,918	396,147	70,778	6,305,083
Fish and Wildlife Facilities (Mitigation)	1.00	LS	100,000	0	0	0	0	100,000
Levees and Floodwalls	1.00	EA	4,182,034	195,089	254,366	333,467	59,579	5,024,536
Relocations	1.00	EA	906,027	87,089	113,551	62,680	11,199	1,180,546
ARN - Reach D	1.00	EA	28,380,510	2,530,242	2,199,364	2,554,860	400,036	36,065,012
Fish and Wildlife Facilities (Mitigation)	1.00	LS	660,000	0	0	0	0	660,000
Levees and Floodwalls	1.00	EA	21,152,369	1,893,310	1,645,724	2,049,386	320,889	27,061,679
Relocations	1.00	EA	6,568,141	636,932	553,641	505,474	79,146	8,343,333
ARN - Reach E	1.00	EA	28,782,304	2,536,284	2,204,616	2,565,960	401,774	36,490,937
Fish and Wildlife Facilities (Mitigation)	1.00	LS	495,000	0	0	0	0	495,000
Levees and Floodwalls	1.00	EA	19,970,130	1,729,743	1,503,546	1,925,884	301,552	25,430,854
Relocations	1.00	EA	8,317,174	806,540	701,070	640,077	100,222	10,565,083
ARN - Reach F	1.00	EA	17,194,676	1,089,465	946,997	1,466,342	236,999	20,934,478
Fish and Wildlife Facilities (Mitigation)	1.00	EA	100,000	0	0	0	0	100,000
Levees and Floodwalls	1.00	EA	13,752,037	765,107	665,054	1,217,612	196,798	16,596,608
Relocations	1.00	EA	3,342,639	324,358	281,942	248,730	40,201	4,237,870
ARN - Reach I (Magpie Cr Div Channel)	1.00	EA	1,669,497	178,665	232,952	170,810	23,603	2,275,527
Fish and Wildlife Facilities (Mitigation)	1.00	LS	275,000	0	0	0	0	275,000
Levees and Floodwalls	1.00	EA	1,356,692	175,052	228,241	167,375	23,128	1,950,487
Relocations	1.00	EA	37,805	3,614	4,712	3,435	475	50,040
ARCF_GRR_SBW-Extend_Bridge (Alt2) MIIv4.2 141020	1.00	EA	65,462,837	3,798,750	3,301,991	5,227,032	781,217	78,571,827
RELOCATIONS	1.00	EA	3,194,682	0	0	218,727	32,690	3,446,099
ROADS, RAILROADS, AND BRIDGES	1.00	EA	18,242,347	0	0	1,592,557	238,019	20,072,923
LEVEES AND FLOODWALLS	1.00	EA	669,386	0	0	58,437	8,734	736,557
FLOODWAY CONTROL-DIVERSION STRUCTURE	1,500.00	LF	31,356,423	3,798,750	3,301,991	3,357,310	501,774	42,316,248
Fish and Wildlife Facilities (Mitigation)	1.00	LS	12,000,000	0	0	0	0	12,000,000
ARCF_GRR_SBW-Widen_Bypass (Alt 2) MIIv4.2 141020	1.00	EA	70,384,252	8,197,365	7,125,402	7,254,376	1,072,925	94,034,320
RELOCATIONS	1.00	EA	12,187,468	1,180,386	1,026,028	996,581	147,395	15,537,859
ROADS, RAILROADS, AND BRIDGES	1.00	EA	1,739,073	168,434	146,408	142,206	21,032	2,217,153
LEVEES AND FLOODWALLS	1.00	EA	56,457,710	6,848,545	5,952,966	6,115,589	904,498	76,279,308

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
0	**ARCFGRR Alt 1 - Total Project Schedule (including Construction)**	**0**		**3192.5 days**	**Mon 10/2/17**	**Wed 12/26/29**			**Per PM & Civil Des, the project is assumed to begin in FY16. Constr Seq/Priority based on the following start years FY16-ARSF & ARSA, FY17-ARSE, FY19-ARSB, FY20-ARSG & ARNA, FY21-ARSD & SBW, FY22-ARSC, FY23-ARNB, ARND, ARNF & ARNC, FY24-ARNE, ARNG & ARNI**
1	**Design & Construction - ARS, Reach F**	**0**		**1335.06 days**	**Mon 10/2/17**	**Mon 11/14/22**			**Sacramento River - Between Clipper Way and River Garden Ct; From table provided by Civil Design, reach extends from ~Sta 353+85 to 640+20; Reach Length ~ 28,635 LF, Seepage & Stability Concern ~25,500 LF**
2	**Design**	0		**1044 days**	**Mon 10/2/17**	**Thu 9/30/21**		**258SS+783 days,160SS+52**	
8	**Pre-Construction - Season 1**	0		**77 days**	**Tue 10/1/19**	**Wed 1/15/20**		**89SS+262 days**	
17	**Constr - Relocations & Levees (Seepage & Stability) - Season 1 - Sta 354+00 to 438+00 (approx)**	**0**		**250 days**	**Wed 4/1/20**	**Fri 11/20/20**			**assumes ~1/3 of DSM cutoff walls will be constructed during Season 1; ~Sta 355+00 to 479+00; seasonal construction window to reestablish levee is approximately 4/1 - 10/31 (sans ABC, reveg, other non-levee-structure items)**
88	**Pre-Construction - Season 2**	0		**77 days**	**Thu 10/1/20**	**Fri 1/15/21**		**124SS+261 days**	
97	**Constr - Relocations & Levees (Seepage & Stability) - Season 2 - Sta 479+00 to 546+00 (approx)**	**0**		**235 days**	**Thu 4/1/21**	**Sat 11/6/21**			**assumes ~1/3 of DSM cutoff walls will be constructed during Season 2; ~Sta 479+00 to 546+00; seasonal construction window to reestablish levee is approximately 4/1 - 10/31 (sans ABC, reveg, other non-levee-structure items)**
123	**Pre-Construction - Season 3**	0		**77 days**	**Fri 10/1/21**	**Mon 1/17/22**			
132	**Constr - Relocations & Levees (Seepage & Stability) - Season 3 - Sta 546+00 to 640+00 (approx)**	**0**		**242.5 days**	**Fri 4/1/22**	**Mon 11/14/22**			**assumes ~1/3 of DSM cutoff walls will be constructed during Season 2; ~Sta 546+00 to 640+00; seasonal construction window to reestablish levee is approximately 4/1 - 10/31 (sans ABC, reveg, other non-levee-structure items)**
158	**Design & Construction - ARS, Reach F (Erosion Protection)**	**0**		**1137.5 days**	**Tue 10/1/19**	**Thu 2/8/24**			**Sacramento River - Between Clipper Way and River Garden Ct; From table provided by Civil Design, reach extends from ~Sta 353+85 to 640+20; Reach Length ~ 28,635 LF, Erosion Concern ~22,055 LF**
159	**Design**	0		**262 days**	**Tue 10/1/19**	**Wed 9/30/20**			
163	**Pre-Construction - Season 1**	0		**77 days**	**Thu 10/1/20**	**Fri 1/15/21**			
172	**Constr - Levees (Eros Prot), Season 1 - - Sta 354+00 to 438+00 (approx)**	**0**		**113.75 days**	**Sat 7/10/21**	**Sat 10/23/21**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1-11/30**
188	**Pre-Construction - Season 2**	0		**77 days**	**Fri 10/1/21**	**Mon 1/17/22**			

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
197	**Constr - Levees (Eros Prot), Season 2 - Sta 479+00 to 546+00 (approx)**	0		108.75 days	Tue 7/12/22	Fri 10/21/22			seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1-11/30; assumes approximately 1/3 the work can be accomplished during season 2
213	**Pre-Construction - Season 3**	0		77 days	Mon 10/3/22	Tue 1/17/23			
222	**Constr - Levees (Eros Prot), Season 3 - Sta 546+00 to 640+00 (approx)**	0		236.25 days	Mon 7/3/23	Thu 2/8/24			seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1-11/30; assumes approximately 1/3 the work can be accomplished during season 3; NOTE: Haul/Access RD repair extends duration
243	**Plant Maintenance - ARS, Reach F**	0		1319.5 days	Mon 10/25/21	Fri 11/13/26			
244	**Plant Establishment Watering, ARS, Reach F (Season 1)**	0		783 days	Mon 10/25/21	Wed 10/23/24			extends 3 years past finish of initial plant establishment
248	**Plant Establishment Watering, ARS, Reach F (Season 2)**	0		783 days	Fri 10/21/22	Wed 10/22/25			extends 3 years past finish of initial plant establishment
252	**Plant Establishment Watering, ARS, Reach F (Season 3)**	0		782 days	Wed 11/15/23	Fri 11/13/26			extends 3 years past finish of initial plant establishment
256	**Design & Construction - ARS, Reach E**	0		1036.75 days	Thu 10/1/20	Fri 9/20/24			Sacramento River - Between Richards Blvd and Lindent Road (SEEPAGE, STABILITY Deficiencies); Reach Length - 22,825 LF; Levee Work = 10,000 LF (seepage), 10,000 LF (stability)
257	**Design**	0		543 days	Thu 10/1/20	Mon 10/31/22		427SS	
263	**Pre-Construction - Season 1**	0		77 days	Tue 11/1/22	Wed 2/15/23		315FS+183 days,361SS	
272	**Constr - Relocations & Levees (Seepage & Stability) - Season 1 - Sta 228+00 to 307+00 (approx)**	0		183.75 days	Sat 4/1/23	Wed 9/20/23			assumes ~1/2 of DSM cutoff walls will be constructed during Season 1; ~Sta 228+00 to 307+00; seasonal construction window is approximately 4/1 - 10/31
314	**Pre-Construction, Season 2**	0		77 days	Tue 10/31/23	Wed 2/14/24		365SS	
323	**Constr - Relocations & Levees (Seepage & Stability) - Season 2 - Sta 307+00 to 354+00 (approx)**	0		185 days	Mon 4/1/24	Fri 9/20/24			assumes ~1/2 of DSM cutoff walls will be constructed during Season 1; ~Sta 307+00 to 354+00; seasonal construction window is approximately 4/1 - 10/31
359	**Design & Construction - ARS, Reach E (Erosion Protection)**	0		774 days	Tue 11/1/22	Sat 10/18/25			Sacramento River - Between Richards Blvd and Lindent Road (EROSION Deficiencies); Reach Length - 22,825 LF; Levee Work = 11,275 LF (erosion protection)
360	**Design**	0		260 days	Tue 11/1/22	Mon 10/30/23			
364	**Pre-Construction - Season 1**	0		77 days	Tue 10/31/23	Wed 2/14/24		374SS+327 days,389SS+26	

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
373	**Constr - Levees (Eros Prot) - Season 1 - Sta 228+00 to 307+00 (approx)**	**0**		**111.25 days**	**Fri 8/30/24**	**Thu 12/12/24**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); rock placement in water is limited to 8/1 - 11/30**
388	**Pre-Construction - Season 2**	0		**77 days**	**Wed 10/30/24**	**Thu 2/13/25**			
397	**Constr - Levees (Eros Prot) - Season 2 - Sta 307+00 to 354+00 (approx)**	**0**		**96.25 days**	**Mon 7/21/25**	**Sat 10/18/25**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); rock placement in water is limited to 8/1 - 11/30**
416	**Plant Maintenance - ARS, Reach E**	0		1002.31 days	Thu 12/12/24	Mon 10/16/28			
417	**Plant Establishment Watering, ARS, Reach E, Season 1**	**0**		**782 days**	**Thu 12/12/24**	**Mon 12/13/27**			**extends 3 years past finish of initial plant establishment**
421	**Plant Establishment Watering, ARS, Reach E, Season 2**	**0**		**781 days**	**Mon 10/20/25**	**Mon 10/16/28**			**extends 3 years past finish of initial plant establishment**
425	**Design & Construction - ARS, Reach G**	**0**		**1341.5 days**	**Thu 10/1/20**	**Fri 11/21/25**			**Sacramento River - Between River Garden Cour and Beach lake Road (SEEPAGE, STABILITY Deficiencies); Reach Length - 13,105 LF; Levee Work = 8333 LF (seepage), 8333 LF (stability)**
426	**Design**	0		**1043 days**	**Thu 10/1/20**	**Mon 9/30/24**		**433SS+1043 days,696SS+78**	
432	**Pre-Construction**	0		**77 days**	**Tue 10/1/24**	**Wed 1/15/25**			
441	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**251.25 days**	**Tue 4/1/25**	**Fri 11/21/25**			**seasonal construction window is approximately 4/1 - 10/31 - Schedule fwill be very tight - assumes Reveg can extend into Nov**
657	**Design & Construction - ARS, Reach G (Erosion Protection)**	**0**		**570.25 days**	**Tue 10/1/24**	**Tue 12/8/26**			**Sacramento River - Between River Garden Cour and Beach lake Road (EROSION Deficiencies); Reach Length - 13,120 LF; Levee Work = 11,120 LF (erosion protection)**
658	**Design**	0		**261 days**	**Tue 10/1/24**	**Tue 9/30/25**			
662	**Pre-Construction**	0		**77 days**	**Wed 10/1/25**	**Thu 1/15/26**		**672SS+294 days**	
671	**Constr - Levees (Eros Prot)**	**0**		**170 days**	**Thu 7/2/26**	**Tue 12/8/26**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1/ - 11/30**
689	**Plant Maintenance, ARS, Reach G**	0		782 days	Tue 12/8/26	Thu 12/6/29			
690	**Plant Establishment Watering**	**0**		**782 days**	**Tue 12/8/26**	**Thu 12/6/29**			**extends 3 years past finish of initial plant establishment**
694	**Design & Construction - ARS, Reach D**	**0**		**844.5 days**	**Mon 10/2/23**	**Fri 12/25/26**			**Sacramento River - Between Richards Blvd and Lindent Road (SEEPAGE, STABILITY Deficiencies); Reach Length - 22,825 LF; Lvee Work = 10,000 LF (seepage), 10,000 LF (stability)**

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
695	**Design**	0		**545 days**	**Mon 10/2/23**	**Fri 10/31/25**		**702,968SS+261 days**	
701	**Pre-Construction**	0		**77 days**	**Mon 11/3/25**	**Tue 2/17/26**			
710	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**287.5 days**	**Wed 4/1/26**	**Fri 12/25/26**			**seasonal construction window is approximately 4/1 - 10/31 (sans ABC, Reveg, Demob, etc)**
966	**Design & Construction - ARS, Reach D (Erosion Protection)**	**0**		**583.5 days**	**Tue 10/1/24**	**Fri 12/25/26**			**Sacramento River - Between Richards Blvd and Lindent Road (EROSION Deficiencies); Reach Length - 22,825 LF; Levee Work = 11,275 LF (erosion protection)**
967	**Design**	0		**261 days**	**Tue 10/1/24**	**Tue 9/30/25**			
971	**Pre-Construction**	0		**77 days**	**Wed 10/1/25**	**Thu 1/15/26**			
980	**Constr - Levees (Eros Prot)**	**0**		**186.25 days**	**Sat 7/4/26**	**Fri 12/25/26**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 - 11/30**
1001	**Plant Maintenance, ARS, Reach D**	0		782 days	Fri 12/25/26	Tue 12/25/29			
1002	**Plant Establishment Watering**	**0**		**782 days**	**Fri 12/25/26**	**Tue 12/25/29**			**extends 3 years past finish of initial plant establishment**
1006	**Design & Construction - ARN, Reach F**	**0**		**809.5 days**	**Mon 10/2/23**	**Fri 11/6/26**			**Between State Route 160 and just West of Arcade Blvd (SEEPAGE, HEIGHT Deficiencies(; Reach Length - 8330 LF; Levee Work = 2850 LF (Height Improvements) & 2450 LF (Seepage Improvements)**
1007	**Design**	0		**544 days**	**Mon 10/2/23**	**Thu 10/30/25**		**1085SS+261 days,1014**	
1013	**Pre-Construction**	0		**77 days**	**Fri 10/31/25**	**Mon 2/16/26**			
1022	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**235 days**	**Wed 4/1/26**	**Fri 11/6/26**			**seasonal construction window is approximately 4/1 - 10/31 (sans reveg, demob, haul route/access road repairs, etc)**
1083	**Design & Construction - ARN, Reach C**	**0**		**722.31 days**	**Tue 10/1/24**	**Thu 7/8/27**			**Between State Route 160 and just West of Arcade Blvd (SEEPAGE, HEIGHT Deficiencies(; Reach Length - 8330 LF; Levee Work = 2850 LF (Height Improvements) & 2450 LF (Seepage Improvements)**
1084	**Design**	0		**545 days**	**Tue 10/1/24**	**Mon 11/2/26**		**1091**	
1090	**Pre-Construction**	0		**77 days**	**Tue 11/3/26**	**Wed 2/17/27**			
1099	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**105 days**	**Thu 4/1/27**	**Thu 7/8/27**			**seasonal construction window is approximately 4/1 - 10/31**

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
1140	**Design & Construction - ARS, Reach A (Erosion Protection)**	**0**		**1139.69 days**	**Mon 10/2/17**	**Fri 2/11/22**			**American River - between Mira Del Rio Drive & Northwest of Carlson Drive (Erosion Deficiency); Reach Length - 36,190 LF; Levee Work = 6850 LF (Bank Protection) 17,750 LF (Rock Trench) (requires 3 seasons)**
1141	**Design**	0		**261 days**	**Mon 10/2/17**	**Mon 10/1/18**		**1146,1245SS+7 days**	
1145	**Pre-Construction, Season 1**	0		**77 days**	**Tue 10/2/18**	**Wed 1/16/19**		**1155SS+242 days**	
1154	**Constr - Levees (Eros Prot), Season 1**	**0**		**228.75 days**	**Wed 5/15/19**	**Sat 12/14/19**		**1232**	**seasonal construction window is approximately 4/1 - 11/30 (sans plantings, demob, etc); placement of rock in water is limited to 8/1-11/30; assumes (approximately 1/3 of the work can be accomplished during this period)**
1172	**Pre-Construction, Season 2**	0		**77 days**	**Thu 10/3/19**	**Fri 1/17/20**			
1181	**Constr - Levees (Eros Prot), Season 2**	**0**		**227.5 days**	**Sat 5/16/20**	**Tue 12/15/20**		**1236**	**seasonal construction window is approximately 4/1 - 11/30 (sans plantings, demob, etc); placement of rock in water is limited to 8/1-11/30; assumes (approximately 1/3 of the work can be accomplished during this period)**
1199	**Pre-Construction, Season 3**	0		**77 days**	**Mon 10/5/20**	**Tue 1/19/21**			
1208	**Constr - Levees (Eros Prot), Season 3**	**0**		**290.75 days**	**Mon 5/17/21**	**Fri 2/11/22**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings, demob, etc); placement of rock in water is limited to 8/1-11/30; assumes (approximately 1/3 of the work can be accomplished during this period); NOTE: Haul/Access RD repair extends**
1230	**Plant Maintenance, ARS, Reach A**	0		1299 days	Mon 12/16/19	Thu 12/5/24			
1231	**Plant Establishment Watering, ARS, Reach A, Season 1**	**1**	**LS**	**782 days**	**Mon 12/16/19**	**Tue 12/13/22**			**extends 3 years past finish of initial plant establishment**
1235	**Plant Establishment Watering, ARS, Reach A, Season 2**	**1**	**LS**	**783 days**	**Tue 12/15/20**	**Fri 12/15/23**			**extends 3 years past finish of initial plant establishment**
1239	**Plant Establishment Watering, ARS, Reach A, Season 3**	**1**	**LS**	**784 days**	**Mon 12/6/21**	**Thu 12/5/24**			**extends 3 years past finish of initial plant establishment**
1243	**Design & Construction - ARS, Reach B (Erosion Protection)**	**0**		**595 days**	**Fri 10/2/20**	**Fri 1/13/23**			**American River - between Carlson Drive and State Route 160 (Erosion Deficiency); Reach Length - 17,405 LF; Levee Work = 850 LF (Erosion Protection), 6400 LF (Rock Trench)**
1244	**Design**	0		**261 days**	**Fri 10/2/20**	**Fri 10/1/21**		**1284SS+261 days,1249**	
1248	**Pre-Construction**	0		**77 days**	**Mon 10/4/21**	**Tue 1/18/22**			
1257	**Constr - Levees (Eros Prot)**	**0**		**199.25 days**	**Mon 7/11/22**	**Fri 1/13/23**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); rock placement in water is limited to 8/1 - 11/30; NOTE: Haul/Access RD repair extends duration**

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
1277	Plant Maintenance, ARS, Reach B	0		783 days	Wed 12/7/22	Fri 12/5/25			
1278	Plant Establishment Watering, ARS, Reach B	0		783 days	Wed 12/7/22	Fri 12/5/25			extends 3 years past finish of initial plant establishment
1282	Design & Construction - ARN, Reach A (Erosion Protection)	0		845.5 days	Mon 10/4/21	Mon 12/30/24			American River - between River Oak Way and North of Northrop Ave (Erosion Deficiency); Reach Length - 36,400 LF; Levee Work = 18,150 LF (Rock Trench) (requires 2 seasons)
1283	Design	0		260 days	Mon 10/4/21	Fri 9/30/22		1354SS+521 days	
1287	Pre-Construction, Season 1	0		77 days	Mon 10/3/22	Tue 1/17/23			
1296	Constr - Levees (Eros Prot), Season 1	0		238.75 days	Tue 5/9/23	Mon 12/18/23			seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 t-11/30; (assumes 50% of the work can be accomplished during this period)
1313	Pre-Construction, Season 2	0		77 days	Tue 10/3/23	Wed 1/17/24			
1322	Constr - Levees (Eros Prot), Season 2	0		251.25 days	Thu 5/9/24	Mon 12/30/24			seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 t-11/30; (assumes 50% of the work can be accomplished during this period)
1343	Plant Maintenance, ARN, Reach A	0		1053.25 days	Mon 12/18/23	Thu 12/30/27			
1344	Plant Establishment Watering, ARN, Reach A, Season 1	1	LS	783 days	Mon 12/18/23	Thu 12/17/26			extends 3 years past finish of initial plant establishment
1348	Plant Establishment Watering, ARN, Reach A, Season 2	1	LS	783 days	Mon 12/30/24	Thu 12/30/27			extends 3 years past finish of initial plant establishment
1352	Design & Construction - ARS, Reach C (Erosion Protection)	0		540.5 days	Tue 10/3/23	Tue 10/28/25			American River & Sacramento River - between State Route 160 and Richards Blvd (Erosion Deficiency); Reach Length - 9895 LF; Levee Work = 3800 LF (Erosion Protection), 2150 LF (Rock Trench)
1353	Design	0		261 days	Tue 10/3/23	Tue 10/1/24		1395	
1357	Pre-Construction	0		77 days	Wed 10/2/24	Thu 1/16/25			
1366	Constr - Levees (Eros Prot)	0		158.75 days	Mon 6/2/25	Tue 10/28/25		1390	seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 - 11/30
1388	Plant Maintenance, ARS, Reach C	0		785 days	Tue 10/28/25	Tue 10/31/28			
1389	Plant Establishment Watering	0		785 days	Tue 10/28/25	Tue 10/31/28			extends 3 years past finish of initial plant establishment

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
1393	**Design & Construction - ARN, Reach B (Erosion Protection)**	**0**		**537.5 days**	**Wed 10/2/24**	**Fri 10/23/26**			**American River - between Northrop Ave and Stae Route 160 (Erosion Deficiency); Reach Length - 1100 LF; Levee Work = 950 LF (Rock Trench)**
1394	**Design**	0		**261 days**	**Wed 10/2/24**	**Wed 10/1/25**		**1399**	
1398	**Pre-Construction**	0		**77 days**	**Thu 10/2/25**	**Fri 1/16/26**		**1408FS+212 days**	
1407	**Constr - Levees (Eros Prot)**	**0**		**87.5 days**	**Mon 8/3/26**	**Fri 10/23/26**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 - 11/30**
1425	**Plant Maintenance, ARN, Reach B**	0		783 days	Fri 10/23/26	Wed 10/24/29			
1426	**Plant Establishment Watering**	**1**	**LS**	**783 days**	**Fri 10/23/26**	**Wed 10/24/29**			**extends 3 years past finish of initial plant establishment**
1430	**Design & Construction - ARN, Reach D**	**0**		**1346 days**	**Thu 10/1/20**	**Fri 11/28/25**			**Between Arcade Blvd & Marysville Blvd (SEEPAGE, HEIGHT Deficiencies); Reach Length - 10,965 LF**
1431	**Design**	0		**1044 days**	**Thu 10/1/20**	**Tue 10/1/24**		**1641SS+261 days**	
1437	**Pre-Construction**	0		**77 days**	**Wed 10/2/24**	**Thu 1/16/25**		**1447SS+195 days**	
1446	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**257.5 days**	**Wed 4/2/25**	**Fri 11/28/25**			**seasonal construction window is approximately 4/1 - 10/31 - assumes work will proceed from both ends of the reach in order to finish in one construction season**
1639	**Design & Construction - ARN, Reach E**	**0**		**1346 days**	**Fri 10/1/21**	**Mon 11/30/26**			**Between Scoles Ct and High St (SEEPAGE, HEIGHT Deficiencies); Reach Length - 11,155 LF**
1640	**Design**	0		**1044 days**	**Fri 10/1/21**	**Wed 10/1/25**		**1918SS+783 days**	
1646	**Pre-Construction**	0		**77 days**	**Thu 10/2/25**	**Fri 1/16/26**		**1656SS+195 days**	
1655	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**258.75 days**	**Thu 4/2/26**	**Mon 11/30/26**			**seasonal construction window is approximately 4/1 - 10/31 (sans reveg, demob, etc) - assumes work will proceed from both ends of the reach in order to finish in one construction season**
1916	**Design & Construction - ARN, Reach I**	**0**		**730 days**	**Wed 10/2/24**	**Wed 7/21/27**			**Between State Route 160 and just West of Arcade Blvd (SEEPAGE, HEIGHT Deficiencies(; Reach Length - 8330 LF; Levee Work = 2850 LF (Height Improvements) & 2450 LF (Seepage Improvements)**
1917	**Design**	0		**544 days**	**Wed 10/2/24**	**Mon 11/2/26**			
1923	**Pre-Construction**	0		**77 days**	**Tue 11/3/26**	**Wed 2/17/27**			
1932	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**83.75 days**	**Tue 5/4/27**	**Wed 7/21/27**			**seasonal construction window is approximately 4/1 - 10/31; schedule of various sites is uncertain, but assuming work is sequential the duration fits in the construction window**

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
1955	**PROJECT COMPLETION**	*0*		1 day	Tue 12/25/29	Wed 12/26/29	1005,247,251,25		

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
0	**ARCFGRR Alt 2 - Total Project Schedule (including Construction)**	**0**		**3192.5 days**	**Mon 10/2/17**	**Wed 12/26/29**			**Per PM & Civil Des, the project is assumed to begin in FY16. Constr Seq/Priority based on the following start years FY16-ARSF & ARSA, FY17-ARSE, FY19-ARSB, FY20-ARSG & ARNA, FY21-ARSD & SBW, FY22-ARSC, FY23-ARNB, ARND, ARNF & ARNC, FY24-ARNE, ARNG & ARNI**
1	**Design & Construction - ARS, Reach F**	**0**		**1335.06 days**	**Mon 10/2/17**	**Mon 11/14/22**			**Sacramento River - Between Clipper Way and River Garden Ct; From table provided by Civil Design, reach extends from ~Sta 353+85 to 640+20; Reach Length ~ 28,635 LF, Seepage & Stability Concern ~25,500 LF**
2	**Design**	0		**1044 days**	**Mon 10/2/17**	**Thu 9/30/21**		**258SS+783 days,160SS+52**	
8	**Pre-Construction - Season 1**	0		**77 days**	**Tue 10/1/19**	**Wed 1/15/20**		**89SS+262 days**	
17	**Constr - Relocations & Levees (Seepage & Stability) - Season 1 - Sta 354+00 to 438+00 (approx)**	**0**		**250 days**	**Wed 4/1/20**	**Fri 11/20/20**			**assumes ~1/3 of DSM cutoff walls will be constructed during Season 1; ~Sta 355+00 to 479+00; seasonal construction window to reestablish levee is approximately 4/1 - 10/31 (sans ABC, reveg, other non-levee-structure items)**
88	**Pre-Construction - Season 2**	0		**77 days**	**Thu 10/1/20**	**Fri 1/15/21**		**124SS+261 days**	
97	**Constr - Relocations & Levees (Seepage & Stability) - Season 2 - Sta 479+00 to 546+00 (approx)**	**0**		**235 days**	**Thu 4/1/21**	**Sat 11/6/21**			**assumes ~1/3 of DSM cutoff walls will be constructed during Season 2; ~Sta 479+00 to 546+00; seasonal construction window to reestablish levee is approximately 4/1 - 10/31 (sans ABC, reveg, other non-levee-structure items)**
123	**Pre-Construction - Season 3**	0		**77 days**	**Fri 10/1/21**	**Mon 1/17/22**			
132	**Constr - Relocations & Levees (Seepage & Stability) - Season 3 - Sta 546+00 to 640+00 (approx)**	**0**		**242.5 days**	**Fri 4/1/22**	**Mon 11/14/22**			**assumes ~1/3 of DSM cutoff walls will be constructed during Season 2; ~Sta 546+00 to 640+00; seasonal construction window to reestablish levee is approximately 4/1 - 10/31 (sans ABC, reveg, other non-levee-structure items)**
158	**Design & Construction - ARS, Reach F (Erosion Protection)**	**0**		**1137.5 days**	**Tue 10/1/19**	**Thu 2/8/24**			**Sacramento River - Between Clipper Way and River Garden Ct; From table provided by Civil Design, reach extends from ~Sta 353+85 to 640+20; Reach Length ~ 28,635 LF, Erosion Concern ~22,055 LF**
159	**Design**	0		**262 days**	**Tue 10/1/19**	**Wed 9/30/20**			
163	**Pre-Construction - Season 1**	0		**77 days**	**Thu 10/1/20**	**Fri 1/15/21**			
172	**Constr - Levees (Eros Prot), Season 1 - - Sta 354+00 to 438+00 (approx)**	**0**		**113.75 days**	**Sat 7/10/21**	**Sat 10/23/21**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1-11/30**
188	**Pre-Construction - Season 2**	0		**77 days**	**Fri 10/1/21**	**Mon 1/17/22**			

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
197	**Constr - Levees (Eros Prot), Season 2 - Sta 479+00 to 546+00 (approx)**	0		108.75 days	Tue 7/12/22	Fri 10/21/22			seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1-11/30; assumes approximately 1/3 the work can be accomplished during season 2
213	**Pre-Construction - Season 3**	0		77 days	Mon 10/3/22	Tue 1/17/23			
222	**Constr - Levees (Eros Prot), Season 3 - Sta 546+00 to 640+00 (approx)**	0		236.25 days	Mon 7/3/23	Thu 2/8/24			seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1-11/30; assumes approximately 1/3 the work can be accomplished during season 3; NOTE: Haul/Access RD repair extends duration
243	**Plant Maintenance - ARS, Reach F**	0		1319.5 days	Mon 10/25/21	Fri 11/13/26			
244	**Plant Establishment Watering, ARS, Reach F (Season 1)**	0		783 days	Mon 10/25/21	Wed 10/23/24			extends 3 years past finish of initial plant establishment
248	**Plant Establishment Watering, ARS, Reach F (Season 2)**	0		783 days	Fri 10/21/22	Wed 10/22/25			extends 3 years past finish of initial plant establishment
252	**Plant Establishment Watering, ARS, Reach F (Season 3)**	0		782 days	Wed 11/15/23	Fri 11/13/26			extends 3 years past finish of initial plant establishment
256	**Design & Construction - ARS, Reach E**	0		1036.75 days	Thu 10/1/20	Fri 9/20/24			Sacramento River - Between Richards Blvd and Lindent Road (SEEPAGE, STABILITY Deficiencies); Reach Length - 22,825 LF; Levee Work = 10,000 LF (seepage), 10,000 LF (stability)
257	**Design**	0		543 days	Thu 10/1/20	Mon 10/31/22		427SS	
263	**Pre-Construction - Season 1**	0		77 days	Tue 11/1/22	Wed 2/15/23		315FS+183 days,361SS	
272	**Constr - Relocations & Levees (Seepage & Stability) - Season 1 - Sta 228+00 to 307+00 (approx)**	0		183.75 days	Sat 4/1/23	Wed 9/20/23			assumes ~1/2 of DSM cutoff walls will be constructed during Season 1; ~Sta 228+00 to 307+00; seasonal construction window is approximately 4/1 - 10/31
314	**Pre-Construction, Season 2**	0		77 days	Tue 10/31/23	Wed 2/14/24		365SS	
323	**Constr - Relocations & Levees (Seepage & Stability) - Season 2 - Sta 307+00 to 354+00 (approx)**	0		185 days	Mon 4/1/24	Fri 9/20/24			assumes ~1/2 of DSM cutoff walls will be constructed during Season 1; ~Sta 307+00 to 354+00; seasonal construction window is approximately 4/1 - 10/31
359	**Design & Construction - ARS, Reach E (Erosion Protection)**	0		774 days	Tue 11/1/22	Sat 10/18/25			Sacramento River - Between Richards Blvd and Lindent Road (EROSION Deficiencies); Reach Length - 22,825 LF; Levee Work = 11,275 LF (erosion protection)
360	**Design**	0		260 days	Tue 11/1/22	Mon 10/30/23			
364	**Pre-Construction - Season 1**	0		77 days	Tue 10/31/23	Wed 2/14/24		374SS+327 days,389SS+26	

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
373	**Constr - Levees (Eros Prot) - Season 1 - Sta 228+00 to 307+00 (approx)**	**0**		**111.25 days**	**Fri 8/30/24**	**Thu 12/12/24**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); rock placement in water is limited to 8/1 - 11/30**
388	**Pre-Construction - Season 2**	0		**77 days**	**Wed 10/30/24**	**Thu 2/13/25**			
397	**Constr - Levees (Eros Prot) - Season 2 - Sta 307+00 to 354+00 (approx)**	**0**		**96.25 days**	**Mon 7/21/25**	**Sat 10/18/25**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); rock placement in water is limited to 8/1 - 11/30**
416	**Plant Maintenance - ARS, Reach E**	0		1002.31 days	Thu 12/12/24	Mon 10/16/28			
417	**Plant Establishment Watering, ARS, Reach E, Season 1**	**0**		**782 days**	**Thu 12/12/24**	**Mon 12/13/27**			**extends 3 years past finish of initial plant establishment**
421	**Plant Establishment Watering, ARS, Reach E, Season 2**	**0**		**781 days**	**Mon 10/20/25**	**Mon 10/16/28**			**extends 3 years past finish of initial plant establishment**
425	**Design & Construction - ARS, Reach G**	**0**		**1341.5 days**	**Thu 10/1/20**	**Fri 11/21/25**			**Sacramento River - Between River Garden Cour and Beach lake Road (SEEPAGE, STABILITY Deficiencies); Reach Length - 13,105 LF; Levee Work = 8333 LF (seepage), 8333 LF (stability)**
426	**Design**	0		**1043 days**	**Thu 10/1/20**	**Mon 9/30/24**		**433SS+1043 days,696SS+78**	
432	**Pre-Construction**	0		**77 days**	**Tue 10/1/24**	**Wed 1/15/25**			
441	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**251.25 days**	**Tue 4/1/25**	**Fri 11/21/25**			**seasonal construction window is approximately 4/1 - 10/31 - Schedule fwill be very tight - assumes Reveg can extend into Nov**
657	**Design & Construction - ARS, Reach G (Erosion Protection)**	**0**		**570.25 days**	**Tue 10/1/24**	**Tue 12/8/26**			**Sacramento River - Between River Garden Cour and Beach lake Road (EROSION Deficiencies); Reach Length - 13,120 LF; Levee Work = 11,120 LF (erosion protection)**
658	**Design**	0		**261 days**	**Tue 10/1/24**	**Tue 9/30/25**			
662	**Pre-Construction**	0		**77 days**	**Wed 10/1/25**	**Thu 1/15/26**		**672SS+294 days**	
671	**Constr - Levees (Eros Prot)**	**0**		**170 days**	**Thu 7/2/26**	**Tue 12/8/26**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1/ - 11/30**
689	**Plant Maintenance, ARS, Reach G**	0		782 days	Tue 12/8/26	Thu 12/6/29			
690	**Plant Establishment Watering**	**0**		**782 days**	**Tue 12/8/26**	**Thu 12/6/29**			**extends 3 years past finish of initial plant establishment**
694	**Design & Construction - ARS, Reach D**	**0**		**844.5 days**	**Mon 10/2/23**	**Fri 12/25/26**			**Sacramento River - Between Richards Blvd and Lindent Road (SEEPAGE, STABILITY Deficiencies); Reach Length - 22,825 LF; Lvee Work = 10,000 LF (seepage), 10,000 LF (stability)**

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
695	**Design**	0		**545 days**	**Mon 10/2/23**	**Fri 10/31/25**		**702,968SS+261 days**	
701	**Pre-Construction**	0		**77 days**	**Mon 11/3/25**	**Tue 2/17/26**			
710	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**287.5 days**	**Wed 4/1/26**	**Fri 12/25/26**			**seasonal construction window is approximately 4/1 - 10/31 (sans ABC, Reveg, Demob, etc)**
966	**Design & Construction - ARS, Reach D (Erosion Protection)**	**0**		**583.5 days**	**Tue 10/1/24**	**Fri 12/25/26**			**Sacramento River - Between Richards Blvd and Lindent Road (EROSION Deficiencies); Reach Length - 22,825 LF; Levee Work = 11,275 LF (erosion protection)**
967	**Design**	0		**261 days**	**Tue 10/1/24**	**Tue 9/30/25**			
971	**Pre-Construction**	0		**77 days**	**Wed 10/1/25**	**Thu 1/15/26**			
980	**Constr - Levees (Eros Prot)**	**0**		**186.25 days**	**Sat 7/4/26**	**Fri 12/25/26**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 - 11/30**
1001	**Plant Maintenance, ARS, Reach D**	0		782 days	Fri 12/25/26	Tue 12/25/29			
1002	**Plant Establishment Watering**	**0**		**782 days**	**Fri 12/25/26**	**Tue 12/25/29**			**extends 3 years past finish of initial plant establishment**
1006	**Design & Construction - SBW**	**0**		**1878.5 days**	**Mon 10/2/17**	**Thu 12/12/24**			**Sacramento River - Between River Garden Cour and Beach lake Road (SEEPAGE, STABILITY Deficiencies); Reach Length - 13,105 LF; Levee Work = 8333 LF (seepage), 8333 LF (stability)**
1007	Design	0		653 days	Mon 10/2/17	Wed 4/1/20			
1013	Pre-Construction	0		130 days	Thu 4/2/20	Wed 9/30/20		1168SS+587 days	
1022	Construction - New Weir Structure	0		1337.5 days	Thu 10/1/20	Fri 3/1/24			assumes construction will begin from both ends and that section with 6 bays will be Bays 16 thru 21
1167	Construction - Sac Bypass Widening (new bypass levee west of RR)	0		340 days	Fri 10/1/21	Mon 8/15/22			Note - It will be necessary to leave small gaps in the new levee for placement of the seepage berm during the final season of SBW construction
1224	Construction - Sac Bypass Widening (W of new weir - remove old bypass levee, construct seepage berm to N of new bypass levee, close gap in new bypass lev; N of new Weir - new Sac	0		273.75 days	Mon 4/1/24	Thu 12/12/24			seasonal construction window for levee work adjacent to streams is approximately 4/1 - 10/31 (sans reveg, demob, etc)
1253	**Design & Construction - ARN, Reach F**	**0**		**809.5 days**	**Mon 10/2/23**	**Fri 11/6/26**			**Between State Route 160 and just West of Arcade Blvd (SEEPAGE, HEIGHT Deficiencies(; Reach Length - 8330 LF; Levee Work = 2850 LF (Height Improvements) & 2450 LF (Seepage Improvements)**
1254	**Design**	0		**544 days**	**Mon 10/2/23**	**Thu 10/30/25**		**1332SS+261 days,1261**	
1260	**Pre-Construction**	0		**77 days**	**Fri 10/31/25**	**Mon 2/16/26**			

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
1269	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**235 days**	**Wed 4/1/26**	**Fri 11/6/26**			**seasonal construction window is approximately 4/1 - 10/31 (sans reveg, demob, haul route/access road repairs, etc)**
1330	**Design & Construction - ARN, Reach C**	**0**		**722.31 days**	**Tue 10/1/24**	**Thu 7/8/27**			**Between State Route 160 and just West of Arcade Blvd (SEEPAGE, HEIGHT Deficiencies(; Reach Length - 8330 LF; Levee Work = 2850 LF (Height Improvements) & 2450 LF (Seepage Improvements)**
1331	**Design**	0		**545 days**	**Tue 10/1/24**	**Mon 11/2/26**		**1338**	
1337	**Pre-Construction**	0		**77 days**	**Tue 11/3/26**	**Wed 2/17/27**			
1346	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**105 days**	**Thu 4/1/27**	**Thu 7/8/27**			**seasonal construction window is approximately 4/1 - 10/31**
1387	**Design & Construction - ARS, Reach A (Erosion Protection)**	**0**		**1139.69 days**	**Mon 10/2/17**	**Fri 2/11/22**			**American River - between Mira Del Rio Drive & Northwest of Carlson Drive (Erosion Deficiency); Reach Length - 36,190 LF; Levee Work = 6850 LF (Bank Protection) 17,750 LF (Rock Trench) (requires 3 seasons)**
1388	**Design**	0		**261 days**	**Mon 10/2/17**	**Mon 10/1/18**		**1393,1492SS+7 days**	
1392	**Pre-Construction, Season 1**	0		**77 days**	**Tue 10/2/18**	**Wed 1/16/19**		**1402SS+242 days**	
1401	**Constr - Levees (Eros Prot), Season 1**	**0**		**228.75 days**	**Wed 5/15/19**	**Sat 12/14/19**		**1479**	**seasonal construction window is approximately 4/1 - 11/30 (sans plantings, demob, etc); placement of rock in water is limited to 8/1-11/30; assumes (approximately 1/3 of the work can be accomplished during this period)**
1419	**Pre-Construction, Season 2**	0		**77 days**	**Thu 10/3/19**	**Fri 1/17/20**			
1428	**Constr - Levees (Eros Prot), Season 2**	**0**		**227.5 days**	**Sat 5/16/20**	**Tue 12/15/20**		**1483**	**seasonal construction window is approximately 4/1 - 11/30 (sans plantings, demob, etc); placement of rock in water is limited to 8/1-11/30; assumes (approximately 1/3 of the work can be accomplished during this period)**
1446	**Pre-Construction, Season 3**	0		**77 days**	**Mon 10/5/20**	**Tue 1/19/21**			
1455	**Constr - Levees (Eros Prot), Season 3**	**0**		**290.75 days**	**Mon 5/17/21**	**Fri 2/11/22**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings, demob, etc); placement of rock in water is limited to 8/1-11/30; assumes (approximately 1/3 of the work can be accomplished during this period); NOTE: Haul/Access RD repair extends**
1477	**Plant Maintenance, ARS, Reach A**	0		1299 days	Mon 12/16/19	Thu 12/5/24			
1478	**Plant Establishment Watering, ARS, Reach A, Season 1**	**1**	**LS**	**782 days**	**Mon 12/16/19**	**Tue 12/13/22**			**extends 3 years past finish of initial plant establishment**
1482	**Plant Establishment Watering, ARS, Reach A, Season 2**	**1**	**LS**	**783 days**	**Tue 12/15/20**	**Fri 12/15/23**			**extends 3 years past finish of initial plant establishment**

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
1486	**Plant Establishment Watering, ARS, Reach A, Season 3**	**1**	**LS**	**784 days**	**Mon 12/6/21**	**Thu 12/5/24**			**extends 3 years past finish of initial plant establishment**
1490	**Design & Construction - ARS, Reach B (Erosion Protection)**	**0**		**595 days**	**Fri 10/2/20**	**Fri 1/13/23**			**American River - between Carlson Drive and State Route 160 (Erosion Deficiency); Reach Length - 17,405 LF; Levee Work = 850 LF (Erosion Protection), 6400 LF (Rock Trench)**
1491	**Design**	0		**261 days**	**Fri 10/2/20**	**Fri 10/1/21**		**1531SS+261 days,1496**	
1495	**Pre-Construction**	0		**77 days**	**Mon 10/4/21**	**Tue 1/18/22**			
1504	**Constr - Levees (Eros Prot)**	**0**		**199.25 days**	**Mon 7/11/22**	**Fri 1/13/23**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); rock placement in water is limited to 8/1 - 11/30; NOTE: Haul/Access RD repair extends duration**
1524	**Plant Maintenance, ARS, Reach B**	0		783 days	Wed 12/7/22	Fri 12/5/25			
1525	**Plant Establishment Watering, ARS, Reach B**	**0**		**783 days**	**Wed 12/7/22**	**Fri 12/5/25**			**extends 3 years past finish of initial plant establishment**
1529	**Design & Construction - ARN, Reach A (Erosion Protection)**	**0**		**845.5 days**	**Mon 10/4/21**	**Mon 12/30/24**			**American River - between River Oak Way and North of Northrop Ave (Erosion Deficiency); Reach Length - 36,400 LF; Levee Work = 18,150 LF (Rock Trench) (requires 2 seasons)**
1530	**Design**	0		**260 days**	**Mon 10/4/21**	**Fri 9/30/22**		**1601SS+521 days**	
1534	**Pre-Construction, Season 1**	0		**77 days**	**Mon 10/3/22**	**Tue 1/17/23**			
1543	**Constr - Levees (Eros Prot), Season 1**	**0**		**238.75 days**	**Tue 5/9/23**	**Mon 12/18/23**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 t-11/30; (assumes 50% of the work can be accomplished during this period)**
1560	**Pre-Construction, Season 2**	0		**77 days**	**Tue 10/3/23**	**Wed 1/17/24**			
1569	**Constr - Levees (Eros Prot), Season 2**	**0**		**251.25 days**	**Thu 5/9/24**	**Mon 12/30/24**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 t-11/30; (assumes 50% of the work can be accomplished during this period)**
1590	**Plant Maintenance, ARN, Reach A**	0		1053.25 days	Mon 12/18/23	Thu 12/30/27			
1591	**Plant Establishment Watering, ARN, Reach A, Season 1**	**1**	**LS**	**783 days**	**Mon 12/18/23**	**Thu 12/17/26**			**extends 3 years past finish of initial plant establishment**
1595	**Plant Establishment Watering, ARN, Reach A, Season 2**	**1**	**LS**	**783 days**	**Mon 12/30/24**	**Thu 12/30/27**			**extends 3 years past finish of initial plant establishment**

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
1599	**Design & Construction - ARS, Reach C (Erosion Protection)**	**0**		**540.5 days**	**Tue 10/3/23**	**Tue 10/28/25**			**American River & Sacramento River - between State Route 160 and Richards Blvd (Erosion Deficiency); Reach Length - 9895 LF; Levee Work = 3800 LF (Erosion Protection), 2150 LF (Rock Trench)**
1600	**Design**	0		**261 days**	**Tue 10/3/23**	**Tue 10/1/24**		**1642**	
1604	**Pre-Construction**	0		**77 days**	**Wed 10/2/24**	**Thu 1/16/25**			
1613	**Constr - Levees (Eros Prot)**	**0**		**158.75 days**	**Mon 6/2/25**	**Tue 10/28/25**		**1637**	**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 - 11/30**
1635	**Plant Maintenance, ARS, Reach C**	0		785 days	Tue 10/28/25	Tue 10/31/28			
1636	**Plant Establishment Watering**	**0**		**785 days**	**Tue 10/28/25**	**Tue 10/31/28**			**extends 3 years past finish of initial plant establishment**
1640	**Design & Construction - ARN, Reach B (Erosion Protection)**	**0**		**537.5 days**	**Wed 10/2/24**	**Fri 10/23/26**			**American River - between Northrop Ave and Stae Route 160 (Erosion Deficiency); Reach Length - 1100 LF; Levee Work = 950 LF (Rock Trench)**
1641	**Design**	0		**261 days**	**Wed 10/2/24**	**Wed 10/1/25**		**1646**	
1645	**Pre-Construction**	0		**77 days**	**Thu 10/2/25**	**Fri 1/16/26**		**1655FS+212 days**	
1654	**Constr - Levees (Eros Prot)**	**0**		**87.5 days**	**Mon 8/3/26**	**Fri 10/23/26**			**seasonal construction window is approximately 4/1 - 11/30 (sans plantings); placement of rock in water is limited to 8/1 - 11/30**
1672	**Plant Maintenance, ARN, Reach B**	0		783 days	Fri 10/23/26	Wed 10/24/29			
1673	**Plant Establishment Watering**	**1**	**LS**	**783 days**	**Fri 10/23/26**	**Wed 10/24/29**			**extends 3 years past finish of initial plant establishment**
1677	**Design & Construction - ARN, Reach D**	**0**		**1346 days**	**Thu 10/1/20**	**Fri 11/28/25**			**Between Arcade Blvd & Marysville Blvd (SEEPAGE, HEIGHT Deficiencies); Reach Length - 10,965 LF**
1678	**Design**	0		**1044 days**	**Thu 10/1/20**	**Tue 10/1/24**		**1888SS+261 days**	
1684	**Pre-Construction**	0		**77 days**	**Wed 10/2/24**	**Thu 1/16/25**		**1694SS+195 days**	
1693	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**257.5 days**	**Wed 4/2/25**	**Fri 11/28/25**			**seasonal construction window is approximately 4/1 - 10/31 - assumes work will proceed from both ends of the reach in order to finish in one construction season**
1886	**Design & Construction - ARN, Reach E**	**0**		**1346 days**	**Fri 10/1/21**	**Mon 11/30/26**			**Between Scoles Ct and High St (SEEPAGE, HEIGHT Deficiencies); Reach Length - 11,155 LF**
1887	**Design**	0		**1044 days**	**Fri 10/1/21**	**Wed 10/1/25**		**2165SS+783 days**	
1893	**Pre-Construction**	0		**77 days**	**Thu 10/2/25**	**Fri 1/16/26**		**1903SS+195 days**	

ID	Task Name	Number1	Unit	Duration	Start	Finish	Predecessors	Successors	Notes
1902	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**258.75 days**	**Thu 4/2/26**	**Mon 11/30/26**			**seasonal construction window is approximately 4/1 - 10/31 (sans reveg, demob, etc) - assumes work will proceed from both ends of the reach in order to finish in one construction season**
2163	**Design & Construction - ARN, Reach I**	**0**		**730 days**	**Wed 10/2/24**	**Wed 7/21/27**			**Between State Route 160 and just West of Arcade Blvd (SEEPAGE, HEIGHT Deficiencies(; Reach Length - 8330 LF; Levee Work = 2850 LF (Height Improvements) & 2450 LF (Seepage Improvements)**
2164	**Design**	0		**544 days**	**Wed 10/2/24**	**Mon 11/2/26**			
2170	**Pre-Construction**	0		**77 days**	**Tue 11/3/26**	**Wed 2/17/27**			
2179	**Constr - Relocations & Levees (Seepage & Stability)**	**0**		**83.75 days**	**Tue 5/4/27**	**Wed 7/21/27**			**seasonal construction window is approximately 4/1 - 10/31; schedule of various sites is uncertain, but assuming work is sequential the duration fits in the construction window**
2202	**PROJECT COMPLETION**	*0*		1 day	Tue 12/25/29	Wed 12/26/29	1005,247,251,25		

US Army Corps
of Engineers®

American River Common Features - General Reevaluation Report
Project Cost and Schedule Risk Analysis Report

Prepared for:

U.S. Army Corps of Engineers,
Sacramento District

Prepared by:

U.S. Army Corps of Engineers
Cost Engineering Technical Center of Expertise, Walla Walla, WA

December 2, 2015

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EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), Sacramento District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the American River Common Features - GRR. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a *Monte-Carlo* based risk analysis was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommended 80% confidence level of successful execution to project completion.

A post authorization change report has been prepared to document a general reevaluation study of the American River Common Features (ARCF) project for the City of Sacramento and surrounding areas, which is one of the most at risk areas for flooding in the United States due to its location at the confluence and within the floodplain of the American and Sacramento rivers. This General Reevaluation Report (GRR) addresses the flood risk management system for the American and Sacramento Rivers and five other smaller channels.

Specific to the American River Common Features GRR, the current project base cost for the National Economic Development (NED) estimate, approximates $946.0M and for the Locally Preferred Plan (LPP) approximates $1,135.4M, both pre-contingency and expressed in FY 2015 dollars. This CSRA study included all estimated construction costs, Planning, Engineering, Design and Construction Management costs. It excluded Real Estate Costs, where contingencies were provided by the Real Restate office. Based on the results of the analysis, the Cost Engineering Mandatory Center of Expertise for Civil Works (MCX located in Walla Walla District) recommends a contingency value of $255.4M or approximately 27% of base project cost for the NED and $317.9M or approximately 28% of base project cost for the LPP at an 80% confidence level of successful execution.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based in cost and per cent values. Should cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, cost values rounded.

Table ES-1A. Construction Contingency Results - NED

Base Case Construction Cost Estimate	**$946,007,000 ***		
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**	**Contingency $**
50%	$1,163,589,000	23%	$217,582,000
80%	**$1,201,429,000**	**27%**	**$255,422,000 ***
90%	$1,229,809,000	30%	$283,802,000

* Excludes 01 – Lands and Damages Costs, Provided by Others

Table ES-1B. Construction Contingency Results - LPP

Base Case Construction Cost Estimate	**$1,135,382,000 ***		
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**	**Contingency $**
50%	$1,396,520,000	23%	$261,138,000
80%	**$1,453,289,000**	**28%**	**$317,907,000 ***
90%	$1,475,997,000	30%	$340,615,000

* Excludes 01 – Lands and Damages Costs, Provided by Others

KEY FINDINGS/OBSERVATIONS/ASSUMPTIONS & RECOMMENDATIONS

The PDT worked through the risk register in December 2014. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $255.4M for the NED Plan and contingency of $317.9M for the LPP Plan and schedule risks adding a potential 120 months; all at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk items of include:

- ET1 – Estimate Quantities – Quantities could vary significantly. No PED level survey is available. No specific designs/quantities based on surveyed cross sections have been developed.
- ET6 – Level of Estimate – Detailed crews and construction methodology have been used in development of the feasibility estimate, but typical cost variations associated with a type 3 estimate should still be anticipated. Crews, assemblies, productivities, and methodologies in the current estimate, while acceptable and reasonable, may not adequately capture ultimate actual contractor technique and

costs. Actual contractor rates are likely to be different than assumed in the estimate. Estimate assumes contractor markups of 13% Job Office Overhead and 10% Home Office Overhead. These Rates could be understated.

Moderate risks, when combined, can also become a cost impact.

- CA1 – Small Business vs Full and Open – Much of this work is conducive for small business contracts. The estimate currently assumes full and open contracts. If individual sites are advertised via Small Business, 8(a) contractors, anticipate additional contract acquisition costs, construction costs and district resources for oversight and administration.
- PR4 – Project Authorization – With submittal of Chief's Report, the project will be awaiting authorization. Chief's Report is scheduled for next year. Next WRDA is scheduled for 2016 but realistically could slip 5 years or more based on current authorization cycle.
- CO6 – Specialized Construction Limiting Competition – Currently some 5 contractors in the area can do slurry wall construction. Deep Soil Mixing has even more limited competition. Multiple contracts between this project and others will be competing for the limited number of construction contractors capable of performing the work.
- CO1 – Modifications and Claims – There is inherent risk of construction modifications and claims that arise after contract award due to issues such as weather, schedules dictated by O&M cycles, differing site conditions, user directed changes or omissions, inaccurate surveys, and variations in estimated quantities.

Schedule Risks: The high value of schedule risk indicates a significant uncertainty of key risk items, time duration growth that can translate into added costs. Over time, risks increase on those out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The greatest risk is:

- PR4 – Project Authorization – With submittal of Chief's Report, the project will be awaiting authorization. Chief's Report is scheduled for next year. Next WRDA is scheduled for 2016 but realistically could slip 5 years or more based on current authorization cycle.
- PM7 – Competing Project Resources – SPK District has multiple high profile ongoing projects all competing for limited resources both in house and in the vertical chain.

Moderate risks, when combined, can also become a time and resulting cost impact.

- CO10 – Utility Relocations – Utility relocations will require coordination with affected parties. From experience, relocations of KNOWN utilities is not a major issue. Relocations only become problematic when unknown utilities are encountered which has been accounted for in Unknown Utilities Risk.
- PM8 – Internal Red Tape and Timely Review Processes – Project has already experienced delays due to timeliness of leadership decisions and direction. It's anticipated this will continue to be ongoing issue.

Recommendations: The CSRA study serves as a "road map" towards project improvements and reduced risks over time. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

MAIN REPORT

1.0 PURPOSE

Within the authority of the US Army Corps of Engineers (USACE), Sacramento District, this report presents the efforts and results of the cost and schedule risk analysis for the American River Common Features GRR. The report includes risk methodology, discussions, findings and recommendations regarding the identified risks and the necessary contingencies to confidently administer the project, presenting a cost and schedule contingency value with an 80% confidence level of successful execution.

2.0 BACKGROUND

A post authorization change report has been prepared to document a general reevaluation study of the American River Common Features (ARCF) project for the City of Sacramento and surrounding areas, which is one of the most at risk areas for flooding in the United States due to its location at the confluence and within the floodplain of the American and Sacramento rivers. This General Reevaluation Report (GRR) addresses the flood risk management system for the American and Sacramento Rivers and five other smaller channels.

3.0 REPORT SCOPE

The scope of the risk analysis report is to identify cost and schedule risks with a resulting recommendation for contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for cost risks for construction features. The CSRA does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the Micro Computer Aided Cost Estimating System (MCACES) cost estimate, project schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates and schedules were developed and presented by the District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of concerns, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2 USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering MCX. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.

- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008.

- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

4.0 METHODOLOGY / PROCESS

The Cost Engineering MCX performed the Cost and Schedule Risk Analysis, relying on local District staff to provide expertise and information gathering. The District PDT

conducted initial risk identification via meetings with the Walla Walla Cost Engineering MCX facilitator in December 2014. The initial risk identification meeting also included qualitative analysis to produce a risk register that served as the draft framework for the risk analysis.

Participants in the risk identification meeting in December 2-3, 2014 included:

Name	Office	Representing
Robert Vrchoticky	Cost Engineer	Sacramento - SPK
Pete Ghelfi	SAFCA	Sponsor
Dan Tibbitts	Project Manager	Sacramento - SPK
Timi Shimabukuo	Economics	Sacramento - SPK
Liz Holland	Environmental Planner	Sacramento - SPK
Melissa Montag	Cultural Resources	Sacramento - SPK
John Hoge	Project Manager	Sacramento - SPK
Mark Boedtker	Civil Engineer	Sacramento – SPK
Jesse Schlunegger	Hydraulic Engineer	Sacramento - SPK
Ajala Ali	DWR	Sponsor
Bob Scarborough	DWR	Sponsor
James Elsberry	Civil Engineer	Sacramento - SPK
Shauna England	Construction	Sacramento - SPK
Andrew Muha	Planner	Sacramento - SPK
Sara Schultz	Planner	Sacramento - SPK
Rachel Rosas	Contracting	Sacramento - SPK
William Bolte	Risk Facilitator	Walla Walla - NWW

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve the desired level of cost confidence. Per regulation and guidance, the P80 confidence level (80% confidence level) is the normal and accepted cost confidence level. District Management has the prerogative to select different confidence levels, pending approval from Headquarters, USACE.

In simple terms, contingency is an amount added to an estimate to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost MCX guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk averse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would

be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.
The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

A formal PDT meeting was held with the District office for the purposes of identifying and assessing risk factors. The meeting included capable and qualified representatives from multiple project team disciplines and functions, including project management, cost engineering, design, environmental compliance, real estate, construction, contracting and representatives of the sponsoring agencies.

The initial formal meetings focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Additionally, numerous conference calls and informal meetings were conducted throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment. An update meeting was held for finalization of the risk register, resulting CSRA model, findings and results.

4.2 Quantify Risk Factor Impacts

The quantitative impacts (putting it to numbers of cost and time) of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were quantified using probability

distributions (density functions) because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable
- Nature of the probability density function used to approximate risk factor uncertainty
- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

The resulting product from the PDT discussions is captured within a risk register as presented in section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5.0 PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the project.

a. The District provided MII MCACES (Micro-Computer Aided Cost Estimating Software) files electronically. The MII and CWE files transmitted and on September 9, 2015 and resulting independent review, served as the basis for the final cost and schedule risk analyses.

b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level of design.

c. Schedules are analyzed for impact to the project cost in terms of delayed funding, uncaptured escalation (variance from OMB factors and the local market) and unavoidable fixed contract costs and/or languishing federal administration costs incurred throughout delay.

d. The Cost Engineering MCX guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.

e. Only high and moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation, and reviewed at each project milestone to determine if they should be placed on the risk “watch list”.

6.0 RESULTS

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in Appendix A. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Contingency and Sensitivity Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project cost at intervals of confidence (probability).

Table 1 provides the construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P5, P50 and P90 confidence levels are also provided for illustrative purposes only.

Table 1A. Construction Cost Contingency Summary – NED

Base Case Construction Cost Estimate	**$946,007,000 ***		
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**	**Contingency $**
50%	$1,163,589,000	23%	$217,582,000
80%	**$1,201,429,000**	**27%**	**$255,422,000 ***
90%	$1,229,809,000	30%	$283,802,000

* Excludes 01 – Lands and Damages Costs, Provided by Others

Table 1B. Construction Cost Contingency Summary – LPP

Base Case Construction Cost Estimate	**$1,135,382,000 ***		
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**	**Contingency $**
50%	$1,396,520,000	23%	$261,138,000
80%	**$1,453,289,000**	**28%**	**$317,907,000 ***
90%	$1,475,997,000	30%	$340,615,000

* Excludes 01 – Lands and Damages Costs, Provided by Others

6.2.1 Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

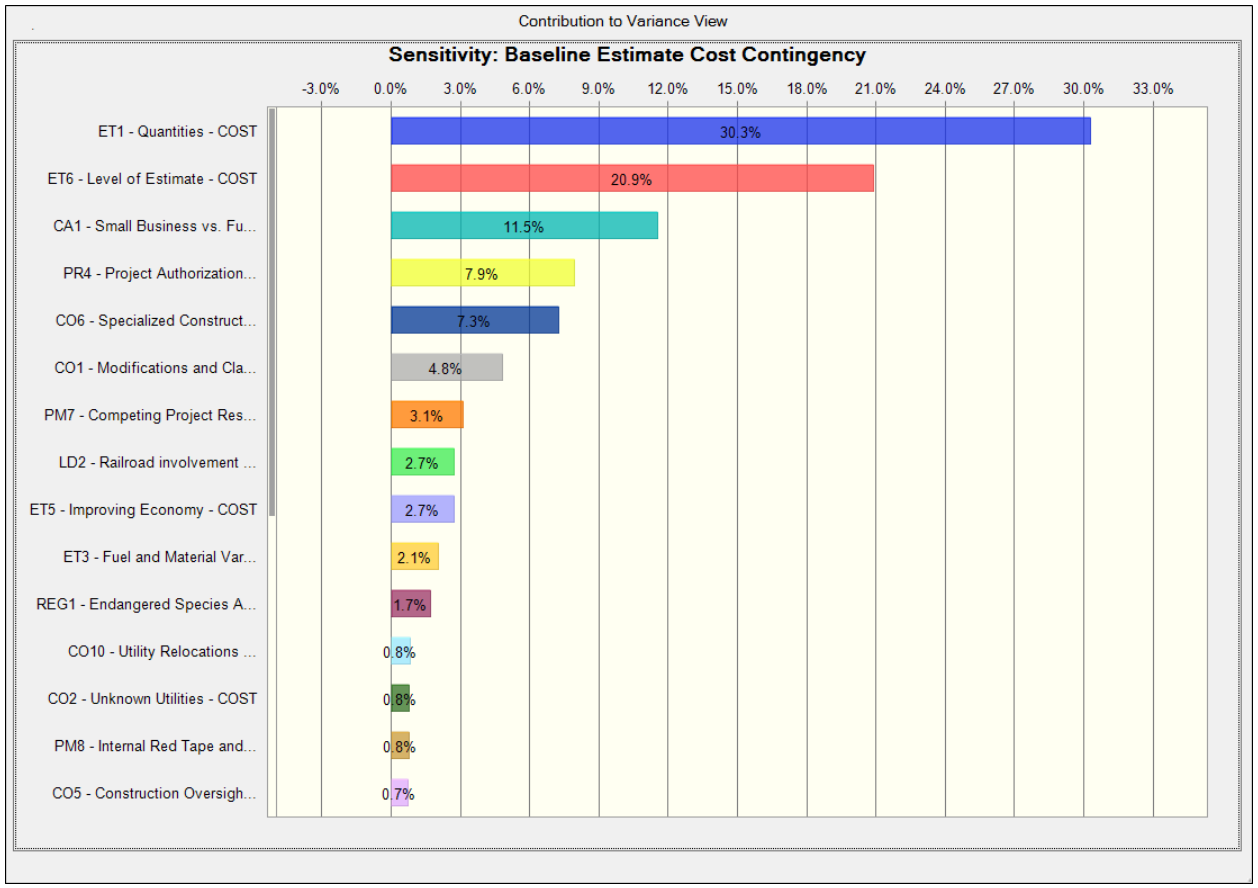
Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

6.2.2 Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers and the respective value variance are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 1 presents a sensitivity analysis for cost growth risk from the high level cost risks identified in the risk register. Likewise, Figure 2 presents a sensitivity analysis for schedule growth risk from the high level schedule risks identified in the risk register.

Figure 1. Cost Sensitivity Analysis



6.3 Schedule and Contingency Risk Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project duration at intervals of confidence (probability).

Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P90 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 120 months based on the P80 level of confidence. These contingencies were used to calculate the projected residual fixed cost impact of project delays that are included in the Table 1 presentation of total cost contingency. The schedule contingencies were calculated by applying the high level

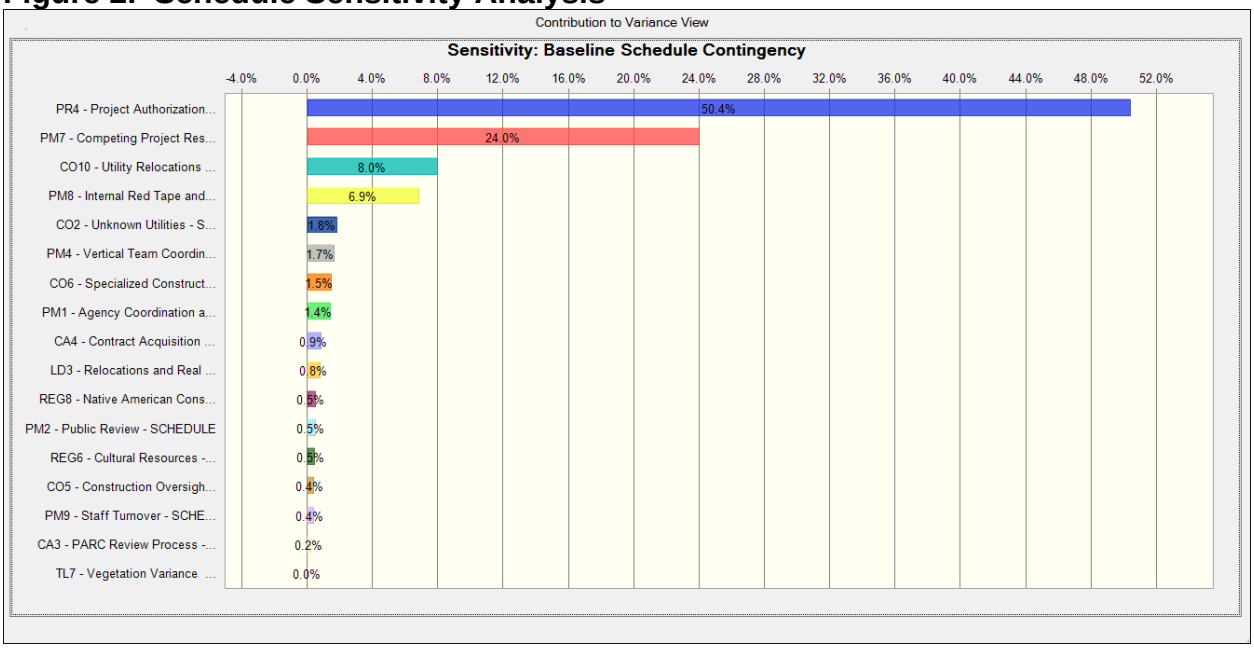
schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs.

Table 2. Schedule Duration Contingency Summary

Risk Analysis Forecast (base schedule of 174 months)	Duration w/ Contingencies (months)	Contingency[1] (months)
50% Confidence	275	101
80% Confidence	394	120
90% Confidence	305	131

Figure 2. Schedule Sensitivity Analysis



7.0 MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. Because of

the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1 Major Findings/Observations

Project cost and schedule comparison summaries are provided in Table 3 and Table 4 respectively. Additional major findings and observations of the risk analysis are listed below.

The PDT worked through the risk register in December 2014. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $255.4M for the NED Plan and contingency of $317.9M for the LPP Plan and schedule risks adding a potential 120 months; all at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk items of include:

- ET1 – Estimate Quantities – Quantities could vary significantly. No PED level survey is available. No specific designs/quantities based on surveyed cross sections have been developed.
- ET6 – Level of Estimate – Detailed crews and construction methodology have been used in development of the feasibility estimate, but typical cost variations associated with a type 3 estimate should still be anticipated. Crews, assemblies, productivities, and methodologies in the current estimate, while acceptable and reasonable, may not adequately capture ultimate actual contractor technique and costs. Actual contractor rates are likely to be different than assumed in the estimate. Estimate assumes contractor markups of 13% Job Office Overhead and 10% Home Office Overhead. These Rates could be understated.

Moderate risks, when combined, can also become a cost impact.

- CA1 – Small Business vs Full and Open – Much of this work is conducive for small business contracts. The estimate currently assumes full and open contracts. If individual sites are advertised via Small Business, 8(a) contractors, anticipate additional contract acquisition costs, construction costs and district resources for oversight and administration.
- PR4 – Project Authorization – With submittal of Chief's Report, the project will be awaiting authorization. Chief's Report is scheduled for next year. Next WRDA is scheduled for 2016 but realistically could slip 5 years or more based on current authorization cycle.
- CO6 – Specialized Construction Limiting Competition – Currently some 5 contractors in the area can do slurry wall construction. Deep Soil Mixing has even more limited competition. Multiple contracts between this project and others will be competing for the limited number of construction contractors capable of performing the work.

- CO1 – Modifications and Claims – There is inherent risk of construction modifications and claims that arise after contract award due to issues such as weather, schedules dictated by O&M cycles, differing site conditions, user directed changes or omissions, inaccurate surveys, and variations in estimated quantities.

Schedule Risks: The high value of schedule risk indicates a significant uncertainty of key risk items, time duration growth that can translate into added costs. Over time, risks increase on those out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The greatest risk is:

- PR4 – Project Authorization – With submittal of Chief's Report, the project will be awaiting authorization. Chief's Report is scheduled for next year. Next WRDA is scheduled for 2016 but realistically could slip 5 years or more based on current authorization cycle.
- PM7 – Competing Project Resources – SPK District has multiple high profile ongoing projects all competing for limited resources both in house and in the vertical chain.

Moderate risks, when combined, can also become a time and resulting cost impact.

- CO10 – Utility Relocations – Utility relocations will require coordination with affected parties. From experience, relocations of KNOWN utilities is not a major issue. Relocations only become problematic when unknown utilities are encountered which has been accounted for in Unknown Utilities Risk.
- PM8 – Internal Red Tape and Timely Review Processes – Project has already experienced delays due to timeliness of leadership decisions and direction. It’s anticipated this will continue to be ongoing issue.

Table 3A. Construction Cost Comparison Summary (Uncertainty Analysis) – NED

PROJECT FIRST COST BASE ESTIMATE	$946,007,000		
Confidence Level	**Project First Cost**	**Contingency**	**Contingency %**
0%	$974,387,210	$28,380,210	3.00%
5%	$1,078,447,980	$132,440,980	14.00%
10%	$1,097,368,120	$151,361,120	16.00%
15%	$1,106,828,190	$160,821,190	17.00%
20%	$1,116,288,260	$170,281,260	18.00%
25%	$1,125,748,330	$179,741,330	19.00%
30%	$1,135,208,400	$189,201,400	20.00%
35%	$1,144,668,470	$198,661,470	21.00%
40%	$1,144,668,470	$198,661,470	21.00%
45%	$1,154,128,540	$208,121,540	22.00%
50%	$1,163,588,610	$217,581,610	23.00%
55%	$1,163,588,610	$217,581,610	23.00%
60%	$1,173,048,680	$227,041,680	24.00%
65%	$1,182,508,750	$236,501,750	25.00%
70%	$1,191,968,820	$245,961,820	26.00%
75%	$1,191,968,820	$245,961,820	26.00%
80%	**$1,201,428,890**	**$255,421,890**	**27.00%**
85%	$1,220,349,030	$274,342,030	29.00%
90%	$1,229,809,100	$283,802,100	30.00%
95%	$1,248,729,240	$302,722,240	32.00%
100%	$1,371,710,150	$425,703,150	45.00%

Table 3B. Construction Cost Comparison Summary (Uncertainty Analysis) – LPP

PROJECT FIRST COST BASE ESTIMATE	$1,135,382,000		
Confidence Level	**Project First Cost**	**Contingency**	**Contingency %**
0%	$1,169,443,460	$34,061,460	3.00%
5%	$1,305,689,300	$170,307,300	15.00%
10%	$1,317,043,120	$181,661,120	16.00%
15%	$1,339,750,760	$204,368,760	18.00%
20%	$1,351,104,580	$215,722,580	19.00%
25%	$1,351,104,580	$215,722,580	19.00%
30%	$1,362,458,400	$227,076,400	20.00%
35%	$1,373,812,220	$238,430,220	21.00%
40%	$1,385,166,040	$249,784,040	22.00%
45%	$1,385,166,040	$249,784,040	22.00%
50%	$1,396,519,860	$261,137,860	23.00%
55%	$1,407,873,680	$272,491,680	24.00%
60%	$1,407,873,680	$272,491,680	24.00%
65%	$1,419,227,500	$283,845,500	25.00%
70%	$1,430,581,320	$295,199,320	26.00%
75%	$1,441,935,140	$306,553,140	27.00%
80%	**$1,453,288,960**	**$317,906,960**	**28.00%**
85%	$1,464,642,780	$329,260,780	29.00%
90%	$1,475,996,600	$340,614,600	30.00%
95%	$1,498,704,240	$363,322,240	32.00%
100%	$1,646,303,900	$510,921,900	45.00%

Table 4. Construction Schedule Comparison Summary (Uncertainty Analysis)

Base Schedule Duration	174.0 Months		
Confidence Level	**Duration**	**Contingency**	**Contingency %**
0%	217.5 Months	43.5 Months	25.00%
5%	245.3 Months	71.3 Months	41.00%
10%	250.6 Months	76.6 Months	44.00%
15%	255.8 Months	81.8 Months	47.00%
20%	259.3 Months	85.3 Months	49.00%
25%	262.7 Months	88.7 Months	51.00%
30%	264.5 Months	90.5 Months	52.00%
35%	268.0 Months	94.0 Months	54.00%
40%	269.7 Months	95.7 Months	55.00%
45%	273.2 Months	99.2 Months	57.00%
50%	274.9 Months	100.9 Months	58.00%
55%	278.4 Months	104.4 Months	60.00%
60%	280.1 Months	106.1 Months	61.00%
65%	283.6 Months	109.6 Months	63.00%
70%	287.1 Months	113.1 Months	65.00%
75%	290.6 Months	116.6 Months	67.00%
80%	**294.1 Months**	**120.1 Months**	**69.00%**
85%	297.5 Months	123.5 Months	71.00%
90%	302.8 Months	128.8 Months	74.00%
95%	311.5 Months	137.5 Months	79.00%
100%	351.5 Months	177.5 Months	102.00%

7.2 Recommendations

Risk Management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute's (PMI) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, *4th edition*, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that the proactive management of risks not conclude with the study completed in this report.

The Cost and Schedule Risk Analysis (CSRA) produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

The CSRA study serves as a "road map" towards project improvements and reduced risks over time. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

Risk Management: Project leadership should use of the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

Risk Analysis Updates: Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and reevaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

APPENDIX A

American River Common Features - ALT 1 (NED)

Risk Matrix

Likelihood of Occurrence	Impact or Consequence of Occurrence				
	Negligible	Marginal	Significant	Critical	Crisis
Certain	Moderate	Moderate	High	High	High
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	Moderate

Overall Project Scope

A post authorization change report has been prepared to document a general reevaluation study of the American River Common Features (ARCF) project for the City of Sacramento and surrounding areas, which is one of the most at risk areas for flooding in the United States due to its location at the confluence and within the floodplain of the American and Sacramento rivers. This General Reevaluation Report (GRR) addresses the flood risk management system for the American and Sacramento Rivers and five other smaller channels.

SEE ASSUMPTIONS TAB FOR COST VALUE RANGES DEVELOPMNENT

Negligible---	***Less than***		**$4,730,035**
Marginal ---	***between***	**$4,730,036**	**and $18,920,140**
Significant ---	***between***	**$18,920,141**	**and $28,380,210**
Critical---	***between***	**$28,380,211**	**and $47,300,350**
Crisis ---	***Over***	**$47,300,351**	

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule			
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)											
	PROJECT & PROGRAM MGMT										
PM1	Agency Coordination and Review	Multiple outside agency reviews remain outstanding and could have significant impacts on project scope.	Multiple SPK USACE projects are going through similar review processes by outside agencies resulting in resource bottlenecks. Typical review timelines may no longer be accurate. It is anticipated schedules could slip 6 to 12 months over the life of the project due to delays in outside agency reviews.	Very Unlikely	Marginal	LOW		Likely	Marginal	MODERATE	
PM2	Public Review	Timeline may not include sufficient time to address public comments and concerns as a result of the public review process.	Major public concerns include acquisition of multiple private properties, loss of wildlife/recreation due to rock placement on the American River. Schedule could slip 3 to 6 months due to public comments. Recirculation or redesign are not anticipated.	Very Unlikely	Negligible	LOW		Likely	Marginal	MODERATE	
PM3	Cost Sharing Agreement	Discussions are ongoing about the cost share for the LPP and the Sacramento Bypass.	Some $100+ Million in cost sharing remain in discussion. A resolution is anticipated within the next 3 to 6 months, which would not impact project schedule. If the sponsor is responsible for the additional $100+ Million cost it is anticipated the sponsor would continue and the LPP design would not change.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PM4	Vertical Team Coordination and Review	System Wide Improvement Framework (SWIF) approval and review by the vertical team.	Vertical team review and approval of the SWIF plan will be required when submitted. It is possible vertical team review could delay schedule 6 to 12 months. Denial of the SWIF would result in sponsors withdrawing from the project and is not modeled in this analysis.	Unlikely	Critical	MODERATE		Unlikely	Critical	MODERATE	
PM5	Project Partnership Agreement Signature	PPA signature will be required.	PPA will be contingent on Cost Sharing Agreement and SWIF approval (captured elsewhere). Once those risks have been resolved, PPA signature will not present an issue.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PM6	Pressure to Compress and Accelerate Schedule	The baseline project assumes an approximate 10 year construction schedule. This deadline came together as a conglomerate of political pressure, anticipated funding levels, staffing levels and managerial judgment.	Schedule is aggressive. All risks of schedule delay have been captured elsewhere in the risk model.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	

PM7	Competing Project Resources	SPK District has multiple high profile ongoing projects all competing for limited resources both in house and in the vertical chain.	ARCF has been a priority project and it is anticipated that it is possible with senior leadership support this project will continue to receive sufficient support, either through internal staffing or through contractual support or with other districts. Work being accomplished by the Sponsor under the 408 process could mitigate staffing requirements. Best case, resource will be sufficiently allocated and no schedule slip; most likely schedule will slip 2 years and worst case schedule could slip 4 years due to staffing shortfalls.	Likely	Marginal	MODERATE		Likely	Significant	HIGH	
PM8	Internal Red Tape and Timely Review Processes	Project has already experienced delays due to timeliness of leadership decisions and direction.	It's anticipated this will continue to be ongoing issue. Schedule could slip another 12 to 24 months over the life of the project. This risk is modeled in correlation with Competing Project Resources.	Very Unlikely	Negligible	LOW		Likely	Significant	HIGH	
PM9	Staff Turnover	Both PDT and Vertical Chain turnover will be an issue resulting in potential project delays as new team members must be brought on board.	Turnover will continue to be an issue. Learning curves will result in inefficiencies and project delays.	Very Unlikely	Negligible	LOW		Likely	Marginal	MODERATE	
	CONTRACT ACQUISITION RISKS										
CA1	Small Business vs. Full and Open	Potential for Small Business Contracts	Much of this work is conducive for small business contracts. The estimate currently assumes full and open contracts. If individual sites are advertised via Small Business, 8(a) contractors, anticipate additional contract acquisition costs, construction costs and district resources for oversight and administration. Assume 30% of the project could be awarded small business with a 20% increase in construction costs.	Likely	Significant	HIGH		Very Unlikely	Negligible	LOW	
CA2	Numerous Contracts	Contracts will attempt to group sites by Fiscal Year wherever practical to minimize the number of individual contracts.	Efforts will be made to minimize number of contracts, but funding constraints, accelerated schedules, limited design resources and site locations could all result in numerous construction contracts. Estimate currently assumes minimal number of contracts. Assume costs could increase marginally due to additional contracts with additional mob/demob, inefficiencies and contract administration costs.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
CA3	PARC Review Process	Several of these construction contracts may be large enough to require PARC review.	PARC review could delay schedules to allow significant time for review. PARC will review to insure that large contracts contain all the same types of work and are bundled projects and full and open procurement is justified. Contracting Market Research and submittal to the PARC should begin at or before 90% design to insure enough time for sufficient review.	Unlikely	Marginal	LOW		Likely	Marginal	MODERATE	
CA4	Contract Acquisition Strategy	Concerns exist for awarding contracts of this magnitude on LPTA / IFB. Contracting Officer reserves the rights to enter into discussions with Offerors to gain a thorough understanding of the contractors approach.	Trade Off approach opens the contract to subjective judgment and can result in potential higher costs and schedule delays. From experience Best Value / Trade Off can extend the contract award 4 months and could result in protest.	Likely	Marginal	MODERATE		Unlikely	Significant	MODERATE	
	TECHNICAL RISKS										
TL1	HTRW	HTRW could be encountered during site excavation and construction.	Known HTRW Landfill site will be handled by Sponsor. Hazardous Waste Remediation for Real Estate procurement is not a project cost (per CERCLA). Minor HTRW issues may be encountered (asbestos on pipe relocations). Borings will be done in a proactive attempt to locate any HTRW. Estimate currently assumes no HTRW is located. It can be assumed 5 to 8 sites could discovered at a cost of $500K EA. If sites are encountered, individual areas will be skipped, remediated and then completed under existing contract or a follow on contract. This approach has been taken on other sites in ARCF and has worked effectively. No schedule impacts are anticipated.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	

TL2	Exploratory Borings	Limited exploratory borings have been taken on the North Levee of the Bypass. Additional geotechnical investigation will be required.	Depending on exploratory results, site specific design could change. Current North Levee Design is very conservative. If anything, design requirements could be reduced. Design changes are anticipated to be marginal.	Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL3	Borrow/Fill Sources	Borrow sources have not been located. It is typically the contractors responsibility to procure borrow material.	Estimate assumes 80% excavated material for South Sites and 20% excavated material for North Site will be disposed of offsite and new material will be brought onsite. Based on NRCS data a 20-25 mile radius was evaluated. Sufficient borrow sites were readily available, but will be dependent on willingness of sellers. Availability of borrow material could present an issue and haul distances could increase. As mitigation, some 1.5M cubic yards in excess material may become available from the sewage treatment plant. Sac Bypass expansion could be another source for borrow material.	Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL4	Rip Rap Supply	Rock quarry availability over time.	Rock placement locations and the volume of rock required is a substantial amount under the current estimates; availability of that magnitude may not be readily available. Estimate currently assumes all Rip Rap will be supplied via barge and placed by either river or land (location dependent). It is believed sufficient quantities will be available over the 20year of the project but may need to be shipped via truck depending on where rock is available from. From similar experience on other local projects with both barge and land placements, cost impacts between differences in truck and barge appear neutral depending on location.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL5	Design Criteria and Assumptions	Given extended project timeline (10yrs or more) revised criteria could result in update designs requirements.	Design criteria changes have lead to changes for projects put "on the shelf". When projects are awarded additional design updates are required with marginal construction cost increases.	Unlikely	Significant	MODERATE		Very Unlikely	Negligible	LOW	
TL6	Design Assumptions	Current construction and design are all based on certain core design assumptions and principals. Changes to those assumptions would result in significant design re-work.	Many similar USACE sites have been constructed. If inspections of constructed sites show current design methodology (slurry wall) is not performing as expected designs could change resulting in significant design re-work.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL7	Vegetation Variance	Project will require a Vegetation Variance to allow riverside vegetation.	Without the Vegetation Variance the project would likely be in danger of receiving a Jeopardy Opinion from resource agencies resulting in the project going through a reformulation. This reformulation process could significantly impact both time and budget for the project.	Very Unlikely	Crisis	HIGH		Very Unlikely	Crisis	HIGH	
TL8	Consideration of Upstream Storage alternative and other screening alternatives	Upstream detention has been screened and eliminated with vertical team approval. If upstream detention were to be included project would not proceed.	Schedule impacts are not anticipated.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL9	Design Development	Scope is based on selected plan feasibility designs. Typical cross sections were developed for reaches. Overall the design is conservative. As an example the estimate currently includes some 9 miles of cutoff wall remediation. Existing design refinements by the sponsor have shown cutoff walls may be needed for 7 miles or less. As a whole, the design requirements are much more likely to decrease as opposed to increase.	There is a uncertainty level inherent with feasibility level designs. Expect negligible scope/cost changes as designs are further refined.	Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL10	As Built Design	Existing Construction was an issue on previous American River construction.	Current design does not rely on existing features and this will not be an issue for this project. In areas where construction projects will overlap, learning from the past, every effort will be made to insure accurate as-builts are created.	Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	
	LANDS AND DAMAGES RISKS										

LD1	Borrow Sites	Potential borrow sites have been located but Real Estate costs do not include procurement costs. It is the responsibility of the contractor to procure borrow material. Borrow material costs in the construction estimate captures all incidental costs to procure real estate.	Multiple potential sites have been located sufficient to supply material for this project. Estimate has conservatively assumed commercial procurement of all material. If the contractor chooses to pursue their own material, it is assumed costs would only decrease.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
LD2	Railroad involvement	Several temporary and permanent easements will be required. Any railroad parcels acquisitions are time consuming and costs vary depending on what railroad charges with no set rates.	Construction schedule has most interactions with the railroad occurring later in the project. Railroad should be engaged early in the project to insure timely resolution. Weir widening will require relocation and integration with Yolo RR. Estimate will require additional costs for temporary closure and disruption of RR service. Estimate includes a $5M lump sum to reflect costs to the RR.	Likely	Significant	HIGH		Very Unlikely	Negligible	LOW	
LD3	Relocations and Real Estate Acquisitions may not happen in time	Relocations can be delayed by unwilling sellers.	Objections to appraisals take more time and funding. If sellers choose to hire attorney and go to court and with judge and jury can delay relocations by over 6 months. With proper management, individual acquisitions may slip schedule but the overall project schedule should not be delayed. Construction would occur in areas where real estate does not hinder project schedule.	Very Unlikely	Negligible	LOW		Likely	Marginal	MODERATE	
LD4	Staging Areas	Staging areas in heavily urban areas will present challenges	Sponsor has begun actively searching for staging areas. Real Estate has included costs at a ratio of 1 acre staging area for every 1 mile of levee. Estimate currently includes fairly long haul distances (say 4miles) for staging areas. Pumping equipment for some cutoff wall construction may need to occur on riverside of levee. Estimate may need to include additional for re-establishment of parks after construction has completed.	Very Likely	Marginal	MODERATE		Unlikely	Negligible	LOW	
LD5	Vagrancy and Loitering Issues	Several homeless encampments will be encountered.	From experience, it is reasonable to assume loitering issues will be encountered. Law enforcement may need to be called and coordinated. For individual contracts this may present a minimal issue, but for overall project costs and schedules, this will be a non-issue.	Unlikely	Negligible	LOW		Unlikely	Negligible	LOW	
	REGULATORY AND ENVIRONMENTAL RISKS										
REG1	Endangered Species Act	It is possible resource agencies could provide an opinion that proposed mitigation areas are inadequate and additional will be required. In addition, species could be added to ESA.	It is likely resource agencies could require additional mitigation. The addition of species could also result in additional mitigation costs or design adaptations and changes. Review periods and iterative processes could result in minimal impacts to schedule. As a mitigation approach, Alternative 2 (LPP) could potentially use the Sacramento Bypass. Worst Case, mitigation costs could increase by 25% with offsite bank.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
REG2	Offsite Mitigation	Additional offsite mitigation could be required.	The estimate currently includes some 100 acres for elderberry mitigation and some 600 additional acres for Giant Garter Snakes. Some of this area will be mitigated offsite. These numbers are based on conservative assumptions. Additional compensation for SRA habitat may be required. Mitigation costs are very minimal relative to project costs and impacts are considered inconsequential (mitigation costs could increase some 15%). Additional offsite mitigation shouldn't impact schedule.	Likely	Marginal	MODERATE		Unlikely	Negligible	LOW	
REG3	Air Quality	Construction could require air quality credits. Air quality is legislated by local California Resource Board by county and program will overlap multiple regions.	In order to accommodate aggressive schedule, multiple sites could be constructed concurrently. Early coordination with the Air Resource Board and inclusion in State Implementation Plan could mitigate schedule delays Minimal additional construction cost impacts ($20K/MO) could be encountered.	Very Unlikely	Negligible	LOW		Unlikely	Negligible	LOW	

REG4	Water Quality	Construction could be limited due to water quality impacts.	Water quality for rock placement in the water would only have minimal potential cost impacts. Placement may require some additional costs (i.e. turbidity monitoring and potential decreased production rates) and are captured in our baseline cost estimate.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
REG5	Onsite Mitigation	Depending on Agencies, additional onsite mitigation could be required.	Resource agencies requirements for onsite mitigation continue to evolve, resulting in additional onsite mitigation requirements. ESA consultations have occurred but Biologic Opinions have not been received. Until opinions have been received, restoration ratios have not been established. Additional offsite mitigation may be required. This risk has been modeled in REG2	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
REG6	Cultural Resources	Only a limited number of surface surveys have been conducted. It is likely cultural resources could be encountered during levee construction. It is known that cultural sites were buried during initial levee construction.	Extensive additional surveys and historical records searches will be required. It is anticipated additional cultural sites will be encountered. Cultural sites encountered during construction will be much more costly then those mitigated prior to construction. By completing sufficient cultural resource identification during PED and prior to construction schedule impacts should be mitigated. If cultural resources are encountered, construction schedules could be impacted 6-12months.	Very Likely	Marginal	MODERATE		Likely	Significant	HIGH	
REG7	Noise and Vibration Controls	Construction could be impacted by noise and vibration monitoring near occupied areas.	Residents may need to be temporarily relocated, but relative to total project, cost impacts would be minimal. ESTIMATE NEEDS TO INCLUDE VIBRATION MONITORING COSTS.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
REG8	Native American Consultation - Section 106 Compliance and Government to Government	Native American tribes may challenge USACE opinions during either PED or construction.	If sensitive sites are encountered, schedule could be delayed. It is hoped that with due diligence the risk may be mitigated. Construction methodology could also dictate how many sites are found. It is considered likely a challenge will occur, resulting in a potential construction schedule delay of up to 1 month, for up to 10 separate contracts over the life of the project. It is recommended an IDIQ be established for site investigation and documentation services and construction contracts include CLINS for contract relocations when sites are encountered.	Likely	Negligible	LOW		Likely	Marginal	MODERATE	
	CONSTRUCTION RISKS										
CO1	Modifications and Claims	Modifications will be experienced on any construction project. Project Construction is heavily dependent on geotechnical design solutions.	Modifications are to be expected. Inherent with any geotechnical design comes the possibility of differing site conditions such as constructed depth of cutoff wall due to change in key in layer elevation and site geology which would not have previously been noted due to the density of explorations in a given area, groundwater chemistry issues affecting curing of the cutoff wall etc. Current design specifies a design depth plus 10ft for keying into impermeable layer. This can become vastly more expensive if additional depth could require a different construction method (i.e. standard cutoff wall to deep soil mixing). Estimate already assumes DSM, so additional depth with this approach wouldn't be significantly more expensive.	Very Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	

CO2	Unknown Utilities	A Slurry Wall was previously installed for the Sacramento River. There is a greater chance of unknown utilities on the American River, but those utilities are fewer with most located around bridges. The Bypass area is a relatively rura and few utilities are anticipated.	Marginal impacts for unknown utilities are anticipated.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
CO3	Site Access and Staging Areas	Access for slurry wall and erosion control along the Sacramento River will be difficult. American River erosion control will also be difficult.	In the Pocket Area, construction will be heavily congested in a dense urban environment and residential streets. Estimate is based on average haul times and distances but may not have sufficiently captured all costs.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO4	Construction Windows	All in water work must be completed between August 1 to Nov 30. Levee construction is limited between 15 April and 30 October. Depending on contract award dates, durations, and inefficient contractors some contracts could be limited or delayed to the following construction season.	In general this has been a minimal risk, with worst case a one season schedule slip may occur, impacting local contract schedule but not does not impact overall project schedule.	Very Unlikely	Negligible	LOW		Unlikely	Negligible	LOW	
CO5	Construction Oversight	Given the large number of potential sites/contracts per year, submittal turn around times and construction oversight could be an issue.	Based on previous experience, mods and claims have been experienced as a result of review delays (either from Construction or Engineering) leading to cost increases. It is being discussed to possibly stand up a Project Office to handle these projects.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
CO6	Specialized Construction Limiting Competition	Currently some 5 contractors in the area can do slurry wall construction. Deep Soil Mixing has even more limited competition. Multiple contracts between this project and others will be competing for the limited number of construction contractors capable of performing the work.	Limited contractor availability and competition could result in higher construction costs and even project delays if no qualified contractors are available.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
CO7	Constrained Site	Multiple locations will have tight site footprints which could constrain construction.	This risk has been captured in Staging Area Risks	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO8	Deep Soil Mixing	Deep soil mixing is fairly specialized construction feature many reaches 80ft deep and a few reaches some 130ft deep.	Schedule is highly dependent on availability of Deep Soil Mixing equipment. DSM is a majority of the length of total cutoff wall required and is a fairly slow process. Assumed Estimate Production rates appear reasonable and limited contractor competition has been accounted for elsewhere	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO9	Haul Road Resurfacing	Levee access for many locations will be through multiple residential locations.	Street resurfacing costs need to be added into the estimate.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
CO10	Utility Relocations	All impacted utilities will be left constructed in a policy compliant manner (existing deficient utilities will not be left in place). Utility relocations will require temporary supply.	Utility relocations will require coordination with affected parties. From experience, relocations of KNOWN utilities is not a major issue. Relocations only become problematic when unknown utilities are encountered which has been accounted for in Unknown Utilities Risk.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
	ESTIMATE AND SCHEDULE RISKS										
ET1	Quantities	Quantities could vary significantly. Earthwork and cutoff wall quantities are probably conservative and are likely to be reduced during PED.	No PED level survey is available. No specific designs/quantities based on surveyed cross sections has been developed. Quantities were calculated using tables with typical cross sections generated to capture the types of fixes needed along the levee as well as the existing geometry of the levee. These sections were then referenced into a dynamic spreadsheet where the type of fix, hydraulic data, and existing levee geometry were identified. Many fixes with varying levee geometry were developed and quantities did not interpolate between the fixes, but used the next larger fix (taller levee, deeper cutoff wall, etc), The spreadsheet calculated civil quantities using average end area method between stations of varying cross section.	Likely	Significant	HIGH		Very Unlikely	Negligible	LOW	
ET2	Utility Relocations	Large number and variety of requirements for utility relocations.	Variable nature of relocation requirements is difficult to quantify. Potential unknown utilities remain. VERIFY ESTIMATE INCLUDES UTILITY RELOCATION COSTS.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	

ET3	Fuel and Material Variations	Fuel Costs are a major cost driver for any large earthwork project. Bentonite availability for slurry cutoff wall construction could become a critical item.	Assume fuel prices could decrease 5% and increase 10%. Given the slurry wall construction, bentonite cost fluctuations could also have impacts on the project costs.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
ET4	Project Complexity	This is a relatively simple project consisting of mass earthwork, rock placement, DSM/slurry cutoff walls and floodwall construction. For alternative 2, the Sacramento Bypass is being widened and an adjacent weir added to allow larger bypass flows.	For contractors familiar with this type of construction, minimal cost variation or uncertainty should be anticipated.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
ET5	Improving Economy	Local economy has been improving and Government Work is becoming less attractive.	Much of this work is specialized (DSM) mitigating some of this concern. But there is the issue other construction features could experience higher prices.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
ET6	Level of Estimate	Feasibility level estimates have been developed.	Detailed crews and construction methodology have been used in development of the feasibility estimate, but typcial cost varitions associated with a type 3 estimate should still be anticipated.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
	Programmatic Risks	(External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR1	Funding Stream - Sponsor	Sponsor feels confident they can match anticipated Federal funding (say some $30M to $40M / year). For full project implementation a $140M / yr total funding stream would be required.	Sponsor anticipates being able to meet funding requirements in thru credits, LERRDs and cash.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PR2	Funding Stream - Federal	Sponsor feels confident they can match anticipated Federal funding (say some $30M to $40M / year). For full project implementation a $140M / yr total funding stream would be required.	National Civil Works Budget for Flood Risk Reduction is some $250M to $300M per year. Given the political awareness of the potential for major flood losses and the history of this project it may be reasonable to assume $100 Million per year in Federal Funding.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PR3	Weather Delays	Weather events could impact in water construction or delay start of construction windows.	It is possible construction seasons could be delayed or postponed with storm or other weather events resulting in additional construction costs but minimal overall project schedule impacts.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
PR4	Project Authorization	With submittal of Chief's Report, the project will be awaiting authorization.	Chief's Report is scheduled for next year. Next WRDA is scheduled for 2016 but realistically could slip 5 years or more based on current authorization cycle.	Very Unlikely	Negligible	LOW		Likely	Critical	HIGH	

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distributi respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

American River Common Features - ALT 2 (LPP)

Risk Matrix

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Certain	Moderate	Moderate	High	High	High
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	Moderate

Impact or Consequence of Occurrence

Overall Project Scope

A post authorization change report has been prepared to document a general reevaluation study of the American River Common Features (ARCF) project for the City of Sacramento and surrounding areas, which is one of the most at risk areas for flooding in the United States due to its location at the confluence and within the floodplain of the American and Sacramento rivers. This General Reevaluation Report (GRR) addresses the flood risk management system for the American and Sacramento Rivers and five other smaller channels.

SEE ASSUMPTIONS TAB FOR COST VALUE RANGES DEVELOPMNENT

Negligible---	***Less than***		**$5,676,910**
Marginal ---	***between***	**$5,676,911**	**and $22,707,640**
Significant ---	***between***	**$22,707,641**	**and $34,061,460**
Critical---	***between***	**$34,061,461**	**and $56,769,100**
Crisis ---	***Over***	**$56,769,101**	

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule			
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)											
	PROJECT & PROGRAM MGMT										
PM1	Agency Coordination and Review	Multiple outside agency reviews remain outstanding and could have significant impacts on project scope.	Multiple SPK USACE projects are going through similar review processes by outside agencies resulting in resource bottlenecks. Typical review timelines may no longer be accurate. It is anticipated schedules could slip 6 to 12 months over the life of the project due to delays in outside agency reviews.	Very Unlikely	Marginal	LOW		Likely	Marginal	MODERATE	
PM2	Public Review	Timeline may not include sufficient time to address public comments and concerns as a result of the public review process.	Major public concerns include acquisition of multiple private properties, loss of wildlife/recreation due to rock placement on the American River. Schedule could slip 3 to 6 months due to public comments. Recirculation or redesign are not anticipated.	Very Unlikely	Negligible	LOW		Likely	Marginal	MODERATE	
PM3	Cost Sharing Agreement	Discussions are ongoing about the cost share for the LPP and the Sacramento Bypass.	Some $100+ Million in cost sharing remain in discussion. A resolution is anticipated within the next 3 to 6 months, which would not impact project schedule. If the sponsor is responsible for the additional $100+ Million cost s is anticipated the sponsor would continue and the LPP design would not change.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PM4	Vertical Team Coordination and Review	System Wide Improvement Framework (SWIF) approval and review by the vertical team.	Vertical team review and approval of the SWIF plan will be required when submitted. It is possible vertical team review could delay schedule 6 to 12 months. Denial of the SWIF would result in sponsors withdrawing from the project and is not modeled in this analysis.	Unlikely	Critical	MODERATE		Unlikely	Critical	MODERATE	
PM5	Project Partnership Agreement Signature	PPA signature will be required.	PPA will be contingent on Cost Sharing Agreement and SWIF approval (captured elsewhere). Once those risks have been resolved, PPA signature will not present an issue.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PM6	Pressure to Compress and Accelerate Schedule	The baseline project assumes an approximate 10 year construction schedule. This deadline came together as a conglomerate of political pressure, anticipated funding levels, staffing levels and managerial judgment.	Schedule is aggressive. All risks of schedule delay have been captured elsewhere in the risk model.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	

PM7	Competing Project Resources	SPK District has multiple high profile ongoing projects all competing for limited resources both in house and in the vertical chain.	ARCF has been a priority project and it is anticipated that it is possible with senior leadership support this project will continue to receive sufficient support, either through internal staffing or through contractual support or with other districts. Work being accomplished by the Sponsor under the 408 process could mitigate staffing requirements. Best case, resource will be sufficiently allocated and no schedule slip; most likely schedule will slip 2 years and worst case schedule could slip 4 years due to staffing shortfalls.	Likely	Marginal	MODERATE		Likely	Significant	HIGH	
PM8	Internal Red Tape and Timely Review Processes	Project has already experienced delays due to timeliness of leadership decisions and direction.	It's anticipated this will continue to be ongoing issue. Schedule could slip another 12 to 24 months over the life of the project. This risk is modeled in correlation with Competing Project Resources.	Very Unlikely	Negligible	LOW		Likely	Significant	HIGH	
PM9	Staff Turnover	Both PDT and Vertical Chain turnover will be an issue resulting in potential project delays as new team members must be brought on board.	Turnover will continue to be an issue. Learning curves will result in inefficiencies and project delays.	Very Unlikely	Negligible	LOW		Likely	Marginal	MODERATE	
	CONTRACT ACQUISITION RISKS										
CA1	Small Business vs. Full and Open	Potential for Small Business Contracts	Much of this work is conducive for small business contracts. The estimate currently assumes full and open contracts. If individual sites are advertised via Small Business, 8(a) contractors, anticipate additional contract acquisition costs, construction costs and district resources for oversight and administration. Assume 30% of the project could be awarded small business with a 20% increase in construction costs.	Likely	Significant	HIGH		Very Unlikely	Negligible	LOW	
CA2	Numerous Contracts	Contracts will attempt to group sites by Fiscal Year wherever practical to minimize the number of individual contracts.	Efforts will be made to minimize number of contracts, but funding constraints, accelerated schedules, limited design resources and site locations could all result in numerous construction contracts. Estimate currently assumes minimal number of contracts. Assume costs could increase marginally due to additional contracts with additional mob/demob, inefficiencies and contract administration costs.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
CA3	PARC Review Process	Several of these construction contracts may be large enough to require PARC review.	PARC review could delay schedules to allow significant time for review. PARC will review to insure that large contracts contain all the same types of work and are bundled projects and full and open procurement is justified. Contracting Market Research and submittal to the PARC should begin at or before 90% design to insure enough time for sufficient review.	Unlikely	Marginal	LOW		Likely	Marginal	MODERATE	
CA4	Contract Acquisition Strategy	Concerns exist for awarding contracts of this magnitude on LPTA / IFB. Contracting Officer reserves the rights to enter into discussions with Offerors to gain a thorough understanding of the contractors approach.	Trade Off approach opens the contract to subjective judgment and can result in potential higher costs and schedule delays. From experience Best Value / Trade Off can extend the contract award 4 months and could result in protest.	Likely	Marginal	MODERATE		Unlikely	Significant	MODERATE	
	TECHNICAL RISKS										
TL1	HTRW	HTRW could be encountered during site excavation and construction.	Known HTRW Landfill Site will be handled by Sponsor. Hazardous Waste Remediation for Real Estate procurement is not a project cost (per CERCLA). Minor HTRW issues may be encountered (asbestos on pipe relocations). Borings will be done in a proactive attempt to locate any HTRW. Estimate currently assumes no HTRW is located. It can be assumed 5 to 8 sites could discovered at a cost of $500K EA. If sites are encountered, individual areas will be skipped, remediated and then completed under existing contract or a follow on contract. This approach has been taken on other sites in ARCF and has worked effectively. No schedule impacts	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
TL2	Exploratory Borings	Limited exploratory borings have been taken on the North Levee of the Bypass. Additional geotechnical investigation will be required.	Depending on exploratory results, site specific design could change. Current North Levee Design is very conservative. If anything, design requirements could be reduced. Design changes are anticipated to be marginal.	Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	

TL3	Borrow/Fill Sources	Borrow sources have not been located. It is typically the contractors responsibility to procure borrow material.	Estimate assumes 80% excavated material for South Sites and 20% excavated material for North Site will be disposed of offsite and new material will be brought onsite. Based on NRCS data a 20-25 mile radius was evaluated. Sufficient quantities of material were readily available, but will be dependent on willingness of sellers. Availability of borrow material could present an issue but it is unlikely that haul distances could increase because of quantities identified were orders of magnitude greater. As mitigation, some 1.5M cubic yards in excess material may become available from the sewage treatment plant. Sac Bypass expansion could be another source for borrow material.	Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL4	Rip Rap Supply	Rock quarry availability over time.	Rock placement locations and the volume of rock required is a substantial amount under the current estimates; availability of that magnitude may not be readily available. Estimate currently assumes all Rip Rap will be supplied via barge and placed by either river or land (location dependent). It is believed sufficient quantities will be available over the 20years of the project but may need to be shipped via truck depending on where rock is available from. From similar experience on other local projects with both barge and land placements, cost impacts between differences in truck and barge appear neutral depending on location.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL5	Design Criteria and Assumptions	Given extended project timeline (10yrs or more) revised criteria could result in update designs requirements.	Design criteria changes have lead to changes for projects put "on the shelf". When projects are awarded additional design updates are required with marginal construction cost increases.	Unlikely	Significant	MODERATE		Very Unlikely	Negligible	LOW	
TL6	Design Assumptions	Current construction and design are all based on certain core design assumptions and principals. Changes to those assumptions would result in significant design re-work.	Many similar USACE sites have been constructed. If inspections of constructed sites show current design methodology (slurry wall) is not performing as expected designs could change resulting in significant design re-work.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL7	Vegetation Variance	Project will require a Vegetation Variance to allow riverside vegetation.	Without the Vegetation Variance the project would likely be in danger of receiving a Jeopardy Opinion from resource agencies resulting in the project going through a reformulation. This reformulation process could significantly impact both time and budget for the project.	Very Unlikely	Crisis	HIGH		Very Unlikely	Crisis	HIGH	
TL8	Consideration of Upstream Storage alternative and other screening alternatives	Upstream detention has been screened and eliminated with vertical team approval. If upstream detention were to be included project would not proceed.	Schedule impacts are not anticipated.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL9	Design Development	Scope is based on selected plan feasibility designs. Typical cross sections were developed for reaches. Overall the design is conservative. As an example the estimate currently includes some 9 miles of cutoff wall remediation. Existing design refinements by the sponsor have shown cutoff walls may be needed for 7 miles or less. As a whole, the design requirements are much more likely to decrease as opposed to increase.	There is a uncertainty level inherent with feasibility level designs. Expect negligible scope/cost changes as designs are further refined.	Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	
TL10	As Built Design	Existing Construction was an issue on previous American River construction.	Current design does not rely on existing features and this will not be an issue for this project. In areas where construction projects will overlap, learning from the past, every effort will be made to insure accurate as-builts are created.	Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	
	LANDS AND DAMAGES RISKS										
LD1	Borrow Sites	Potential borrow sites have been located but Real Estate costs do not include procurement costs. It is the responsibility of the contractor to procure borrow material. Borrow material costs in the construction estimate captures all incidental costs to procure real estate.	Multiple potential sites have been located sufficient to supply material for this project. Estimate has conservatively assumed commercial procurement of all material. If the contractor chooses to pursue their own material, it is assumed costs would only decrease.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	

LD2	Railroad involvement	Several temporary and permanent easements will be required. Any railroad parcels acquisitions are time consuming and costs vary depending on what railroad charges with no set rates.	Construction schedule has most interactions with the railroad occurring later in the project. Railroad should be engaged early in the project to insure timely resolution. Weir widening will require relocation and integration with Yolo RR. Estimate will require additional costs for temporary closure and disruption of RR service. Estimate includes a $5M lump sum to reflect costs to the RR.	Likely	Significant	HIGH		Very Unlikely	Negligible	LOW	
LD3	Relocations and Real Estate Acquisitions may not happen in time	Relocations can be delayed by unwilling sellers.	Objections to appraisals take more time and funding. If sellers choose to hire attorney and go to court and with judge and jury can delay relocations by over 6 months. With proper management, individual acquisitions may slip schedule but the overall project schedule should not be delayed. Construction would occur in areas where real estate does not hinder project schedule.	Very Unlikely	Negligible	LOW		Likely	Marginal	MODERATE	
LD4	Staging Areas	Staging areas in heavily urban areas will present challenges	Sponsor has begun actively searching for staging areas. Real Estate has included costs at a ratio of 1 acre staging area for every 1 mile of levee. Estimate currently includes fairly long haul distances (say 4miles) for staging areas. Pumping equipment for some cutoff wall construction may need to occur on riverside of levee. Estimate may need to include additional for re-establishment of parks after construction has completed.	Very Likely	Marginal	MODERATE		Unlikely	Negligible	LOW	
LD5	Vagrancy and Loitering Issues	Several homeless encampments will be encountered.	From experience, it is reasonable to assume loitering issues will be encountered. Law enforcement may need to be called and coordinated. For individual contracts this may present a minimal issue, but for overall project costs and schedules, this will be a non issue.	Unlikely	Negligible	LOW		Unlikely	Negligible	LOW	
	REGULATORY AND ENVIRONMENTAL RISKS										
REG1	Endangered Species Act	It is possible resource agencies could provide an opinion that proposed mitigation areas are inadequate and additional will be required. In addition, species could be added to ESA.	It is likely resource agencies could require additional mitigation. The addition of species could also result in additional mitigation costs or design adaptations and changes. Review periods and iterative processes could result in minimal impacts to schedule. As a mitigation approach, Alternative 2 (LPP) could potentially use the Sacramento Bypass. Worst Case, mitigation costs could increase by 25% with offsite bank.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
REG2	Offsite Mitigation	Additional offsite mitigation could be required.	The estimate currently includes some 100 acres for elderberry mitigation and some 600 additional acres for Giant Garter Snakes. Some of this area will be mitigated offsite. These numbers are based on conservative assumptions. Additional compensation for SRA habitat may be required. Mitigation costs are very minimal relative to project costs and impacts are considered inconsequential (mitigation costs could increase some 15%). Additional offsite mitigation shouldn't impact schedule.	Likely	Marginal	MODERATE		Unlikely	Negligible	LOW	
REG3	Air Quality	Construction could require air quality credits. Air quality is legislated by local California Resource Board by county and program will overlap multiple regions.	In order to accommodate aggressive schedule, multiple sites could be constructed concurrently. Early coordination with the Air Resource Board and inclusion in State Implementation Plan could mitigate schedule delays. Minimal additional construction cost impacts ($20K/MO) could be encountered.	Very Unlikely	Negligible	LOW		Unlikely	Negligible	LOW	
REG4	Water Quality	Construction could be limited due to water quality impacts.	Water quality for rock placement in the water would only have minimal potential cost impacts. Placement may require some additional costs (i.e. turbidity monitoring and potential decreased production rates) and are captured in our baseline cost estimate.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
REG5	Onsite Mitigation	Depending on Agencies, additional onsite mitigation could be required.	Resource agencies requirements for onsite mitigation continue to evolve, resulting in additional onsite mitigation requirements. ESA consultations have occurred but Biologic Opinions have not been received. Until opinions have been received, restoration ratios have not been established. Additional offsite mitigation may be required. This risk has been modeled in REG2	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	

REG6	Cultural Resources	Only a limited number of surface surveys have been conducted. It is likely cultural resources could be encountered during levee construction. It is known that cultural sites were buried during initial levee construction.	Extensive additional surveys and historical records searches will be required. It is anticipated additional cultural sites will be encountered. Cultural sites encountered during construction will be much more costly then those mitigated prior to construction. By completing sufficient cultural resource identification during PED and prior to construction schedule impacts should be mitigated. If cultural resources are encountered, construction schedules could be impacted 6-12months.	Very Likely	Marginal	MODERATE		Likely	Significant	HIGH	
REG7	Noise and Vibration Controls	Construction could be impacted by noise and vibration monitoring near occupied areas.	Residents may need to be temporarily relocated, but relative to total project, cost impacts would be minimal. ESTIMATE NEEDS TO INCLUDE VIBRATION MONITORING COSTS.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
REG8	Native American Consultation - Section 106 Compliance and Government to Government	Native American tribes may challenge USACE opinions during either PED or construction.	If sensitive sites are encountered, schedule could be delayed. It is hoped that with due diligence the risk may be mitigated. Construction methodology could also dictate how many sites are found. It is considered likely a challenge will occur, resulting in a potential construction schedule delay of up to 1 month, for up to 10 separate contracts over the life of the project. It is recommended an IDIQ be established for site investigation and documentation services and construction contracts include CLINS for contract relocations when sites are encountered.	Likely	Negligible	LOW		Likely	Marginal	MODERATE	
	CONSTRUCTION RISKS										
CO1	Modifications and Claims	Modifications will be experienced on any construction project. Project Construction is heavily dependent on geotechnical design solutions.	Modifications are to be expected Inherent with any geotechnical design comes the possibility of differing site conditions such as constructed depth of cutoff wall due to change in key in layer elevation and site geology which would not have previously been noted due to the density of explorations in a given area, groundwater chemistry issues affecting curing of the cutoff wall etc. Current design specifies a design depth plus 10ft for keying into impermeable layer. This can become vastly more expensive if additional depth could require a different construction method (i.e standard cutoff wall to deep soil mixing). Estimate already assumes DSM, so additional depth with this approach wouldn't be	Very Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
CO2	Unknown Utilities	A Slurry Wall was previously installed for the Sacramento River. There is a greater chance of unknown utilities on the American River, but those utilities are fewer with most located around bridges. The Bypass area is a relatively rural and few utilities are anticipated.	Marginal impacts for unknown utilities are anticipated.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
CO3	Site Access and Staging Areas	Access for slurry wall and erosion control along the Sacramento River will be difficult. American River erosion control will also be difficult.	In the Pocket Area, construction will be heavily congested in a dense urban environment and residential streets. Estimate is based on average haul times and distances but may not have sufficiently captured all costs.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO4	Construction Windows	All in water work must be completed between August 1 to Nov 30. Levee construction is limited between 15 April and 30 October. Depending on contract award dates, durations, and inefficient contractors some contracts could be limited or delayed to the following construction season.	In general this has been a minimal risk, with worst case a one season schedule slip may occur, impacting local contract schedule but not does not impact overall project schedule.	Very Unlikely	Negligible	LOW		Unlikely	Negligible	LOW	
CO5	Construction Oversight	Given the large number of potential sites/contracts per year, submittal turn around times and construction oversight could be an issue.	Based on previous experience, mods and claims have been experienced as a result of review delays (either from Construction or Engineering) leading to cost increases. It is being discussed to possibly stand up a Project Office to handle these projects.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
CO6	Specialized Construction Limiting Competition	Currently some 5 contractors in the area can do slurry wall construction. Deep Soil Mixing has even more limited competition. Multiple contracts between this project and others will be competing for the limited number of construction contractors capable of performing the work.	Limited contractor availability and competition could result in higher construction costs and even project delays if no qualified contractors are available.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	

CO7	Constrained Site	Multiple locations will have tight site footprints which could constrain construction.	This risk has been captured in Staging Area Risks	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO8	Deep Soil Mixing	Deep soil mixing is fairly specialized construction feature many reaches 80ft deep and a few reaches some 130ft deep.	Schedule is highly dependent on availability of Deep Soil Mixing equipment. DSM is a majority of the length of total cutoff wall required and is a fairly slow process. Assumed Estimate Production rates appear reasonable and limited contractor competition has been accounted for elsewhere	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO9	Haul Road Resurfacing	Levee access for many locations will be through multiple residential locations.	Street resurfacing costs need to be added into the estimate.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
CO10	Utility Relocations	All impacted utilities will be left constructed in a policy compliant manner (existing deficient utilities will not be left in place). Utility relocations will require temporary supply.	Utility relocations will require coordination with affected parties. From experience, relocations of KNOWN utilities is not a major issue. Relocations only become problematic when unknown utilities are encountered which has been accounted for in Unknown Utilities Risk.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
	ESTIMATE AND SCHEDULE RISKS										
ET1	Quantities	Quantities could vary significantly. Earthwork and cutoff wall quantities are probably conservative and are likely to be reduced during PED.	No PED level survey is available. No specific designs/quantities based on surveyed cross sections has been developed. Quantities were calculated using tables with typical cross sections generated to capture the types of fixes needed along the levee as well as the existing geometry of the levee. These sections were then referenced into a dynamic spreadsheet where the type of fix, hydraulic data, and existing levee geometry were identified. Many fixes with varying levee geometry were developed and quantities did not interpolate between the fixes, but used the next larger fix (taller levee, higher floodwall, deeper cutoff wall, etc), The spreadsheet calculated civil quantities using average end area method between stations of varying cross section.	Likely	Significant	HIGH		Very Unlikely	Negligible	LOW	
ET2	Utility Relocations	Large number and variety of requirements for utility relocations.	Variable nature of relocation requirements is difficult to quantify. Potential unknown utilities remain. VERIFY ESTIMATE INCLUDES UTILITY RELOCATION COSTS.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
ET3	Fuel and Material Variations	Fuel Costs are a major cost driver for any large earthwork project. Bentonite availability for slurry cutoff wall construction could become a critical item.	Assume fuel prices could decrease 5% and increase 10%. Given the slurry wall construction, bentonite cost fluctuations could also have impacts on the project costs.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
ET4	Project Complexity	earthwork, rock placement, DSM/slurry cutoff walls and floodwall construction. For alternative 2, the Sacramento Bypass is being widened and an adjacent weir added to allow larger bypass flows.	For contractors familiar with this type of construction, minimal cost variation or uncertainty should be anticipated.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
ET5	Improving Economy	Local economy has been improving and Government Work is becoming less attractive.	Much of this work is specialized (DSM) mitigating some of this concern. But there is the issue other construction features could experience higher prices.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
ET6	Level of Estimate	Feasibility level estimates have been developed.	Detailed crews and construction methodology have been used in development of the feasibility estimate, but typical cost variations associated with a type 3 estimate should still be anticipated.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
	Programmatic Risks	(External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR1	Funding Stream - Sponsor	Sponsor feels confident they can match anticipated Federal funding (say some $30M to $40M / year). For full project implementation a $140M / yr total funding stream would be required.	Sponsor anticipates being able to meet funding requirements in thru credits, LERRDs and cash.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PR2	Funding Stream - Federal	Sponsor feels confident they can match anticipated Federal funding (say some $30M to $40M / year). For full project implementation a $140M / yr total funding stream would be required.	National Civil Works Budget for Flood Risk Reduction is some $250M to $300M per year. Given the political awareness of the potential for major flood losses and the history of this project it may be reasonable to assume $100 Million per year in Federal Funding.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PR3	Weather Delays	Weather events could impact in water construction or delay start of construction windows.	It is possible construction seasons could be delayed or postponed with storm or other weather events resulting in additional construction costs but minimal overall project schedule impacts.	Likely	Marginal	MODERATE		Very Unlikely	Negligible	LOW	
PR4	Project Authorization	With submittal of Chief's Report, the project will be awaiting authorization.	Chief's Report is scheduled for next year. Next WRDA is scheduled for 2016 but realistically could slip 5 years or more based on current authorization cycle.	Very Unlikely	Negligible	LOW		Likely	Critical	HIGH	

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

SPK - PN 149827
American River Common Features GRR
Sacramento, CA

The American River Common Features GRR, as presented by the Sacramento District, has undergone a successful Cost Agency Technical Review (Cost ATR) of remaining costs, performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the cost products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of December 3, 2015, the Cost MCX certifies the estimated total project costs:

Alternative 1 - NED Plan:

Total First Costs:	$1,343,992,000 (Cost ATR Certified) *****
Fully Funded Costs:	$1,597,400,000 *

Alternative 2 - LPP Plan:

Total First Costs:	$1,565,750,000 (Cost ATR Certified) *****
Fully Funded Costs:	$1,851,993,000 *

***** Spent Costs Not Included. "Per direction from HQUSACE, the proposed elements of the American River Common Features GRR should be considered separate from the previously authorized portions including the work constructed using the WRDA 1996 and 1999 authorities as well as the Natomas levee improvements authorized by WRDDA 2014. Both cost sharing and the Section 902 limit would be established individually for the WRDA 96/99 features, for the WRRDA 2014 features, and for the GRR recommended plan."

Note: Cost ATR was devoted to remaining work. It did not review spent costs, which requires an audit process. It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.

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Kim C. Callan, PE, CCE, PM
Chief, Cost Engineering MCX
Walla Walla District

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NO: P2 # 149827
LOCATION: Sacramento, CA

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

This Estimate reflects the scope and schedule in report; Feasibility Report

Program Year (Budget EC): 2016
Effective Price Level Date: 1 OCT 15

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
											Spent Thru:	TOTAL				
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	**10/1/2014** ($K)	**FIRST COST** ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*				*M*	*N*	*O*
02	RELOCATIONS *		$101,612	$27,435	27%	$129,048	0.8%	$102,411	$27,651	$130,062	$0	$130,062	22.8%	$125,718	$33,944	$159,661
06	FISH & WILDLIFE FACILITIES	Construction	$19,020	$5,135	27%	$24,156	0.4%	$19,103	$5,158	$24,261	$0	$24,261	20.5%	$23,017	$6,215	$29,232
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$48,413	$13,071	27%	$61,484	0.4%	$48,624	$13,128	$61,752	$0	$61,752	15.1%	$55,972	$15,112	$71,084
11	LEVEES & FLOODWALLS	Levees	$298,680	$80,643	27%	$379,323	0.4%	$299,871	$80,965	$380,836	$0	$380,836	17.3%	$351,674	$94,952	$446,626
16	BANK STABILIZATION		$292,672	$79,021	27%	$371,694	1.8%	$297,828	$80,414	$378,242	$0	$378,242	14.7%	$341,678	$92,253	$433,931
	CONSTRUCTION ESTIMATE TOTALS:		$760,397	$205,307		$965,705	1.0%	$767,837	$207,316	$975,153	$0	$975,153	17.0%	$898,059	$242,476	$1,140,535
01	LANDS AND DAMAGES		$88,537	$38,715	44%	$127,253	0.6%	$89,028	$38,930	$127,958	$0	$127,958	12.8%	$100,492	$43,908	$144,399
30	PLANNING, ENGINEERING & DESIGN *		$119,772	$32,338	27%	$152,110	2.3%	$122,529	$33,083	$155,611	$0	$155,611	27.6%	$156,388	$42,225	$198,613
31	CONSTRUCTION MANAGEMENT *		$59,291	$16,009	27%	$75,300	2.3%	$60,656	$16,377	$77,033	$0	$77,033	35.8%	$82,356	$22,236	$104,592
18	CULTURAL RESOURCE PRESERVATION		$6,550	$1,768	27%	$8,318	0.8%	$6,486	$1,751	$8,237	$0	$8,237	12.4%	$7,292	$1,969	$9,260
	PROJECT COST TOTALS:		$1,034,548	$294,138	28%	$1,328,686		$1,046,535	$297,457	**$1,343,992**	$0	**$1,343,992**	18.9%	$1,244,586	$352,813	$1,597,400

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CHIEF, COST ENGINEERING, Jeremiah Frost

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PROJECT MANAGER, Dan Tibbitts

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CHIEF, REAL ESTATE, Diane Simpson

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CHIEF, ENGINEERING, Rick Poeppelman

ESTIMATED FEDERAL COST:	**65%**	**$1,038,310**
ESTIMATED NON-FEDERAL COST:	**35%**	**$559,090**
ESTIMATED TOTAL PROJECT COST:		**$1,597,400**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account.

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST						TOTAL PROJECT COST			
							Program Year (Budget EC):			2016						
							Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach A																
02	RELOCATIONS *		$4,899	$1,323	27%	$6,222	0.8%	$4,937	$1,333	$6,271		0	$6,271	9.8%	$5,419	$1,463	$6,882
06	FISH & WILDLIFE FACILITIES	Construction	$4,251	$1,148	27%	$5,399	0.4%	$4,270	$1,153	$5,422		0	$5,422	13.3%	$4,837	$1,306	$6,143
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$9,182	$2,479	27%	$11,662	0.4%	$9,222	$2,490	$11,712		0	$11,712	8.9%	$10,043	$2,712	$12,754
16	BANK STABILIZATION		$91,765	$24,777	27%	$116,542	1.8%	$93,382	$25,213	$118,595		0	$118,595	8.9%	$101,688	$27,456	$129,144
	CONSTRUCTION ESTIMATE TOTALS:		$110,097	$29,726		$139,824	1.6%	$111,811	$30,189	$142,000		0	$142,000	9.1%	$121,987	$32,936	$154,923
01	LANDS AND DAMAGES		$2,002	$832	42%	$2,834	0.6%	$2,013	$836	$2,850		0	$2,850	4.7%	$2,107	$875	$2,982
30	PLANNING, ENGINEERING & DESIGN *		$18,858	$5,092	27%	$23,950	2.3%	$19,292	$5,209	$24,501		0	$24,501	11.1%	$21,431	$5,786	$27,217
31	CONSTRUCTION MANAGEMENT *		$9,468	$2,556	27%	$12,024	2.3%	$9,686	$2,615	$12,301		0	$12,301	19.3%	$11,551	$3,119	$14,669
18	CULTURAL RESOURCE PRESERVATION		$906	$245	27%	$1,151	0.8%	$898	$242	$1,140		0	$1,140	4.7%	$940	$254	$1,194
	PROJECT COST TOTALS:		$141,332	$38,451	27%	$179,783		$143,700	$39,092	**$182,792**		0	**$182,792**	10.0%	$158,015	$42,970	$200,986

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$130,641**
ESTIMATED NON-FEDERAL COST:	35%	**$70,345**
ESTIMATED TOTAL PROJECT COST:		**$200,986**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach A, Erosion Protection															
02	RELOCATIONS		$3,919	$1,058	27%	$4,977	0.4%	$3,935	$1,062	$4,997	$0	2020Q3	8.9%	$4,285	$1,157	$5,442
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$9,182	$2,479	27%	$11,662	0.4%	$9,222	$2,490	$11,712	$0	2020Q3	8.9%	$10,043	$2,712	$12,754
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$91,765	$24,777	27%	$116,542	1.8%	$93,382	$25,213	$118,595	$0	2020Q3	8.9%	$101,688	$27,456	$129,144
	CONSTRUCTION ESTIMATE TOTALS:		$104,866	$28,314	27%	**$133,180**		$106,539	$28,765	$135,304	$0			$116,015	$31,324	$147,340
01	LANDS AND DAMAGES	Fed	$95	$5	5%	$100	0.6%	$96	$5	$101	$0	2018Q3	4.7%	$100	$5	$105
01	LANDS AND DAMAGES	Non-Fed	$1,907	$827	43%	$2,734	0.6%	$1,918	$831	$2,749	$0	2018Q3	4.7%	$2,007	$870	$2,877
18	CULTURAL RESOURCE PRESERVATION		$872	$235	27%	$1,107	-1.0%	$863	$233	$1,096	$0	2018Q3	4.7%	$903	$244	$1,147
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$1,615	$436	27%	$2,051	2.3%	$1,652	$446	$2,098	$0	2018Q3	9.9%	$1,815	$490	$2,306
0.006	Planning & Environmental Compliance		$1,578	$426	27%	$2,004	2.3%	$1,614	$436	$2,050	$0	2018Q3	9.9%	$1,774	$479	$2,253
0.082	Engineering & Design		$8,278	$2,235	27%	$10,513	2.3%	$8,469	$2,286	$10,755	$0	2018Q3	9.9%	$9,306	$2,513	$11,818
0.003	Reviews, ATRs, IEPRs, VE		$303	$82	27%	$385	2.3%	$310	$84	$394	$0	2018Q3	9.9%	$341	$92	$433
0.007	Life Cycle Updates (cost, schedule, risks)		$707	$191	27%	$898	2.3%	$723	$195	$919	$0	2018Q3	9.9%	$795	$215	$1,009
0.01	Contracting & Reprographics		$1,009	$272	27%	$1,281	2.3%	$1,032	$279	$1,311	$0	2018Q3	9.9%	$1,134	$306	$1,441
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$1,009	$272	27%	$1,281	2.3%	$1,032	$279	$1,311	$0	2018Q3	9.9%	$1,134	$306	$1,441
0.02	Engineering During Construction		$2,019	$545	27%	$2,564	2.3%	$2,065	$558	$2,623	$0	2020Q3	18.9%	$2,455	$663	$3,118
0.003	Planning During Construction		$303	$82	27%	$385	2.3%	$310	$84	$394	$0	2020Q3	18.9%	$368	$99	$468
0.013	Project Operations		$1,312	$354	27%	$1,666	2.3%	$1,342	$362	$1,705	$0	2018Q3	9.9%	$1,475	$398	$1,873
0.16	NON-FED Planning, Engineering & Design (Relocations)		$627	$169	27%	$796	2.3%	$641	$173	$815	$0	2018Q3	9.9%	$705	$190	$895
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$4,745	$1,281	27%	$6,026	2.3%	$4,854	$1,311	$6,165	$0	2020Q3	18.9%	$5,769	$1,558	$7,327
0.012	Project Operation:		$1,211	$327	27%	$1,538	2.3%	$1,239	$334	$1,573	$0	2020Q3	18.9%	$1,472	$398	$1,870
0.031	Project Management		$3,129	$845	27%	$3,974	2.3%	$3,201	$864	$4,065	$0	2020Q3	18.9%	$3,804	$1,027	$4,832
0.09	NON-FED Construction Management (Relocations)		$353	$95	27%	$448	2.3%	$361	$98	$459	$0	2020Q3	18.9%	$429	$116	$545
	CONTRACT COST TOTALS:		$135,938	$36,994		**$172,933**		$138,262	$37,624	$175,886	$0			$151,803	$41,293	**$193,096**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach A, Erosion Protection, Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$4,251	$1,148	27%	$5,399	0.4%	$4,270	$1,153	$5,422	$0	2022Q3	13.3%	$4,837	$1,306	$6,143
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$4,251	$1,148	27%	**$5,399**		$4,270	$1,153	$5,422	$0			$4,837	$1,306	$6,143
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$35	$9	27%	$44	-1.0%	$34	$9	$44	$0	2019Q3	6.8%	$37	$10	$47
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$68	$18	27%	$86	2.3%	$70	$19	$88	$0	2018Q3	9.9%	$76	$21	$97
0.006	Planning & Environmental Compliance		$26	$7	27%	$33	2.3%	$27	$7	$34	$0	2018Q3	9.9%	$29	$8	$37
0.082	Engineering & Design		$349	$94	27%	$443	2.3%	$357	$96	$453	$0	2018Q3	9.9%	$392	$106	$498
0.003	Reviews, ATRs, IEPRs, VE		$13	$4	27%	$17	2.3%	$13	$4	$17	$0	2018Q3	9.9%	$15	$4	$19
0.007	Life Cycle Updates (cost, schedule, risks)		$30	$8	27%	$38	2.3%	$31	$8	$39	$0	2018Q3	9.9%	$34	$9	$43
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$43	$12	27%	$55	2.3%	$44	$12	$56	$0	2018Q3	9.9%	$48	$13	$61
0.01	Contracting & Reprographics		$43	$12	27%	$55	2.3%	$44	$12	$56	$0	2018Q3	9.9%	$48	$13	$61
0.02	Engineering During Construction		$85	$23	27%	$108	2.3%	$87	$23	$110	$0	2022Q3	28.7%	$112	$30	$142
0.003	Planning During Construction		$13	$4	27%	$17	2.3%	$13	$4	$17	$0	2022Q3	28.7%	$17	$5	$22
0.013	Project Operations		$55	$15	27%	$70	2.3%	$56	$15	$71	$0	2018Q3	9.9%	$62	$17	$79
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$200	$54	27%	$254	2.3%	$205	$55	$260	$0	2022Q3	28.7%	$263	$71	$334
0.012	Project Operation:		$51	$14	27%	$65	2.3%	$52	$14	$66	$0	2022Q3	28.7%	$67	$18	$85
0.031	Project Management		$132	$36	27%	$168	2.3%	$135	$36	$171	$0	2022Q3	28.7%	$174	$47	$221
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$5,394	$1,456		**$6,850**		$5,438	$1,468	$6,906	$0			$6,212	$1,677	**$7,889**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach B																
02	RELOCATIONS *		$2,313	$625	27%	$2,938	0.8%	$2,332	$630	$2,961		0	$2,961	15.8%	$2,699	$729	$3,428
06	FISH & WILDLIFE FACILITIES	Construction	$1,170	$316	27%	$1,486	0.4%	$1,175	$317	$1,492		0	$1,492	17.9%	$1,385	$374	$1,759
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$3,218	$869	27%	$4,087	0.4%	$3,232	$873	$4,104		0	$4,104	13.3%	$3,661	$989	$4,650
16	BANK STABILIZATION		$21,641	$5,843	27%	$27,484	1.8%	$22,022	$5,946	$27,969		0	$27,969	13.3%	$24,950	$6,737	$31,687
	CONSTRUCTION ESTIMATE TOTALS:		$28,342	$7,652		$35,995	1.5%	$28,761	$7,765	$36,526		0	$36,526	13.7%	$32,696	$8,828	$41,523
01	LANDS AND DAMAGES		$1,011	$208	21%	$1,219	0.6%	$1,017	$209	$1,226		0	$1,226	11.1%	$1,129	$232	$1,361
30	PLANNING, ENGINEERING & DESIGN *		$5,399	$1,458	27%	$6,857	2.3%	$5,523	$1,491	$7,015		0	$7,015	24.3%	$6,863	$1,853	$8,716
31	CONSTRUCTION MANAGEMENT *		$2,342	$632	27%	$2,974	2.3%	$2,396	$647	$3,043		0	$3,043	29.2%	$3,095	$836	$3,931
18	CULTURAL RESOURCE PRESERVATION		$238	$64	27%	$302	0.8%	$236	$64	$299		0	$299	11.2%	$262	$71	$333
	PROJECT COST TOTALS:		$37,332	$10,015	27%	$47,347		$37,932	$10,176	**$48,109**		0	**$48,109**	16.1%	$44,045	$11,820	$55,865

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$36,312**
ESTIMATED NON-FEDERAL COST:	35%	**$19,553**
ESTIMATED TOTAL PROJECT COST:		**$55,865**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach B, Erosion Protection															
02	RELOCATIONS		$1,850	$500	27%	$2,350	0.4%	$1,858	$502	$2,360	$0	2022Q3	13.3%	$2,105	$568	$2,673
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$3,218	$869	27%	$4,087	0.4%	$3,232	$873	$4,104	$0	2022Q3	13.3%	$3,661	$989	$4,650
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$21,641	$5,843	27%	$27,484	1.8%	$22,022	$5,946	$27,969	$0	2022Q3	13.3%	$24,950	$6,737	$31,687
	CONSTRUCTION ESTIMATE TOTALS:		$26,709	$7,212	27%	**$33,921**		$27,112	$7,320	$34,433	$0			$30,717	$8,293	$39,010
01	LANDS AND DAMAGES	Fed	$166	$9	5%	$175	0.6%	$167	$9	$176	$0	2021Q3	11.1%	$186	$10	$195
01	LANDS AND DAMAGES	Non-Fed	$845	$199	24%	$1,044	0.6%	$849	$200	$1,050	$0	2021Q3	11.1%	$943	$223	$1,166
18	CULTURAL RESOURCE PRESERVATION		$229	$62	27%	$290	-1.0%	$226	$61	$287	$0	2021Q3	11.1%	$251	$68	$319
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$398	$107	27%	$505	2.3%	$407	$110	$517	$0	2021Q3	23.6%	$503	$136	$639
0.006	Planning & Environmental Compliance		$1,121	$303	27%	$1,424	2.3%	$1,147	$310	$1,456	$0	2021Q3	23.6%	$1,418	$383	$1,801
0.082	Engineering & Design		$2,038	$550	27%	$2,588	2.3%	$2,085	$563	$2,648	$0	2021Q3	23.6%	$2,578	$696	$3,274
0.003	Reviews, ATRs, IEPRs, VE		$75	$20	27%	$95	2.3%	$77	$21	$97	$0	2021Q3	23.6%	$95	$26	$120
0.007	Life Cycle Updates (cost, schedule, risks)		$174	$47	27%	$221	2.3%	$178	$48	$226	$0	2021Q3	23.6%	$220	$59	$280
0.01	Contracting & Reprographics		$249	$67	27%	$316	2.3%	$255	$69	$324	$0	2021Q3	23.6%	$315	$85	$400
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$249	$67	27%	$316	2.3%	$255	$69	$324	$0	2021Q3	23.6%	$315	$85	$400
0.02	Engineering During Construction		$497	$134	27%	$631	2.3%	$508	$137	$646	$0	2022Q3	28.7%	$654	$177	$831
0.003	Planning During Construction		$75	$20	27%	$95	2.3%	$77	$21	$97	$0	2022Q3	28.7%	$99	$27	$125
0.013	Project Operations		$323	$87	27%	$410	2.3%	$330	$89	$420	$0	2021Q3	23.6%	$409	$110	$519
0.16	NON-FED Planning, Engineering & Design (Relocations)		$296	$80	27%	$376	2.3%	$303	$82	$385	$0	2021Q3	23.6%	$374	$101	$475
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,168	$315	27%	$1,483	2.3%	$1,195	$323	$1,517	$0	2022Q3	28.7%	$1,538	$415	$1,953
0.012	Project Operation:		$298	$80	27%	$378	2.3%	$305	$82	$387	$0	2022Q3	28.7%	$392	$106	$498
0.031	Project Management		$771	$208	27%	$979	2.3%	$789	$213	$1,002	$0	2022Q3	28.7%	$1,015	$274	$1,289
0.09	NON-FED Construction Management (Relocations)		$167	$45	27%	$212	2.3%	$171	$46	$217	$0	2022Q3	28.7%	$220	$59	$279
	CONTRACT COST TOTALS:		$35,848	$9,614		**$45,462**		$36,436	$9,772	$46,208	$0			$42,242	$11,333	**$53,575**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach B, Erosion Protection, Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$1,170	$316	27%	$1,486	0.4%	$1,175	$317	$1,492	$0	2024Q3	17.9%	$1,385	$374	$1,759
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$1,170	$316	27%	**$1,486**		$1,175	$317	$1,492	$0			$1,385	$374	$1,759
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$10	$3	27%	$12	-1.0%	$9	$3	$12	$0	2022Q3	13.3%	$11	$3	$14
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$19	$5	27%	$24	2.3%	$19	$5	$25	$0	2021Q3	23.6%	$24	$6	$31
0.006	Planning & Environmental Compliance		$7	$2	27%	$9	2.3%	$7	$2	$9	$0	2021Q3	23.6%	$9	$2	$11
0.082	Engineering & Design		$96	$26	27%	$122	2.3%	$98	$27	$125	$0	2021Q3	23.6%	$121	$33	$154
0.003	Reviews, ATRs, IEPRs, VE		$4	$1	27%	$5	2.3%	$4	$1	$5	$0	2021Q3	23.6%	$5	$1	$6
0.007	Life Cycle Updates (cost, schedule, risks)		$8	$2	27%	$10	2.3%	$8	$2	$10	$0	2021Q3	23.6%	$10	$3	$13
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$12	$3	27%	$15	2.3%	$12	$3	$16	$0	2021Q3	23.6%	$15	$4	$19
0.01	Contracting & Reprographics		$12	$3	27%	$15	2.3%	$12	$3	$16	$0	2021Q3	23.6%	$15	$4	$19
0.02	Engineering During Construction		$23	$6	27%	$29	2.3%	$24	$6	$30	$0	2024Q3	39.6%	$33	$9	$42
0.003	Planning During Construction		$4	$1	27%	$5	2.3%	$4	$1	$5	$0	2024Q3	39.6%	$6	$2	$7
0.013	Project Operations		$15	$4	27%	$19	2.3%	$15	$4	$19	$0	2021Q3	23.6%	$19	$5	$24
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$55	$15	27%	$70	2.3%	$56	$15	$71	$0	2024Q3	39.6%	$79	$21	$100
0.012	Project Operation:		$14	$4	27%	$18	2.3%	$14	$4	$18	$0	2024Q3	39.6%	$20	$5	$25
0.031	Project Management		$36	$10	27%	$46	2.3%	$37	$10	$47	$0	2024Q3	39.6%	$51	$14	$65
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$1,484	$401		**$1,885**		$1,496	$404	$1,900	$0			$1,803	$487	**$2,290**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		Spent Thru: 10/1/2014 ($K)	FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach C																
02	RELOCATIONS *		$500	$135	27%	$635	0.8%	$504	$136	$640		0	$640	24.6%	$627	$169	$797
06	FISH & WILDLIFE FACILITIES	Construction	$1,164	$314	27%	$1,479	0.4%	$1,170	$316	$1,485		0	$1,485	25.1%	$1,463	$395	$1,858
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$1,128	$305	27%	$1,432	0.4%	$1,133	$306	$1,439		0	$1,439	20.2%	$1,362	$368	$1,730
16	BANK STABILIZATION		$14,915	$4,027	27%	$18,942	1.8%	$15,177	$4,098	$19,275		0	$19,275	20.2%	$18,248	$4,927	$23,175
	CONSTRUCTION ESTIMATE TOTALS:		$17,707	$4,781		$22,487	1.6%	$17,983	$4,855	$22,839		0	$22,839	20.7%	$21,700	$5,859	$27,559
01	LANDS AND DAMAGES		$875	$183	21%	$1,058	0.6%	$880	$184	$1,064		0	$1,064	17.9%	$1,037	$217	$1,254
30	PLANNING, ENGINEERING & DESIGN *		$3,896	$1,052	27%	$4,948	2.3%	$3,986	$1,076	$5,062		0	$5,062	40.3%	$5,593	$1,510	$7,103
31	CONSTRUCTION MANAGEMENT *		$1,549	$418	27%	$1,967	2.3%	$1,585	$428	$2,013		0	$2,013	46.5%	$2,321	$627	$2,948
18	CULTURAL RESOURCE PRESERVATION		$156	$42	27%	$198	0.8%	$154	$42	$196		0	$196	18.0%	$182	$49	$231
	PROJECT COST TOTALS:		$24,182	$6,476	27%	$30,658		$24,588	$6,585	**$31,173**		0	**$31,173**	25.4%	$30,833	$8,262	$39,095

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$25,412**
ESTIMATED NON-FEDERAL COST:	35%	**$13,683**
ESTIMATED TOTAL PROJECT COST:		**$39,095**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach C, Erosion Protection															
02	RELOCATIONS		$400	$108	27%	$508	0.4%	$401	$108	$510	$0	2025Q3	20.2%	$482	$130	$613
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$1,128	$305	27%	$1,432	0.4%	$1,133	$306	$1,439	$0	2025Q3	20.2%	$1,362	$368	$1,730
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$14,915	$4,027	27%	$18,942	1.8%	$15,177	$4,098	$19,275	$0	2025Q3	20.2%	$18,248	$4,927	$23,175
	CONSTRUCTION ESTIMATE TOTALS:		$16,442	$4,439	27%	**$20,882**		$16,711	$4,512	$21,224	$0			$20,092	$5,425	$25,517
01	LANDS AND DAMAGES	Fed	$143	$7	5%	$150	0.6%	$143	$8	$151	$0	2024Q3	17.9%	$169	$9	$178
01	LANDS AND DAMAGES	Non-Fed	$733	$175	24%	$908	0.6%	$737	$176	$913	$0	2024Q3	17.9%	$868	$208	$1,076
18	CULTURAL RESOURCE PRESERVATION		$146	$39	27%	$185	-1.0%	$145	$39	$184	$0	2024Q3	17.9%	$170	$46	$216
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$257	$69	27%	$326	2.3%	$263	$71	$334	$0	2024Q3	39.6%	$367	$99	$466
0.006	Planning & Environmental Compliance		$1,069	$289	27%	$1,358	2.3%	$1,094	$295	$1,389	$0	2024Q3	39.6%	$1,527	$412	$1,939
0.082	Engineering & Design		$1,315	$355	27%	$1,670	2.3%	$1,345	$363	$1,708	$0	2024Q3	39.6%	$1,879	$507	$2,386
0.003	Reviews, ATRs, IEPRs, VE		$48	$13	27%	$61	2.3%	$49	$13	$62	$0	2024Q3	39.6%	$69	$19	$87
0.007	Life Cycle Updates (cost, schedule, risks)		$112	$30	27%	$142	2.3%	$115	$31	$146	$0	2024Q3	39.6%	$160	$43	$203
0.01	Contracting & Reprographics		$160	$43	27%	$203	2.3%	$164	$44	$208	$0	2024Q3	39.6%	$229	$62	$290
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$160	$43	27%	$203	2.3%	$164	$44	$208	$0	2024Q3	39.6%	$229	$62	$290
0.02	Engineering During Construction		$321	$87	27%	$408	2.3%	$328	$89	$417	$0	2025Q3	45.6%	$478	$129	$607
0.003	Planning During Construction		$48	$13	27%	$61	2.3%	$49	$13	$62	$0	2025Q3	45.6%	$71	$19	$91
0.013	Project Operations		$209	$56	27%	$265	2.3%	$214	$58	$272	$0	2024Q3	39.6%	$299	$81	$379
0.16	NON-FED Planning, Engineering & Design (Relocations)		$64	$17	27%	$81	2.3%	$65	$18	$83	$0	2024Q3	39.6%	$91	$25	$116
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$754	$204	27%	$958	2.3%	$771	$208	$980	$0	2025Q3	45.6%	$1,123	$303	$1,426
0.012	Project Operation:		$193	$52	27%	$245	2.3%	$197	$53	$251	$0	2025Q3	45.6%	$287	$78	$365
0.031	Project Management		$497	$134	27%	$631	2.3%	$508	$137	$646	$0	2025Q3	45.6%	$740	$200	$940
0.09	NON-FED Construction Management (Relocations)		$36	$10	27%	$46	2.3%	$37	$10	$47	$0	2025Q3	45.6%	$54	$14	$68
	CONTRACT COST TOTALS:		$22,706	$6,077		**$28,784**		$23,100	$6,183	$29,283	$0			$28,902	$7,740	**$36,642**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach C, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$1,164	$314	27%	$1,479	0.4%	$1,170	$316	$1,485	$0	2027Q3	25.1%	$1,463	$395	$1,858
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$1,164	$314	27%	**$1,479**		$1,170	$316	$1,485	$0			$1,463	$395	$1,858
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$10	$3	27%	$12	-1.0%	$9	$3	$12	$0	2025Q3	20.2%	$11	$3	$14
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$19	$5	27%	$24	2.3%	$19	$5	$25	$0	2024Q3	39.6%	$27	$7	$34
0.006	Planning & Environmental Compliance		$7	$2	27%	$9	2.3%	$7	$2	$9	$0	2024Q3	39.6%	$10	$3	$13
0.082	Engineering & Design		$95	$26	27%	$121	2.3%	$97	$26	$123	$0	2024Q3	39.6%	$136	$37	$172
0.003	Reviews, ATRs, IEPRs, VE		$3	$1	27%	$4	2.3%	$3	$1	$4	$0	2024Q3	39.6%	$4	$1	$5
0.007	Life Cycle Updates (cost, schedule, risks)		$8	$2	27%	$10	2.3%	$8	$2	$10	$0	2024Q3	39.6%	$11	$3	$15
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$12	$3	27%	$15	2.3%	$12	$3	$16	$0	2024Q3	39.6%	$17	$5	$22
0.01	Contracting & Reprographics		$12	$3	27%	$15	2.3%	$12	$3	$16	$0	2024Q3	39.6%	$17	$5	$22
0.02	Engineering During Construction		$23	$6	27%	$29	2.3%	$24	$6	$30	$0	2027Q3	58.7%	$37	$10	$47
0.003	Planning During Construction		$3	$1	27%	$4	2.3%	$3	$1	$4	$0	2027Q3	58.7%	$5	$1	$6
0.013	Project Operations		$15	$4	27%	$19	2.3%	$15	$4	$19	$0	2024Q3	39.6%	$21	$6	$27
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$55	$15	27%	$70	2.3%	$56	$15	$71	$0	2027Q3	58.7%	$89	$24	$113
0.012	Project Operation:		$14	$4	27%	$18	2.3%	$14	$4	$18	$0	2027Q3	58.7%	$23	$6	$29
0.031	Project Management		$36	$10	27%	$46	2.3%	$37	$10	$47	$0	2027Q3	58.7%	$58	$16	$74
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$1,476	$399		**$1,875**		$1,488	$402	$1,890	$0			$1,931	$521	**$2,453**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST						TOTAL PROJECT COST			
							Program Year (Budget EC):			2016						
							Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach D																
02	RELOCATIONS *		$25,524	$6,891	27%	$32,415	0.8%	$25,724	$6,946	$32,670		0	$32,670	27.4%	$32,764	$8,846	$41,610
06	FISH & WILDLIFE FACILITIES	Construction	$2,102	$568	27%	$2,670	0.4%	$2,111	$570	$2,681		0	$2,681	27.6%	$2,694	$727	$3,421
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$6,551	$1,769	27%	$8,320	0.4%	$6,580	$1,777	$8,356		0	$8,356	22.6%	$8,069	$2,179	$10,248
11	LEVEES & FLOODWALLS	Levees	$44,404	$11,989	27%	$56,393	0.4%	$44,581	$12,037	$56,618		0	$56,618	22.6%	$54,672	$14,761	$69,433
16	BANK STABILIZATION		$20,205	$5,455	27%	$25,661	1.8%	$20,561	$5,552	$26,113		0	$26,113	22.6%	$25,215	$6,808	$32,023
	CONSTRUCTION ESTIMATE TOTALS:		$98,787	$26,672		$125,459	0.8%	$99,558	$26,881	$126,439		0	$126,439	24.0%	$123,413	$33,322	$156,735
01	LANDS AND DAMAGES		$2,034	$634	31%	$2,668	0.6%	$2,045	$638	$2,683		0	$2,683	19.0%	$2,434	$759	$3,193
30	PLANNING, ENGINEERING & DESIGN *		$13,427	$3,625	27%	$17,052	2.3%	$13,736	$3,709	$17,445		0	$17,445	44.5%	$19,852	$5,360	$25,212
31	CONSTRUCTION MANAGEMENT *		$6,593	$1,780	27%	$8,373	2.3%	$6,745	$1,821	$8,566		0	$8,566	52.4%	$10,278	$2,775	$13,053
18	CULTURAL RESOURCE PRESERVATION		$752	$203	27%	$955	0.8%	$745	$201	$946		0	$946	19.9%	$893	$241	$1,134
	PROJECT COST TOTALS:		$121,593	$32,915	27%	$154,508		$122,829	$33,249	**$156,078**		0	**$156,078**	27.7%	$156,870	$42,457	$199,327

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$129,563**
ESTIMATED NON-FEDERAL COST:	35%	**$69,764**
ESTIMATED TOTAL PROJECT COST:		**$199,327**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach D, Levee Improvements															
02	RELOCATIONS		$20,419	$5,513	27%	$25,932	0.4%	$20,502	$5,535	$26,037	$0	2026Q3	22.6%	$25,142	$6,788	$31,930
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$6,551	$1,769	27%	$8,320	0.4%	$6,580	$1,777	$8,356	$0	2026Q3	22.6%	$8,069	$2,179	$10,248
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$44,404	$11,989	27%	$56,393	0.4%	$44,581	$12,037	$56,618	$0	2026Q3	22.6%	$54,672	$14,761	$69,433
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$71,374	$19,271	27%	**$90,645**		$71,663	$19,349	$91,012	$0			$87,882	$23,728	$111,611
01	LANDS AND DAMAGES	Fed	$214	$11	5%	$225	0.6%	$215	$11	$226	$0	2025Q1	19.0%	$256	$13	$269
01	LANDS AND DAMAGES	Non-Fed	$1,820	$623	34%	$2,443	0.6%	$1,830	$626	$2,457	$0	2025Q1	19.0%	$2,178	$746	$2,924
18	CULTURAL RESOURCE PRESERVATION		$570	$154	27%	$723	-1.0%	$564	$152	$716	$0	2025Q1	19.0%	$671	$181	$853
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$815	$220	27%	$1,035	2.3%	$834	$225	$1,059	$0	2025Q1	42.5%	$1,188	$321	$1,509
0.006	Planning & Environmental Compliance		$1,278	$345	27%	$1,623	2.3%	$1,307	$353	$1,660	$0	2025Q1	42.5%	$1,864	$503	$2,367
0.082	Engineering & Design		$4,178	$1,128	27%	$5,306	2.3%	$4,274	$1,154	$5,428	$0	2025Q1	42.5%	$6,093	$1,645	$7,738
0.003	Reviews, ATRs, IEPRs, VE		$153	$41	27%	$194	2.3%	$157	$42	$199	$0	2025Q1	42.5%	$223	$60	$283
0.007	Life Cycle Updates (cost, schedule, risks)		$357	$96	27%	$453	2.3%	$365	$99	$464	$0	2025Q1	42.5%	$521	$141	$661
0.01	Contracting & Reprographics		$510	$138	27%	$648	2.3%	$522	$141	$663	$0	2025Q1	42.5%	$744	$201	$945
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$510	$138	27%	$648	2.3%	$522	$141	$663	$0	2025Q1	42.5%	$744	$201	$945
0.02	Engineering During Construction		$1,019	$275	27%	$1,294	2.3%	$1,042	$281	$1,324	$0	2026Q3	52.0%	$1,584	$428	$2,012
0.003	Planning During Construction		$153	$41	27%	$194	2.3%	$157	$42	$199	$0	2026Q3	52.0%	$238	$64	$302
0.013	Project Operations		$662	$179	27%	$841	2.3%	$677	$183	$860	$0	2025Q1	42.5%	$965	$261	$1,226
0.16	NON-FED Planning, Engineering & Design (Relocations)		$3,267	$882	27%	$4,149	2.3%	$3,342	$902	$4,245	$0	2025Q1	42.5%	$4,764	$1,286	$6,051
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$2,395	$647	27%	$3,042	2.3%	$2,450	$662	$3,112	$0	2026Q3	52.0%	$3,724	$1,005	$4,729
0.012	Project Operation:		$611	$165	27%	$776	2.3%	$625	$169	$794	$0	2026Q3	52.0%	$950	$257	$1,207
0.031	Project Management		$1,580	$427	27%	$2,007	2.3%	$1,616	$436	$2,053	$0	2026Q3	52.0%	$2,457	$663	$3,120
0.09	NON-FED Construction Management (Relocations)		$1,838	$496	27%	$2,334	2.3%	$1,880	$508	$2,388	$0	2026Q3	52.0%	$2,858	$772	$3,629
	CONTRACT COST TOTALS:		$93,304	$25,277		**$118,581**		$94,043	$25,477	$119,520	$0			$119,904	$32,476	**$152,380**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach D, Erosion Protection															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$20,205	$5,455	27%	$25,661	1.8%	$20,561	$5,552	$26,113	$0	2026Q3	22.6%	$25,215	$6,808	$32,023
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$20,205	$5,455	27%	**$25,661**		$20,561	$5,552	$26,113	$0			$25,215	$6,808	$32,023
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$165	$45	27%	$210	-1.0%	$164	$44	$208	$0	2026Q3	22.6%	$201	$54	$255
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$323	$87	27%	$410	2.3%	$330	$89	$420	$0	2025Q3	45.6%	$481	$130	$611
0.006	Planning & Environmental Compliance		$121	$33	27%	$154	2.3%	$124	$33	$157	$0	2025Q3	45.6%	$180	$49	$229
0.082	Engineering & Design		$1,657	$447	27%	$2,104	2.3%	$1,695	$458	$2,153	$0	2025Q3	45.6%	$2,468	$666	$3,134
0.003	Reviews, ATRs, IEPRs, VE		$61	$16	27%	$77	2.3%	$62	$17	$79	$0	2025Q3	45.6%	$91	$25	$115
0.007	Life Cycle Updates (cost, schedule, risks)		$141	$38	27%	$179	2.3%	$144	$39	$183	$0	2025Q3	45.6%	$210	$57	$267
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$202	$55	27%	$257	2.3%	$207	$56	$262	$0	2025Q3	45.6%	$301	$81	$382
0.01	Contracting & Reprographics		$202	$55	27%	$257	2.3%	$207	$56	$262	$0	2025Q3	45.6%	$301	$81	$382
0.02	Engineering During Construction		$404	$109	27%	$513	2.3%	$413	$112	$525	$0	2026Q3	52.0%	$628	$170	$798
0.003	Planning During Construction		$61	$16	27%	$77	2.3%	$62	$17	$79	$0	2026Q3	52.0%	$95	$26	$120
0.013	Project Operations		$263	$71	27%	$334	2.3%	$269	$73	$342	$0	2025Q3	45.6%	$392	$106	$497
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$950	$257	27%	$1,207	2.3%	$972	$262	$1,234	$0	2026Q3	52.0%	$1,477	$399	$1,876
0.012	Project Operation:		$242	$65	27%	$307	2.3%	$248	$67	$314	$0	2026Q3	52.0%	$376	$102	$478
0.031	Project Management		$626	$169	27%	$795	2.3%	$640	$173	$813	$0	2026Q3	52.0%	$973	$263	$1,236
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$25,624	$6,918		**$32,542**		$26,099	$7,047	$33,146	$0			$33,389	$9,015	**$42,404**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach D, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$2,102	$568	27%	$2,670	0.4%	$2,111	$570	$2,681	$0	2028Q3	27.6%	$2,694	$727	$3,421
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,102	$568	27%	**$2,670**		$2,111	$570	$2,681	$0			$2,694	$727	$3,421
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$17	$5	27%	$22	-1.0%	$17	$5	$22	$0	2026Q3	22.6%	$21	$6	$27
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$34	$9	27%	$43	2.3%	$35	$9	$44	$0	2025Q3	45.6%	$51	$14	$64
0.006	Planning & Environmental Compliance		$13	$4	27%	$17	2.3%	$13	$4	$17	$0	2025Q3	45.6%	$19	$5	$25
0.082	Engineering & Design		$172	$46	27%	$218	2.3%	$176	$48	$223	$0	2025Q3	45.6%	$256	$69	$325
0.003	Reviews, ATRs, IEPRs, VE		$6	$2	27%	$8	2.3%	$6	$2	$8	$0	2025Q3	45.6%	$9	$2	$11
0.007	Life Cycle Updates (cost, schedule, risks)		$15	$4	27%	$19	2.3%	$15	$4	$19	$0	2025Q3	45.6%	$22	$6	$28
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$21	$6	27%	$27	2.3%	$21	$6	$27	$0	2025Q3	45.6%	$31	$8	$40
0.01	Contracting & Reprographics		$21	$6	27%	$27	2.3%	$21	$6	$27	$0	2025Q3	45.6%	$31	$8	$40
0.02	Engineering During Construction		$42	$11	27%	$53	2.3%	$43	$12	$55	$0	2028Q3	65.9%	$71	$19	$91
0.003	Planning During Construction		$6	$2	27%	$8	2.3%	$6	$2	$8	$0	2028Q3	65.9%	$10	$3	$13
0.013	Project Operations		$27	$7	27%	$34	2.3%	$28	$7	$35	$0	2025Q3	45.6%	$40	$11	$51
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$99	$27	27%	$126	2.3%	$101	$27	$129	$0	2028Q3	65.9%	$168	$45	$213
0.012	Project Operation:		$25	$7	27%	$32	2.3%	$26	$7	$32	$0	2028Q3	65.9%	$42	$11	$54
0.031	Project Management		$65	$18	27%	$83	2.3%	$66	$18	$84	$0	2028Q3	65.9%	$110	$30	$140
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$2,665	$720		**$3,385**		$2,687	$725	$3,412	$0			$3,577	$966	**$4,543**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):				2016						
							Effective Price Level Date:				1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach E																
02	RELOCATIONS *		$4,143	$1,119	27%	$5,262	0.8%	$4,176	$1,127	$5,303		0	$5,303	19.4%	$4,986	$1,346	$6,332
06	FISH & WILDLIFE FACILITIES	Construction	$2,061	$557	27%	$2,618	0.4%	$2,070	$559	$2,629		0	$2,629	23.8%	$2,564	$692	$3,256
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$5,464	$1,475	27%	$6,939	0.4%	$5,488	$1,482	$6,970		0	$6,970	16.7%	$6,404	$1,729	$8,133
11	LEVEES & FLOODWALLS	Levees	$39,875	$10,766	27%	$50,641	0.4%	$40,034	$10,809	$50,843		0	$50,843	16.7%	$46,718	$12,614	$59,331
16	BANK STABILIZATION		$15,001	$4,050	27%	$19,051	1.8%	$15,265	$4,122	$19,387		0	$19,387	19.0%	$18,170	$4,906	$23,076
	CONSTRUCTION ESTIMATE TOTALS:		$66,545	$17,967		$84,512	0.7%	$67,033	$18,099	$85,132		0	$85,132	17.6%	$78,841	$21,287	$100,128
01	LANDS AND DAMAGES		$6,538	$752	12%	$7,291	0.6%	$6,575	$756	$7,331		0	$7,331	12.2%	$7,374	$848	$8,223
30	PLANNING, ENGINEERING & DESIGN *		$11,578	$3,126	27%	$14,704	2.3%	$11,844	$3,198	$15,042		0	$15,042	29.4%	$15,329	$4,139	$19,468
31	CONSTRUCTION MANAGEMENT *		$5,617	$1,517	27%	$7,134	2.3%	$5,746	$1,551	$7,298		0	$7,298	38.8%	$7,976	$2,153	$10,129
18	CULTURAL RESOURCE PRESERVATION		$581	$157	27%	$738	0.8%	$576	$155	$731		0	$731	12.7%	$649	$175	$824
	PROJECT COST TOTALS:		$90,859	$23,519	26%	$114,378		$91,774	$23,760	**$115,535**		0	**$115,535**	20.1%	$110,169	$28,603	$138,772

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$90,202**
ESTIMATED NON-FEDERAL COST:	35%	**$48,570**
ESTIMATED TOTAL PROJECT COST:		**$138,772**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach E, Levee Improvements															
02	RELOCATIONS		$3,315	$895	27%	$4,210	0.4%	$3,329	$899	$4,228	$0	2024Q1	16.7%	$3,884	$1,049	$4,933
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$5,464	$1,475	27%	$6,939	0.4%	$5,488	$1,482	$6,970	$0	2024Q1	16.7%	$6,404	$1,729	$8,133
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$39,875	$10,766	27%	$50,641	0.4%	$40,034	$10,809	$50,843	$0	2024Q1	16.7%	$46,718	$12,614	$59,331
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$48,654	$13,137	27%	**$61,791**		$48,851	$13,190	$62,040	$0			$57,006	$15,392	$72,398
01	LANDS AND DAMAGES	Fed	$1,401	$74	5%	$1,475	0.6%	$1,409	$74	$1,483	$0	2022Q1	12.2%	$1,580	$83	$1,664
01	LANDS AND DAMAGES	Non-Fed	$5,137	$678	13%	$5,816	0.6%	$5,166	$682	$5,848	$0	2022Q1	12.2%	$5,794	$765	$6,559
18	CULTURAL RESOURCE PRESERVATION		$442	$119	27%	$561	-1.0%	$437	$118	$555	$0	2022Q1	12.2%	$491	$132	$623
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$725	$196	27%	$921	2.3%	$742	$200	$942	$0	2022Q1	26.1%	$936	$253	$1,188
0.006	Planning & Environmental Compliance		$1,244	$336	27%	$1,580	2.3%	$1,273	$344	$1,616	$0	2022Q1	26.1%	$1,605	$433	$2,039
0.082	Engineering & Design		$3,718	$1,004	27%	$4,722	2.3%	$3,804	$1,027	$4,831	$0	2022Q1	26.1%	$4,798	$1,295	$6,094
0.003	Reviews, ATRs, IEPRs, VE		$136	$37	27%	$173	2.3%	$139	$38	$177	$0	2022Q1	26.1%	$176	$47	$223
0.007	Life Cycle Updates (cost, schedule, risks)		$317	$86	27%	$403	2.3%	$324	$88	$412	$0	2022Q1	26.1%	$409	$110	$520
0.01	Contracting & Reprographics		$453	$122	27%	$575	2.3%	$463	$125	$589	$0	2022Q1	26.1%	$585	$158	$742
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$453	$122	27%	$575	2.3%	$463	$125	$589	$0	2022Q1	26.1%	$585	$158	$742
0.02	Engineering During Construction		$907	$245	27%	$1,152	2.3%	$928	$251	$1,178	$0	2024Q1	36.8%	$1,269	$343	$1,612
0.003	Planning During Construction		$136	$37	27%	$173	2.3%	$139	$38	$177	$0	2024Q1	36.8%	$190	$51	$242
0.013	Project Operations		$589	$159	27%	$748	2.3%	$603	$163	$765	$0	2022Q1	26.1%	$760	$205	$965
0.16	NON-FED Planning, Engineering & Design (Relocations)		$530	$143	27%	$673	2.3%	$542	$146	$689	$0	2022Q1	26.1%	$684	$185	$869
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$2,131	$575	27%	$2,706	2.3%	$2,180	$589	$2,769	$0	2024Q1	36.8%	$2,982	$805	$3,788
0.012	Project Operation:		$544	$147	27%	$691	2.3%	$557	$150	$707	$0	2024Q1	36.8%	$761	$206	$967
0.031	Project Management		$1,406	$380	27%	$1,786	2.3%	$1,438	$388	$1,827	$0	2024Q1	36.8%	$1,968	$531	$2,499
0.09	NON-FED Construction Management (Relocations)		$298	$80	27%	$378	2.3%	$305	$82	$387	$0	2024Q1	36.8%	$417	$113	$530
	CONTRACT COST TOTALS:		$69,221	$17,677		**$86,898**		$69,762	$17,817	$87,580	$0			$82,996	$21,266	**$104,262**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach E, Erosion Protection															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$15,001	$4,050	27%	$19,051	1.8%	$15,265	$4,122	$19,387	$0	2025Q1	19.0%	$18,170	$4,906	$23,076
	CONSTRUCTION ESTIMATE TOTALS:		$15,001	$4,050	27%	**$19,051**		$15,265	$4,122	$19,387	$0			$18,170	$4,906	$23,076
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$123	$33	27%	$156	-1.0%	$122	$33	$154	$0	2023Q3	15.6%	$141	$38	$179
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$240	$65	27%	$305	2.3%	$246	$66	$312	$0	2023Q3	34.0%	$329	$89	$418
0.006	Planning & Environmental Compliance		$90	$24	27%	$114	2.3%	$92	$25	$117	$0	2023Q3	34.0%	$123	$33	$157
0.082	Engineering & Design		$1,230	$332	27%	$1,562	2.3%	$1,258	$340	$1,598	$0	2023Q3	34.0%	$1,686	$455	$2,142
0.003	Reviews, ATRs, IEPRs, VE		$45	$12	27%	$57	2.3%	$46	$12	$58	$0	2023Q3	34.0%	$62	$17	$78
0.007	Life Cycle Updates (cost, schedule, risks)		$105	$28	27%	$133	2.3%	$107	$29	$136	$0	2023Q3	34.0%	$144	$39	$183
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$150	$41	27%	$191	2.3%	$153	$41	$195	$0	2023Q3	34.0%	$206	$56	$261
0.01	Contracting & Reprographics		$150	$41	27%	$191	2.3%	$153	$41	$195	$0	2023Q3	34.0%	$206	$56	$261
0.02	Engineering During Construction		$300	$81	27%	$381	2.3%	$307	$83	$390	$0	2025Q1	42.5%	$437	$118	$556
0.003	Planning During Construction		$45	$12	27%	$57	2.3%	$46	$12	$58	$0	2025Q1	42.5%	$66	$18	$83
0.013	Project Operations		$195	$53	27%	$248	2.3%	$199	$54	$253	$0	2023Q3	34.0%	$267	$72	$340
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$705	$190	27%	$895	2.3%	$721	$195	$916	$0	2025Q1	42.5%	$1,028	$278	$1,306
0.012	Project Operation:		$180	$49	27%	$229	2.3%	$184	$50	$234	$0	2025Q1	42.5%	$262	$71	$333
0.031	Project Management		$465	$126	27%	$591	2.3%	$476	$128	$604	$0	2025Q1	42.5%	$678	$183	$861
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$19,024	$5,136		**$24,160**		$19,377	$5,232	$24,608	$0			$23,805	$6,427	**$30,233**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach E, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$2,061	$557	27%	$2,618	0.4%	$2,070	$559	$2,629	$0	2027Q1	23.8%	$2,564	$692	$3,256
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,061	$557	27%	**$2,618**		$2,070	$559	$2,629	$0			$2,564	$692	$3,256
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$17	$5	27%	$21	-1.0%	$17	$5	$21	$0	2018Q4	5.1%	$18	$5	$22
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$33	$9	27%	$42	2.3%	$34	$9	$43	$0	2023Q3	34.0%	$45	$12	$57
0.006	Planning & Environmental Compliance		$12	$3	27%	$15	2.3%	$12	$3	$16	$0	2023Q3	34.0%	$16	$4	$21
0.082	Engineering & Design		$169	$46	27%	$215	2.3%	$173	$47	$220	$0	2023Q3	34.0%	$232	$63	$294
0.003	Reviews, ATRs, IEPRs, VE		$6	$2	27%	$8	2.3%	$6	$2	$8	$0	2023Q3	34.0%	$8	$2	$10
0.007	Life Cycle Updates (cost, schedule, risks)		$14	$4	27%	$18	2.3%	$14	$4	$18	$0	2023Q3	34.0%	$19	$5	$24
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$21	$6	27%	$27	2.3%	$21	$6	$27	$0	2023Q3	34.0%	$29	$8	$37
0.01	Contracting & Reprographics		$21	$6	27%	$27	2.3%	$21	$6	$27	$0	2023Q3	34.0%	$29	$8	$37
0.02	Engineering During Construction		$41	$11	27%	$52	2.3%	$42	$11	$53	$0	2027Q1	55.3%	$65	$18	$83
0.003	Planning During Construction		$6	$2	27%	$8	2.3%	$6	$2	$8	$0	2027Q1	55.3%	$10	$3	$12
0.013	Project Operations		$27	$7	27%	$34	2.3%	$28	$7	$35	$0	2023Q3	34.0%	$37	$10	$47
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$97	$26	27%	$123	2.3%	$99	$27	$126	$0	2027Q1	55.3%	$154	$42	$196
0.012	Project Operation:		$25	$7	27%	$32	2.3%	$26	$7	$32	$0	2027Q1	55.3%	$40	$11	$50
0.031	Project Management		$64	$17	27%	$81	2.3%	$65	$18	$83	$0	2027Q1	55.3%	$102	$27	$129
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$2,614	$706		**$3,320**		$2,635	$712	$3,347	$0			$3,367	$909	**$4,276**

PROJECT: American River Common Features GRR - Alt 1 - NED

PROJECT NUMBER: P2 # 149827

LOCATION: Sacramento, CA

This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015

POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):				2016						
							Effective Price Level Date:				1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach F																
02	RELOCATIONS *		$11,421	$3,084	27%	$14,504	0.8%	$11,511	$3,108	$14,618		0	$14,618	12.7%	$12,972	$3,503	$16,475
06	FISH & WILDLIFE FACILITIES	Construction	$3,156	$852	27%	$4,009	0.4%	$3,170	$856	$4,026		0	$4,026	17.9%	$3,737	$1,009	$4,746
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$11,523	$3,111	27%	$14,635	0.4%	$11,574	$3,125	$14,698		0	$14,698	11.1%	$12,855	$3,471	$16,326
11	LEVEES & FLOODWALLS	Levees	$106,874	$28,856	27%	$135,731	0.4%	$107,301	$28,971	$136,272		0	$136,272	11.1%	$119,181	$32,179	$151,360
16	BANK STABILIZATION		$37,099	$10,017	27%	$47,116	1.8%	$37,752	$10,193	$47,946		0	$47,946	13.3%	$42,771	$11,548	$54,320
	CONSTRUCTION ESTIMATE TOTALS:		$170,074	$45,920		$215,994	0.7%	$171,308	$46,253	$217,561		0	$217,561	11.8%	$191,517	$51,710	$243,227
01	LANDS AND DAMAGES		$40,436	$21,182	52%	$61,618	0.6%	$40,661	$21,299	$61,960		0	$61,960	7.8%	$43,835	$22,962	$66,798
30	PLANNING, ENGINEERING & DESIGN *		$27,944	$7,545	27%	$35,489	2.3%	$28,587	$7,719	$36,306		0	$36,306	18.2%	$33,777	$9,120	$42,897
31	CONSTRUCTION MANAGEMENT *		$14,279	$3,855	27%	$18,134	2.3%	$14,608	$3,944	$18,552		0	$18,552	25.1%	$18,280	$4,936	$23,216
18	CULTURAL RESOURCE PRESERVATION		$1,628	$440	27%	$2,067	0.8%	$1,612	$435	$2,047		0	$2,047	8.0%	$1,740	$470	$2,210
	PROJECT COST TOTALS:		$254,361	$78,941	31%	$333,303		$256,775	$79,650	**$336,425**		0	**$336,425**	12.5%	$289,150	$89,197	$378,347

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$245,926**
ESTIMATED NON-FEDERAL COST:	35%	**$132,422**
ESTIMATED TOTAL PROJECT COST:		**$378,347**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach F, Levee Improvements															
02	RELOCATIONS		$9,137	$2,467	27%	$11,604	0.4%	$9,174	$2,477	$11,651	$0	2021Q3	11.1%	$10,190	$2,751	$12,941
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$11,523	$3,111	27%	$14,635	0.4%	$11,574	$3,125	$14,698	$0	2021Q3	11.1%	$12,855	$3,471	$16,326
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$106,874	$28,856	27%	$135,731	0.4%	$107,301	$28,971	$136,272	$0	2021Q3	11.1%	$119,181	$32,179	$151,360
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$127,535	$34,434	27%	**$161,969**		$128,048	$34,573	$162,621	$0			$142,226	$38,401	$180,627
01	LANDS AND DAMAGES	Fed	$3,016	$159	5%	$3,175	0.6%	$3,033	$160	$3,193	$0	2020Q1	7.8%	$3,270	$172	$3,442
01	LANDS AND DAMAGES	Non-Fed	$37,420	$21,023	56%	$58,443	0.6%	$37,628	$21,140	$58,767	$0	2020Q1	7.8%	$40,566	$22,790	$63,356
18	CULTURAL RESOURCE PRESERVATION		$1,298	$351	27%	$1,649	-1.0%	$1,285	$347	$1,633	$0	2020Q1	7.8%	$1,386	$374	$1,760
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$1,894	$511	27%	$2,405	2.3%	$1,938	$523	$2,461	$0	2020Q1	16.5%	$2,258	$610	$2,868
0.006	Planning & Environmental Compliance		$1,683	$454	27%	$2,137	2.3%	$1,722	$465	$2,187	$0	2020Q1	16.5%	$2,007	$542	$2,548
0.082	Engineering & Design		$9,709	$2,621	27%	$12,330	2.3%	$9,932	$2,682	$12,614	$0	2020Q1	16.5%	$11,576	$3,125	$14,701
0.003	Reviews, ATRs, IEPRs, VE		$355	$96	27%	$451	2.3%	$363	$98	$461	$0	2020Q1	16.5%	$423	$114	$538
0.007	Life Cycle Updates (cost, schedule, risks)		$829	$224	27%	$1,053	2.3%	$848	$229	$1,077	$0	2020Q1	16.5%	$988	$267	$1,255
0.01	Contracting & Reprographics		$1,184	$320	27%	$1,504	2.3%	$1,211	$327	$1,538	$0	2020Q1	16.5%	$1,412	$381	$1,793
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$1,184	$320	27%	$1,504	2.3%	$1,211	$327	$1,538	$0	2020Q1	16.5%	$1,412	$381	$1,793
0.02	Engineering During Construction		$2,368	$639	27%	$3,007	2.3%	$2,422	$654	$3,077	$0	2021Q3	23.6%	$2,995	$809	$3,804
0.003	Planning During Construction		$355	$96	27%	$451	2.3%	$363	$98	$461	$0	2021Q3	23.6%	$449	$121	$570
0.013	Project Operations		$1,539	$416	27%	$1,955	2.3%	$1,574	$425	$2,000	$0	2020Q1	16.5%	$1,835	$495	$2,330
0.16	NON-FED Planning, Engineering & Design (Relocations)		$1,462	$395	27%	$1,857	2.3%	$1,496	$404	$1,899	$0	2020Q1	16.5%	$1,743	$471	$2,214
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$5,565	$1,503	27%	$7,068	2.3%	$5,693	$1,537	$7,230	$0	2021Q3	23.6%	$7,039	$1,900	$8,939
0.012	Project Operation:		$1,421	$384	27%	$1,805	2.3%	$1,454	$393	$1,846	$0	2021Q3	23.6%	$1,797	$485	$2,283
0.031	Project Management		$3,670	$991	27%	$4,661	2.3%	$3,754	$1,014	$4,768	$0	2021Q3	23.6%	$4,642	$1,253	$5,895
0.09	NON-FED Construction Management (Relocations)		$822	$222	27%	$1,044	2.3%	$841	$227	$1,068	$0	2021Q3	23.6%	$1,040	$281	$1,320
	CONTRACT COST TOTALS:		$203,309	$65,157		**$268,467**		$204,818	$65,622	$270,440	$0			$229,063	$72,974	**$302,036**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach F, Erosion Protection															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$37,099	$10,017	27%	$47,116	1.8%	$37,752	$10,193	$47,946	$0	2022Q3	13.3%	$42,771	$11,548	$54,320
	CONSTRUCTION ESTIMATE TOTALS:		$37,099	$10,017	27%	**$47,116**		$37,752	$10,193	$47,946	$0			$42,771	$11,548	$54,320
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$304	$82	27%	$386	-1.0%	$301	$81	$382	$0	2020Q3	8.9%	$328	$88	$416
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$594	$160	27%	$754	2.3%	$608	$164	$772	$0	2020Q3	18.9%	$722	$195	$917
0.006	Planning & Environmental Compliance		$223	$60	27%	$283	2.3%	$228	$62	$290	$0	2020Q3	18.9%	$271	$73	$344
0.082	Engineering & Design		$3,042	$821	27%	$3,863	2.3%	$3,112	$840	$3,952	$0	2020Q3	18.9%	$3,699	$999	$4,697
0.003	Reviews, ATRs, IEPRs, VE		$111	$30	27%	$141	2.3%	$114	$31	$144	$0	2020Q3	18.9%	$135	$36	$171
0.007	Life Cycle Updates (cost, schedule, risks)		$260	$70	27%	$330	2.3%	$266	$72	$338	$0	2020Q3	18.9%	$316	$85	$401
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$371	$100	27%	$471	2.3%	$380	$102	$482	$0	2020Q3	18.9%	$451	$122	$573
0.01	Contracting & Reprographics		$371	$100	27%	$471	2.3%	$380	$102	$482	$0	2020Q3	18.9%	$451	$122	$573
0.02	Engineering During Construction		$742	$200	27%	$942	2.3%	$759	$205	$964	$0	2022Q3	28.7%	$977	$264	$1,241
0.003	Planning During Construction		$111	$30	27%	$141	2.3%	$114	$31	$144	$0	2022Q3	28.7%	$146	$39	$186
0.013	Project Operations		$482	$130	27%	$612	2.3%	$493	$133	$626	$0	2020Q3	18.9%	$586	$158	$744
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,744	$471	27%	$2,215	2.3%	$1,784	$482	$2,266	$0	2022Q3	28.7%	$2,296	$620	$2,916
0.012	Project Operation:		$445	$120	27%	$565	2.3%	$455	$123	$578	$0	2022Q3	28.7%	$586	$158	$744
0.031	Project Management		$1,150	$311	27%	$1,461	2.3%	$1,176	$318	$1,494	$0	2022Q3	28.7%	$1,514	$409	$1,923
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$47,049	$12,703		**$59,752**		$47,921	$12,939	$60,860	$0			$55,250	$14,917	**$70,167**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach F, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$3,156	$852	27%	$4,009	0.4%	$3,170	$856	$4,026	$0	2024Q3	17.9%	$3,737	$1,009	$4,746
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$3,156	$852	27%	**$4,009**		$3,170	$856	$4,026	$0			$3,737	$1,009	$4,746
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$26	$7	27%	$33	-1.0%	$26	$7	$33	$0	2018Q4	5.1%	$27	$7	$34
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$51	$14	27%	$65	2.3%	$52	$14	$66	$0	2020Q3	18.9%	$62	$17	$79
0.006	Planning & Environmental Compliance		$19	$5	27%	$24	2.3%	$19	$5	$25	$0	2020Q3	18.9%	$23	$6	$29
0.082	Engineering & Design		$259	$70	27%	$329	2.3%	$265	$72	$337	$0	2020Q3	18.9%	$315	$85	$400
0.003	Reviews, ATRs, IEPRs, VE		$9	$2	27%	$11	2.3%	$9	$2	$12	$0	2020Q3	18.9%	$11	$3	$14
0.007	Life Cycle Updates (cost, schedule, risks)		$22	$6	27%	$28	2.3%	$23	$6	$29	$0	2020Q3	18.9%	$27	$7	$34
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$32	$9	27%	$41	2.3%	$33	$9	$42	$0	2020Q3	18.9%	$39	$11	$49
0.01	Contracting & Reprographics		$32	$9	27%	$41	2.3%	$33	$9	$42	$0	2020Q3	18.9%	$39	$11	$49
0.02	Engineering During Construction		$63	$17	27%	$80	2.3%	$64	$17	$82	$0	2024Q3	39.6%	$90	$24	$114
0.003	Planning During Construction		$9	$2	27%	$11	2.3%	$9	$2	$12	$0	2024Q3	39.6%	$13	$3	$16
0.013	Project Operations		$41	$11	27%	$52	2.3%	$42	$11	$53	$0	2020Q3	18.9%	$50	$13	$63
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$148	$40	27%	$188	2.3%	$151	$41	$192	$0	2024Q3	39.6%	$211	$57	$269
0.012	Project Operation:		$38	$10	27%	$48	2.3%	$39	$10	$49	$0	2024Q3	39.6%	$54	$15	$69
0.031	Project Management		$98	$26	27%	$124	2.3%	$100	$27	$127	$0	2024Q3	39.6%	$140	$38	$178
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$4,003	$1,081		**$5,084**		$4,036	$1,090	$5,125	$0			$4,838	$1,306	**$6,144**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J						M	N	O
	ARS, Reach G																	
02	RELOCATIONS *		$26,383	$7,124	27%	$33,507	0.8%	$26,591	$7,180	$33,770			0	$33,770	23.5%	$32,845	$8,868	$41,714
06	FISH & WILDLIFE FACILITIES	Construction	$2,211	$597	27%	$2,808	0.4%	$2,221	$600	$2,820			0	$2,820	27.6%	$2,833	$765	$3,598
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$4,706	$1,271	27%	$5,976	0.4%	$4,726	$1,276	$6,002			0	$6,002	20.2%	$5,682	$1,534	$7,217
11	LEVEES & FLOODWALLS	Levees	$31,462	$8,495	27%	$39,956	0.4%	$31,587	$8,529	$40,116			0	$40,116	20.2%	$37,977	$10,254	$48,231
16	BANK STABILIZATION		$18,457	$4,983	27%	$23,441	1.8%	$18,782	$5,071	$23,854			0	$23,854	22.6%	$23,034	$6,219	$29,253
	CONSTRUCTION ESTIMATE TOTALS:		$83,219	$22,469		$105,689	0.8%	$83,908	$22,655	$106,563			0	$106,563	22.0%	$102,372	$27,640	$130,012
01	LANDS AND DAMAGES		$5,336	$1,496	28%	$6,832	0.6%	$5,365	$1,505	$6,870			0	$6,870	14.4%	$6,138	$1,721	$7,860
30	PLANNING, ENGINEERING & DESIGN *		$10,635	$2,871	27%	$13,506	2.3%	$10,880	$2,938	$13,817			0	$13,817	37.5%	$14,959	$4,039	$18,999
31	CONSTRUCTION MANAGEMENT *		$5,115	$1,381	27%	$6,496	2.3%	$5,233	$1,413	$6,646			0	$6,646	48.5%	$7,768	$2,097	$9,866
18	CULTURAL RESOURCE PRESERVATION		$644	$174	27%	$817	0.8%	$637	$172	$809			0	$809	15.9%	$739	$200	$938
	PROJECT COST TOTALS:		$104,949	$28,392	27%	$133,341		$106,023	$28,682	**$134,705**			0	**$134,705**	24.5%	$131,977	$35,698	$167,674

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$108,988**
ESTIMATED NON-FEDERAL COST:	35%	**$58,686**
ESTIMATED TOTAL PROJECT COST:		**$167,674**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach G, Levee Improvements															
02	RELOCATIONS		$21,106	$5,699	27%	$26,805	0.4%	$21,192	$5,722	$26,914	$0	2025Q3	20.2%	$25,479	$6,879	$32,358
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$4,706	$1,271	27%	$5,976	0.4%	$4,726	$1,276	$6,002	$0	2025Q3	20.2%	$5,682	$1,534	$7,217
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$31,462	$8,495	27%	$39,956	0.4%	$31,587	$8,529	$40,116	$0	2025Q3	20.2%	$37,977	$10,254	$48,231
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$57,274	$15,464	27%	**$72,738**		$57,506	$15,527	$73,032	$0			$69,138	$18,667	$87,806
01	LANDS AND DAMAGES	Fed	$570	$30	5%	$600	0.6%	$573	$30	$603	$0	2023Q1	14.4%	$656	$35	$690
01	LANDS AND DAMAGES	Non-Fed	$4,766	$1,466	31%	$6,232	0.6%	$4,792	$1,474	$6,267	$0	2023Q1	14.4%	$5,483	$1,687	$7,169
18	CULTURAL RESOURCE PRESERVATION		$474	$128	27%	$603	-1.0%	$470	$127	$597	$0	2023Q1	14.4%	$537	$145	$683
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$579	$156	27%	$735	2.3%	$592	$160	$752	$0	2023Q1	31.3%	$778	$210	$988
0.006	Planning & Environmental Compliance		$1,189	$321	27%	$1,510	2.3%	$1,216	$328	$1,545	$0	2023Q1	31.3%	$1,597	$431	$2,029
0.082	Engineering & Design		$2,966	$801	27%	$3,767	2.3%	$3,034	$819	$3,854	$0	2023Q1	31.3%	$3,985	$1,076	$5,060
0.003	Reviews, ATRs, IEPRs, VE		$109	$29	27%	$138	2.3%	$112	$30	$142	$0	2023Q1	31.3%	$146	$40	$186
0.007	Life Cycle Updates (cost, schedule, risks)		$253	$68	27%	$321	2.3%	$259	$70	$329	$0	2023Q1	31.3%	$340	$92	$432
0.01	Contracting & Reprographics		$362	$98	27%	$460	2.3%	$370	$100	$470	$0	2023Q1	31.3%	$486	$131	$618
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$362	$98	27%	$460	2.3%	$370	$100	$470	$0	2023Q1	31.3%	$486	$131	$618
0.02	Engineering During Construction		$723	$195	27%	$918	2.3%	$740	$200	$939	$0	2025Q3	45.6%	$1,077	$291	$1,368
0.003	Planning During Construction		$109	$29	27%	$138	2.3%	$112	$30	$142	$0	2025Q3	45.6%	$162	$44	$206
0.013	Project Operations		$470	$127	27%	$597	2.3%	$481	$130	$611	$0	2023Q1	31.3%	$631	$170	$802
0.16	NON-FED Planning, Engineering & Design (Relocations)		$3,377	$912	27%	$4,289	2.3%	$3,455	$933	$4,387	$0	2023Q1	31.3%	$4,537	$1,225	$5,762
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,700	$459	27%	$2,159	2.3%	$1,739	$470	$2,209	$0	2025Q3	45.6%	$2,532	$684	$3,215
0.012	Project Operation:		$434	$117	27%	$551	2.3%	$444	$120	$564	$0	2025Q3	45.6%	$646	$175	$821
0.031	Project Management		$1,121	$303	27%	$1,424	2.3%	$1,147	$310	$1,456	$0	2025Q3	45.6%	$1,670	$451	$2,120
0.09	NON-FED Construction Management (Relocations)		$1,900	$513	27%	$2,413	2.3%	$1,944	$525	$2,469	$0	2025Q3	45.6%	$2,830	$764	$3,594
	CONTRACT COST TOTALS:		$78,738	$21,315		**$100,053**		$79,355	$21,482	$100,837	$0			$97,717	$26,448	**$124,165**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach G, Erosion Protection															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$18,457	$4,983	27%	$23,441	1.8%	$18,782	$5,071	$23,854	$0	2026Q3	22.6%	$23,034	$6,219	$29,253
	CONSTRUCTION ESTIMATE TOTALS:		$18,457	$4,983	27%	**$23,441**		$18,782	$5,071	$23,854	$0			$23,034	$6,219	$29,253
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$151	$41	27%	$192	-1.0%	$150	$40	$190	$0	2025Q3	20.2%	$180	$49	$229
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$295	$80	27%	$375	2.3%	$302	$81	$383	$0	2025Q3	45.6%	$439	$119	$558
0.006	Planning & Environmental Compliance		$111	$30	27%	$141	2.3%	$114	$31	$144	$0	2025Q3	45.6%	$165	$45	$210
0.082	Engineering & Design		$1,514	$409	27%	$1,923	2.3%	$1,549	$418	$1,967	$0	2025Q3	45.6%	$2,255	$609	$2,864
0.003	Reviews, ATRs, IEPRs, VE		$55	$15	27%	$70	2.3%	$56	$15	$71	$0	2025Q3	45.6%	$82	$22	$104
0.007	Life Cycle Updates (cost, schedule, risks)		$129	$35	27%	$164	2.3%	$132	$36	$168	$0	2025Q3	45.6%	$192	$52	$244
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$185	$50	27%	$235	2.3%	$189	$51	$240	$0	2025Q3	45.6%	$276	$74	$350
0.01	Contracting & Reprographics		$185	$50	27%	$235	2.3%	$189	$51	$240	$0	2025Q3	45.6%	$276	$74	$350
0.02	Engineering During Construction		$369	$100	27%	$469	2.3%	$377	$102	$479	$0	2026Q3	52.0%	$574	$155	$729
0.003	Planning During Construction		$55	$15	27%	$70	2.3%	$56	$15	$71	$0	2026Q3	52.0%	$86	$23	$109
0.013	Project Operations		$240	$65	27%	$305	2.3%	$246	$66	$312	$0	2025Q3	45.6%	$357	$97	$454
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$867	$234	27%	$1,101	2.3%	$887	$239	$1,126	$0	2026Q3	52.0%	$1,348	$364	$1,712
0.012	Project Operation:		$221	$60	27%	$281	2.3%	$226	$61	$287	$0	2026Q3	52.0%	$344	$93	$436
0.031	Project Management		$572	$154	27%	$726	2.3%	$585	$158	$743	$0	2026Q3	52.0%	$889	$240	$1,130
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$23,406	$6,320		**$29,726**		$23,841	$6,437	$30,278	$0			$30,496	$8,234	**$38,730**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach G, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$2,211	$597	27%	$2,808	0.4%	$2,221	$600	$2,820	$0	2028Q3	27.6%	$2,833	$765	$3,598
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,211	$597	27%	**$2,808**		$2,221	$600	$2,820	$0			$2,833	$765	$3,598
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$18	$5	27%	$23	-1.0%	$18	$5	$23	$0	2025Q3	20.2%	$22	$6	$27
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$35	$9	27%	$44	2.3%	$36	$10	$45	$0	2025Q3	45.6%	$52	$14	$66
0.006	Planning & Environmental Compliance		$13	$4	27%	$17	2.3%	$13	$4	$17	$0	2025Q3	45.6%	$19	$5	$25
0.082	Engineering & Design		$181	$49	27%	$230	2.3%	$185	$50	$235	$0	2025Q3	45.6%	$270	$73	$342
0.003	Reviews, ATRs, IEPRs, VE		$7	$2	27%	$9	2.3%	$7	$2	$9	$0	2025Q3	45.6%	$10	$3	$13
0.007	Life Cycle Updates (cost, schedule, risks)		$15	$4	27%	$19	2.3%	$15	$4	$19	$0	2025Q3	45.6%	$22	$6	$28
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$22	$6	27%	$28	2.3%	$23	$6	$29	$0	2025Q3	45.6%	$33	$9	$42
0.01	Contracting & Reprographics		$22	$6	27%	$28	2.3%	$23	$6	$29	$0	2025Q3	45.6%	$33	$9	$42
0.02	Engineering During Construction		$44	$12	27%	$56	2.3%	$45	$12	$57	$0	2028Q3	65.9%	$75	$20	$95
0.003	Planning During Construction		$7	$2	27%	$9	2.3%	$7	$2	$9	$0	2028Q3	65.9%	$12	$3	$15
0.013	Project Operations		$29	$8	27%	$37	2.3%	$30	$8	$38	$0	2025Q3	45.6%	$43	$12	$55
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$104	$28	27%	$132	2.3%	$106	$29	$135	$0	2028Q3	65.9%	$177	$48	$224
0.012	Project Operation:		$27	$7	27%	$34	2.3%	$28	$7	$35	$0	2028Q3	65.9%	$46	$12	$58
0.031	Project Management		$69	$19	27%	$88	2.3%	$71	$19	$90	$0	2028Q3	65.9%	$117	$32	$149
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$2,804	$757		**$3,561**		$2,827	$763	$3,590	$0			$3,763	$1,016	**$4,780**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J				M	N	O	
	ARN, Reach A																
02	RELOCATIONS *		$1,972	$532	27%	$2,504	0.8%	$1,987	$537	$2,524		0	$2,524	19.7%	$2,379	$642	$3,021
06	FISH & WILDLIFE FACILITIES	Construction	$2,521	$681	27%	$3,201	0.4%	$2,531	$684	$3,215		0	$3,215	19.0%	$3,013	$814	$3,827
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$4,602	$1,243	27%	$5,845	0.4%	$4,622	$1,248	$5,870		0	$5,870	16.7%	$5,394	$1,456	$6,850
16	BANK STABILIZATION		$70,051	$18,914	27%	$88,965	1.8%	$71,285	$19,247	$90,532		0	$90,532	16.7%	$83,187	$22,461	$105,648
	CONSTRUCTION ESTIMATE TOTALS:		$79,146	$21,369		$100,515	1.6%	$80,426	$21,715	$102,141		0	$102,141	16.8%	$93,974	$25,373	$119,346
01	LANDS AND DAMAGES		$1,646	$518	31%	$2,164	0.6%	$1,656	$520	$2,176		0	$2,176	13.3%	$1,876	$590	$2,465
30	PLANNING, ENGINEERING & DESIGN *		$14,093	$3,805	27%	$17,898	2.3%	$14,417	$3,893	$18,310		0	$18,310	29.7%	$18,706	$5,051	$23,757
31	CONSTRUCTION MANAGEMENT *		$6,945	$1,875	27%	$8,820	2.3%	$7,105	$1,918	$9,023		0	$9,023	37.0%	$9,733	$2,628	$12,361
18	CULTURAL RESOURCE PRESERVATION		$659	$178	27%	$837	0.8%	$653	$176	$829		0	$829	13.4%	$740	$200	$940
	PROJECT COST TOTALS:		$102,489	$27,745	27%	$130,235		$104,257	$28,223	**$132,480**		0	**$132,480**	19.9%	$125,028	$33,841	$158,869

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$103,265**
ESTIMATED NON-FEDERAL COST:	35%	**$55,604**
ESTIMATED TOTAL PROJECT COST:		**$158,869**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach A, Erosion Protection															
02	RELOCATIONS		$1,578	$426	27%	$2,004	0.4%	$1,584	$428	$2,012	$0	2024Q1	16.7%	$1,849	$499	$2,348
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$4,602	$1,243	27%	$5,845	0.4%	$4,622	$1,248	$5,870	$0	2024Q1	16.7%	$5,394	$1,456	$6,850
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$70,051	$18,914	27%	$88,965	1.8%	$71,285	$19,247	$90,532	$0	2024Q1	16.7%	$83,187	$22,461	$105,648
	CONSTRUCTION ESTIMATE TOTALS:		$76,231	$20,582	27%	**$96,813**		$77,492	$20,923	$98,414	$0			$90,430	$24,416	$114,846
01	LANDS AND DAMAGES	Fed	$190	$10	5%	$200	0.6%	$191	$10	$201	$0	2022Q3	13.3%	$216	$11	$228
01	LANDS AND DAMAGES	Non-Fed	$1,456	$508	35%	$1,964	0.6%	$1,465	$510	$1,975	$0	2022Q3	13.3%	$1,659	$578	$2,237
18	CULTURAL RESOURCE PRESERVATION		$639	$172	27%	$811	-1.0%	$632	$171	$803	$0	2022Q3	13.3%	$717	$193	$910
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$1,194	$322	27%	$1,516	2.3%	$1,221	$330	$1,551	$0	2022Q3	28.7%	$1,572	$424	$1,997
0.006	Planning & Environmental Compliance		$1,420	$383	27%	$1,803	2.3%	$1,453	$392	$1,845	$0	2022Q3	28.7%	$1,870	$505	$2,375
0.082	Engineering & Design		$6,122	$1,653	27%	$7,775	2.3%	$6,263	$1,691	$7,954	$0	2022Q3	28.7%	$8,061	$2,176	$10,237
0.003	Reviews, ATRs, IEPRs, VE		$224	$60	27%	$284	2.3%	$229	$62	$291	$0	2022Q3	28.7%	$295	$80	$375
0.007	Life Cycle Updates (cost, schedule, risks)		$523	$141	27%	$664	2.3%	$535	$144	$679	$0	2022Q3	28.7%	$689	$186	$875
0.01	Contracting & Reprographics		$747	$202	27%	$949	2.3%	$764	$206	$971	$0	2022Q3	28.7%	$984	$266	$1,249
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$747	$202	27%	$949	2.3%	$764	$206	$971	$0	2022Q3	28.7%	$984	$266	$1,249
0.02	Engineering During Construction		$1,493	$403	27%	$1,896	2.3%	$1,527	$412	$1,940	$0	2024Q1	36.8%	$2,089	$564	$2,654
0.003	Planning During Construction		$224	$60	27%	$284	2.3%	$229	$62	$291	$0	2024Q1	36.8%	$313	$85	$398
0.013	Project Operations		$970	$262	27%	$1,232	2.3%	$992	$268	$1,260	$0	2022Q3	28.7%	$1,277	$345	$1,622
0.16	NON-FED Planning, Engineering & Design (Relocations)		$252	$68	27%	$320	2.3%	$258	$70	$327	$0	2022Q3	28.7%	$332	$90	$421
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$3,509	$947	27%	$4,456	2.3%	$3,590	$969	$4,559	$0	2024Q1	36.8%	$4,911	$1,326	$6,237
0.012	Project Operation:		$896	$242	27%	$1,138	2.3%	$917	$247	$1,164	$0	2024Q1	36.8%	$1,254	$339	$1,593
0.031	Project Management		$2,314	$625	27%	$2,939	2.3%	$2,367	$639	$3,006	$0	2024Q1	36.8%	$3,238	$874	$4,113
0.09	NON-FED Construction Management (Relocations)		$142	$38	27%	$180	2.3%	$145	$39	$184	$0	2024Q1	36.8%	$199	$54	$252
	CONTRACT COST TOTALS:		$99,293	$26,882		**$126,175**		$101,035	$27,353	$128,388	$0			$121,089	$32,777	**$153,866**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach A, Erosion Protection, Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$2,521	$681	27%	$3,201	0.4%	$2,531	$684	$3,215	$0	2025Q1	19.0%	$3,013	$814	$3,827
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,521	$681	27%	**$3,201**		$2,531	$684	$3,215	$0			$3,013	$814	$3,827
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$21	$6	27%	$26	-1.0%	$20	$6	$26	$0	2023Q3	15.6%	$24	$6	$30
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$40	$11	27%	$51	2.3%	$41	$11	$52	$0	2022Q3	28.7%	$53	$14	$67
0.006	Planning & Environmental Compliance		$15	$4	27%	$19	2.3%	$15	$4	$19	$0	2022Q3	28.7%	$20	$5	$25
0.082	Engineering & Design		$207	$56	27%	$263	2.3%	$212	$57	$269	$0	2022Q3	28.7%	$273	$74	$346
0.003	Reviews, ATRs, IEPRs, VE		$8	$2	27%	$10	2.3%	$8	$2	$10	$0	2022Q3	28.7%	$11	$3	$13
0.007	Life Cycle Updates (cost, schedule, risks)		$18	$5	27%	$23	2.3%	$18	$5	$23	$0	2022Q3	28.7%	$24	$6	$30
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$25	$7	27%	$32	2.3%	$26	$7	$32	$0	2022Q3	28.7%	$33	$9	$42
0.01	Contracting & Reprographics		$25	$7	27%	$32	2.3%	$26	$7	$32	$0	2022Q3	28.7%	$33	$9	$42
0.02	Engineering During Construction		$50	$14	27%	$64	2.3%	$51	$14	$65	$0	2025Q1	42.5%	$73	$20	$93
0.003	Planning During Construction		$8	$2	27%	$10	2.3%	$8	$2	$10	$0	2025Q1	42.5%	$12	$3	$15
0.013	Project Operations		$33	$9	27%	$42	2.3%	$34	$9	$43	$0	2022Q3	28.7%	$43	$12	$55
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$118	$32	27%	$150	2.3%	$121	$33	$153	$0	2025Q1	42.5%	$172	$46	$219
0.012	Project Operation:		$30	$8	27%	$38	2.3%	$31	$8	$39	$0	2025Q1	42.5%	$44	$12	$56
0.031	Project Management		$78	$21	27%	$99	2.3%	$80	$22	$101	$0	2025Q1	42.5%	$114	$31	$144
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$3,196	$863		**$4,059**		$3,222	$870	$4,092	$0			$3,939	$1,064	**$5,003**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST						TOTAL PROJECT COST			
							Program Year (Budget EC):			2016						
							Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARN, Reach B															
02	RELOCATIONS *		$81	$22	27%	$103	0.8%	$82	$22	$104		0	$104	27.7%	$105	$28	$133
06	FISH & WILDLIFE FACILITIES	Construction	$383	$104	27%	$487	0.4%	$385	$104	$489		0	$489	27.6%	$491	$133	$624
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$408	$110	27%	$518	0.4%	$410	$111	$520		0	$520	22.6%	$503	$136	$638
16	BANK STABILIZATION		$3,538	$955	27%	$4,493	1.8%	$3,600	$972	$4,572		0	$4,572	22.6%	$4,415	$1,192	$5,607
	CONSTRUCTION ESTIMATE TOTALS:		$4,410	$1,191		$5,601	1.5%	$4,477	$1,209	$5,685		0	$5,685	23.2%	$5,513	$1,489	$7,002
01	LANDS AND DAMAGES		$235	$41	18%	$276	0.6%	$236	$41	$278		0	$278	20.2%	$284	$50	$334
30	PLANNING, ENGINEERING & DESIGN *		$736	$199	27%	$935	2.3%	$753	$203	$956		0	$956	46.6%	$1,104	$298	$1,402
31	CONSTRUCTION MANAGEMENT *		$389	$105	27%	$494	2.3%	$398	$107	$505		0	$505	53.2%	$610	$165	$774
18	CULTURAL RESOURCE PRESERVATION		$37	$10	27%	$48	0.8%	$37	$10	$47		0	$47	20.4%	$45	$12	$57
	PROJECT COST TOTALS:		$5,808	$1,546	27%	$7,353		$5,901	$1,571	**$7,472**		0	**$7,472**	28.1%	$7,556	$2,013	$9,569

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$6,220**
ESTIMATED NON-FEDERAL COST:	35%	**$3,349**
ESTIMATED TOTAL PROJECT COST:		**$9,569**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach B, Erosion Protection															
02	RELOCATIONS		$65	$18	27%	$83	0.4%	$66	$18	$83	$0	2026Q3	22.6%	$80	$22	$102
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$408	$110	27%	$518	0.4%	$410	$111	$520	$0	2026Q3	22.6%	$503	$136	$638
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$3,538	$955	27%	$4,493	1.8%	$3,600	$972	$4,572	$0	2026Q3	22.6%	$4,415	$1,192	$5,607
	CONSTRUCTION ESTIMATE TOTALS:		$4,011	$1,083	27%	**$5,094**		$4,075	$1,100	$5,176	$0			$4,998	$1,349	$6,347
01	LANDS AND DAMAGES	Fed	$48	$2	5%	$50	0.6%	$48	$3	$50	$0	2025Q3	20.2%	$57	$3	$60
01	LANDS AND DAMAGES	Non-Fed	$187	$39	21%	$226	0.6%	$188	$39	$227	$0	2025Q3	20.2%	$227	$47	$273
18	CULTURAL RESOURCE PRESERVATION		$34	$9	27%	$44	-1.0%	$34	$9	$43	$0	2025Q3	20.2%	$41	$11	$52
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$63	$17	27%	$80	2.3%	$64	$17	$82	$0	2025Q3	45.6%	$94	$25	$119
0.006	Planning & Environmental Compliance		$24	$6	27%	$30	2.3%	$25	$7	$31	$0	2025Q3	45.6%	$36	$10	$45
0.082	Engineering & Design		$324	$87	27%	$411	2.3%	$331	$89	$421	$0	2025Q3	45.6%	$483	$130	$613
0.003	Reviews, ATRs, IEPRs, VE		$12	$3	27%	$15	2.3%	$12	$3	$16	$0	2025Q3	45.6%	$18	$5	$23
0.007	Life Cycle Updates (cost, schedule, risks)		$28	$8	27%	$36	2.3%	$29	$8	$36	$0	2025Q3	45.6%	$42	$11	$53
0.01	Contracting & Reprographics		$39	$11	27%	$50	2.3%	$40	$11	$51	$0	2025Q3	45.6%	$58	$16	$74
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$39	$11	27%	$50	2.3%	$40	$11	$51	$0	2025Q3	45.6%	$58	$16	$74
0.02	Engineering During Construction		$79	$21	27%	$100	2.3%	$81	$22	$103	$0	2026Q3	52.0%	$123	$33	$156
0.003	Planning During Construction		$12	$3	27%	$15	2.3%	$12	$3	$16	$0	2026Q3	52.0%	$19	$5	$24
0.013	Project Operations		$51	$14	27%	$65	2.3%	$52	$14	$66	$0	2025Q3	45.6%	$76	$21	$96
0.16	NON-FED Planning, Engineering & Design (Relocations)		$10	$3	27%	$13	2.3%	$10	$3	$13	$0	2025Q3	45.6%	$15	$4	$19
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$185	$50	27%	$235	2.3%	$189	$51	$240	$0	2026Q3	52.0%	$288	$78	$365
0.012	Project Operation:		$47	$13	27%	$60	2.3%	$48	$13	$61	$0	2026Q3	52.0%	$73	$20	$93
0.031	Project Management		$122	$33	27%	$155	2.3%	$125	$34	$159	$0	2026Q3	52.0%	$190	$51	$241
0.09	NON-FED Construction Management (Relocations)		$6	$2	27%	$8	2.3%	$6	$2	$8	$0	2026Q3	52.0%	$9	$3	$12
	CONTRACT COST TOTALS:		$5,321	$1,414		**$6,736**		$5,410	$1,438	$6,849	$0			$6,902	$1,837	**$8,739**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach B, Erosion Protection, Plant Establishment															
02	RELOCATIONS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$383	$104	27%	$487	0.4%	$385	$104	$489	$0	2028Q3	27.6%	$491	$133	$624
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$383	$104	27%	**$487**		$385	$104	$489	$0			$491	$133	$624
01	LANDS AND DAMAGES	Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$3	$1	27%	$4	-1.0%	$3	$1	$4	$0	2026Q3	22.6%	$4	$1	$5
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$6	$2	27%	$8	2.3%	$6	$2	$8	$0	2025Q3	45.6%	$9	$2	$11
0.006	Planning & Environmental Compliance		$2	$1	27%	$3	2.3%	$2	$1	$3	$0	2025Q3	45.6%	$3	$1	$4
0.082	Engineering & Design		$31	$8	27%	$39	2.3%	$32	$9	$40	$0	2025Q3	45.6%	$46	$12	$59
0.003	Reviews, ATRs, IEPRs, VE		$1	$0	27%	$1	2.3%	$1	$0	$1	$0	2025Q3	45.6%	$1	$0	$2
0.007	Life Cycle Updates (cost, schedule, risks)		$3	$1	27%	$4	2.3%	$3	$1	$4	$0	2025Q3	45.6%	$4	$1	$6
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$4	$1	27%	$5	2.3%	$4	$1	$5	$0	2025Q3	45.6%	$6	$2	$8
0.01	Contracting & Reprographics		$4	$1	27%	$5	2.3%	$4	$1	$5	$0	2025Q3	45.6%	$6	$2	$8
0.02	Engineering During Construction		$8	$2	27%	$10	2.3%	$8	$2	$10	$0	2028Q3	65.9%	$14	$4	$17
0.003	Planning During Construction		$1	$0	27%	$1	2.3%	$1	$0	$1	$0	2028Q3	65.9%	$2	$0	$2
0.013	Project Operations		$5	$1	27%	$6	2.3%	$5	$1	$6	$0	2025Q3	45.6%	$7	$2	$9
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$18	$5	27%	$23	2.3%	$18	$5	$23	$0	2028Q3	65.9%	$31	$8	$39
0.012	Project Operation:		$5	$1	27%	$6	2.3%	$5	$1	$6	$0	2028Q3	65.9%	$8	$2	$11
0.031	Project Management		$12	$3	27%	$15	2.3%	$12	$3	$16	$0	2028Q3	65.9%	$20	$5	$26
0.09	NON-FED Construction Management (Relocations)		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$487	$131		**$618**		$490	$132	$623	$0			$653	$176	**$830**

PROJECT: American River Common Features GRR - Alt 1 - NED

PROJECT NUMBER: P2 # 149827

LOCATION: Sacramento, CA

This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015

POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**		10/1/2014 ($K)	**FIRST COST** ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*					*M*	*N*	*O*
	ARN, Reach C																
02	RELOCATIONS *		$1,180	$319	27%	$1,499	0.8%	$1,190	$321	$1,511		0	$1,511	30.0%	$1,546	$418	$1,964
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$100	$27	27%	$127	0.4%	$100	$27	$128		0	$128	24.5%	$125	$34	$159
11	LEVEES & FLOODWALLS	Levees	$5,025	$1,357	27%	$6,381	0.4%	$5,045	$1,362	$6,407		0	$6,407	24.5%	$6,279	$1,695	$7,974
	CONSTRUCTION ESTIMATE TOTALS:		$6,305	$1,702		$8,007	0.5%	$6,335	$1,710	$8,045		0	$8,045	25.5%	$7,950	$2,147	$10,097
01	LANDS AND DAMAGES		$191	$15	8%	$206	0.6%	$192	$15	$207		0	$207	21.4%	$233	$18	$251
30	PLANNING, ENGINEERING & DESIGN *		$870	$235	27%	$1,105	2.3%	$890	$240	$1,130		0	$1,130	49.9%	$1,334	$360	$1,694
31	CONSTRUCTION MANAGEMENT *		$461	$124	27%	$585	2.3%	$472	$127	$599		0	$599	56.9%	$740	$200	$940
18	CULTURAL RESOURCE PRESERVATION		$49	$13	27%	$63	0.8%	$49	$13	$62		0	$62	21.4%	$59	$16	$75
	PROJECT COST TOTALS:		$7,876	$2,090	27%	$9,966		$7,937	$2,106	**$10,043**		0	**$10,043**	30.0%	$10,316	$2,741	$13,057

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$8,487**
ESTIMATED NON-FEDERAL COST:	35%	**$4,570**
ESTIMATED TOTAL PROJECT COST:		**$13,057**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach C, Levee Improvements															
02	RELOCATIONS		$944	$255	27%	$1,199	0.4%	$948	$256	$1,204	$0	2027Q2	24.5%	$1,180	$319	$1,499
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$100	$27	27%	$127	0.4%	$100	$27	$128	$0	2027Q2	24.5%	$125	$34	$159
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$5,025	$1,357	27%	$6,381	0.4%	$5,045	$1,362	$6,407	$0	2027Q2	24.5%	$6,279	$1,695	$7,974
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$6,069	$1,639	27%	**$7,708**		$6,093	$1,645	$7,738	$0			$7,584	$2,048	$9,631
01	LANDS AND DAMAGES	Fed	$48	$2	5%	$50	0.6%	$48	$3	$50	$0	2026Q1	21.4%	$58	$3	$61
01	LANDS AND DAMAGES	Non-Fed	$143	$13	9%	$156	0.6%	$144	$13	$157	$0	2026Q1	21.4%	$175	$15	$190
18	CULTURAL RESOURCE PRESERVATION		$49	$13	27%	$63	-1.0%	$49	$13	$62	$0	2026Q1	21.4%	$59	$16	$75
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$82	$22	27%	$104	2.3%	$84	$23	$107	$0	2026Q1	48.7%	$125	$34	$158
0.006	Planning & Environmental Compliance		$31	$8	27%	$39	2.3%	$32	$9	$40	$0	2026Q1	48.7%	$47	$13	$60
0.082	Engineering & Design		$420	$113	27%	$533	2.3%	$430	$116	$546	$0	2026Q1	48.7%	$639	$173	$812
0.003	Reviews, ATRs, IEPRs, VE		$15	$4	27%	$19	2.3%	$15	$4	$19	$0	2026Q1	48.7%	$23	$6	$29
0.007	Life Cycle Updates (cost, schedule, risks)		$36	$10	27%	$46	2.3%	$37	$10	$47	$0	2026Q1	48.7%	$55	$15	$70
0.01	Contracting & Reprographics		$51	$14	27%	$65	2.3%	$52	$14	$66	$0	2026Q1	48.7%	$78	$21	$99
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$51	$14	27%	$65	2.3%	$52	$14	$66	$0	2026Q1	48.7%	$78	$21	$99
0.02	Engineering During Construction		$102	$28	27%	$130	2.3%	$104	$28	$133	$0	2027Q2	56.9%	$164	$44	$208
0.003	Planning During Construction		$15	$4	27%	$19	2.3%	$15	$4	$19	$0	2027Q2	56.9%	$24	$7	$31
0.013	Project Operations		$67	$18	27%	$85	2.3%	$69	$19	$87	$0	2026Q1	48.7%	$102	$28	$129
0.16	NON-FED Planning, Engineering & Design (Relocations)		$151	$41	27%	$192	2.3%	$154	$42	$196	$0	2026Q1	48.7%	$230	$62	$292
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$241	$65	27%	$306	2.3%	$247	$67	$313	$0	2027Q2	56.9%	$387	$104	$491
0.012	Project Operation:		$61	$16	27%	$77	2.3%	$62	$17	$79	$0	2027Q2	56.9%	$98	$26	$124
0.031	Project Management		$159	$43	27%	$202	2.3%	$163	$44	$207	$0	2027Q2	56.9%	$255	$69	$324
0.09	NON-FED Construction Management (Relocations)		$85	$23	27%	$108	2.3%	$87	$23	$110	$0	2027Q2	56.9%	$136	$37	$173
	CONTRACT COST TOTALS:		$7,876	$2,090		**$9,966**		$7,937	$2,106	$10,043	$0			$10,316	$2,741	**$13,057**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST						TOTAL PROJECT COST			
							Program Year (Budget EC):			2016						
							Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARN, Reach D																
02	RELOCATIONS *		$8,344	$2,253	27%	$10,596	0.8%	$8,409	$2,271	$10,680		0	$10,680	23.5%	$10,387	$2,805	$13,192
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$660	$178	27%	$838	0.4%	$663	$179	$842		0	$842	20.2%	$797	$215	$1,012
11	LEVEES & FLOODWALLS	Levees	$27,062	$7,307	27%	$34,368	0.4%	$27,170	$7,336	$34,505		0	$34,505	20.2%	$32,666	$8,820	$41,485
	CONSTRUCTION ESTIMATE TOTALS:		$36,065	$9,738		$45,803	0.5%	$36,242	$9,785	$46,027		0	$46,027	21.0%	$43,850	$11,839	$55,689
01	LANDS AND DAMAGES		$2,950	$405	14%	$3,355	0.6%	$2,967	$407	$3,374		0	$3,374	14.4%	$3,394	$465	$3,860
30	PLANNING, ENGINEERING & DESIGN *		$4,711	$1,272	27%	$5,983	2.3%	$4,819	$1,301	$6,121		0	$6,121	33.2%	$6,422	$1,734	$8,156
31	CONSTRUCTION MANAGEMENT *		$2,495	$674	27%	$3,169	2.3%	$2,552	$689	$3,242		0	$3,242	45.6%	$3,716	$1,003	$4,719
18	CULTURAL RESOURCE PRESERVATION		$290	$78	27%	$368	0.8%	$287	$77	$364		0	$364	14.4%	$328	$89	$417
	PROJECT COST TOTALS:		$46,511	$12,166	26%	$58,677		$46,867	$12,260	**$59,127**		0	**$59,127**	23.2%	$57,710	$15,131	$72,840

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$47,346**
ESTIMATED NON-FEDERAL COST:	35%	**$25,494**
ESTIMATED TOTAL PROJECT COST:		**$72,840**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARN, Reach D, Levee Improvements															
02	RELOCATIONS		$6,675	$1,802	27%	$8,477	0.4%	$6,702	$1,809	$8,511	$0	2025Q3	20.2%	$8,057	$2,176	$10,233
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$660	$178	27%	$838	0.4%	$663	$179	$842	$0	2025Q3	20.2%	$797	$215	$1,012
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$27,062	$7,307	27%	$34,368	0.4%	$27,170	$7,336	$34,505	$0	2025Q3	20.2%	$32,666	$8,820	$41,485
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$34,396	$9,287	27%	**$43,683**		$34,534	$9,324	$43,859	$0			$41,520	$11,210	$52,731
01	LANDS AND DAMAGES	Fed	$665	$35	5%	$700	0.6%	$669	$35	$704	$0	2023Q1	14.4%	$765	$40	$805
01	LANDS AND DAMAGES	Non-Fed	$2,285	$370	16%	$2,655	0.6%	$2,298	$372	$2,670	$0	2023Q1	14.4%	$2,629	$425	$3,054
18	CULTURAL RESOURCE PRESERVATION		$290	$78	27%	$368	-1.0%	$287	$77	$364	$0	2023Q1	14.4%	$328	$89	$417
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$444	$120	27%	$564	2.3%	$454	$123	$577	$0	2023Q1	31.3%	$596	$161	$758
0.006	Planning & Environmental Compliance		$166	$45	27%	$211	2.3%	$170	$46	$216	$0	2023Q1	31.3%	$223	$60	$283
0.082	Engineering & Design		$2,273	$614	27%	$2,887	2.3%	$2,325	$628	$2,953	$0	2023Q1	31.3%	$3,054	$824	$3,878
0.003	Reviews, ATRs, IEPRs, VE		$83	$22	27%	$105	2.3%	$85	$23	$108	$0	2023Q1	31.3%	$112	$30	$142
0.007	Life Cycle Updates (cost, schedule, risks)		$194	$52	27%	$246	2.3%	$198	$54	$252	$0	2023Q1	31.3%	$261	$70	$331
0.01	Contracting & Reprographics		$277	$75	27%	$352	2.3%	$283	$77	$360	$0	2023Q1	31.3%	$372	$100	$473
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$277	$75	27%	$352	2.3%	$283	$77	$360	$0	2023Q1	31.3%	$372	$100	$473
0.02	Engineering During Construction		$554	$150	27%	$704	2.3%	$567	$153	$720	$0	2025Q3	45.6%	$825	$223	$1,048
0.003	Planning During Construction		$83	$22	27%	$105	2.3%	$85	$23	$108	$0	2025Q3	45.6%	$124	$33	$157
0.013	Project Operations		$360	$97	27%	$457	2.3%	$368	$99	$468	$0	2023Q1	31.3%	$484	$131	$614
0.16	NON-FED Planning, Engineering & Design (Relocations)		$1,068	$288	27%	$1,356	2.3%	$1,093	$295	$1,388	$0	2023Q1	31.3%	$1,435	$387	$1,822
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,303	$352	27%	$1,655	2.3%	$1,333	$360	$1,693	$0	2025Q3	45.6%	$1,941	$524	$2,465
0.012	Project Operation:		$333	$90	27%	$423	2.3%	$341	$92	$433	$0	2025Q3	45.6%	$496	$134	$630
0.031	Project Management		$859	$232	27%	$1,091	2.3%	$879	$237	$1,116	$0	2025Q3	45.6%	$1,279	$345	$1,625
0.09	NON-FED Construction Management (Relocations)		$601	$162	27%	$763	2.3%	$615	$166	$781	$0	2025Q3	45.6%	$895	$242	$1,137
	CONTRACT COST TOTALS:		$46,511	$12,166		**$58,677**		$46,867	$12,260	$59,127	$0			$57,710	$15,131	**$72,840**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST						TOTAL PROJECT COST			
							Program Year (Budget EC):			2016						
							Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARN, Reach E																
02	RELOCATIONS *		$10,565	$2,853	27%	$13,418	0.8%	$10,648	$2,875	$13,523		0	$13,523	26.6%	$13,483	$3,640	$17,123
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$495	$134	27%	$629	0.4%	$497	$134	$631		0	$631	22.6%	$610	$165	$774
11	LEVEES & FLOODWALLS	Levees	$25,431	$6,866	27%	$32,297	0.4%	$25,532	$6,894	$32,426		0	$32,426	22.6%	$31,311	$8,454	$39,765
	CONSTRUCTION ESTIMATE TOTALS:		$36,491	$9,853		$46,343	0.5%	$36,678	$9,903	$46,581		0	$46,581	23.8%	$45,403	$12,259	$57,662
01	LANDS AND DAMAGES		$4,325	$594	14%	$4,919	0.6%	$4,348	$597	$4,946		0	$4,946	16.7%	$5,074	$697	$5,771
30	PLANNING, ENGINEERING & DESIGN *		$4,408	$1,190	27%	$5,598	2.3%	$4,509	$1,218	$5,727		0	$5,727	38.9%	$6,262	$1,691	$7,952
31	CONSTRUCTION MANAGEMENT *		$2,334	$630	27%	$2,964	2.3%	$2,388	$645	$3,032		0	$3,032	52.0%	$3,629	$980	$4,609
18	CULTURAL RESOURCE PRESERVATION		$295	$80	27%	$375	0.8%	$292	$79	$371		0	$371	16.7%	$341	$92	$433
	PROJECT COST TOTALS:		$47,853	$12,347	26%	$60,199		$48,216	$12,441	**$60,657**		0	**$60,657**	26.0%	$60,710	$15,719	$76,428

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST: 65% **$49,678**
ESTIMATED NON-FEDERAL COST: 35% **$26,750**
ESTIMATED TOTAL PROJECT COST: **$76,428**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach E, Levee Improvements															
02	RELOCATIONS		$8,452	$2,282	27%	$10,734	0.4%	$8,486	$2,291	$10,778	$0	2026Q3	22.6%	$10,407	$2,810	$13,217
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$495	$134	27%	$629	0.4%	$497	$134	$631	$0	2026Q3	22.6%	$610	$165	$774
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$25,431	$6,866	27%	$32,297	0.4%	$25,532	$6,894	$32,426	$0	2026Q3	22.6%	$31,311	$8,454	$39,765
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$34,378	$9,282	27%	**$43,660**		$34,516	$9,319	$43,835	$0			$42,328	$11,429	$53,757
01	LANDS AND DAMAGES	Fed	$974	$51	5%	$1,025	0.6%	$979	$52	$1,031	$0	2024Q1	16.7%	$1,143	$60	$1,203
01	LANDS AND DAMAGES	Non-Fed	$3,351	$543	16%	$3,894	0.6%	$3,369	$546	$3,915	$0	2024Q1	16.7%	$3,932	$637	$4,569
18	CULTURAL RESOURCE PRESERVATION		$295	$80	27%	$375	-1.0%	$292	$79	$371	$0	2024Q1	16.7%	$341	$92	$433
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$415	$112	27%	$527	2.3%	$425	$115	$539	$0	2024Q1	36.8%	$581	$157	$738
0.006	Planning & Environmental Compliance		$156	$42	27%	$198	2.3%	$160	$43	$203	$0	2024Q1	36.8%	$218	$59	$277
0.082	Engineering & Design		$2,126	$574	27%	$2,700	2.3%	$2,175	$587	$2,762	$0	2024Q1	36.8%	$2,975	$803	$3,779
0.003	Reviews, ATRs, IEPRs, VE		$78	$21	27%	$99	2.3%	$80	$22	$101	$0	2024Q1	36.8%	$109	$29	$139
0.007	Life Cycle Updates (cost, schedule, risks)		$181	$49	27%	$230	2.3%	$185	$50	$235	$0	2024Q1	36.8%	$253	$68	$322
0.01	Contracting & Reprographics		$259	$70	27%	$329	2.3%	$265	$72	$337	$0	2024Q1	36.8%	$362	$98	$460
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$259	$70	27%	$329	2.3%	$265	$72	$337	$0	2024Q1	36.8%	$362	$98	$460
0.02	Engineering During Construction		$519	$140	27%	$659	2.3%	$531	$143	$674	$0	2026Q3	52.0%	$807	$218	$1,025
0.003	Planning During Construction		$78	$21	27%	$99	2.3%	$80	$22	$101	$0	2026Q3	52.0%	$121	$33	$154
0.013	Project Operations		$337	$91	27%	$428	2.3%	$345	$93	$438	$0	2024Q1	36.8%	$472	$127	$599
0.16	NON-FED Planning, Engineering & Design (Relocations)		$1,352	$365	27%	$1,717	2.3%	$1,383	$373	$1,757	$0	2024Q1	36.8%	$1,892	$511	$2,403
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,219	$329	27%	$1,548	2.3%	$1,247	$337	$1,584	$0	2026Q3	52.0%	$1,895	$512	$2,407
0.012	Project Operation:		$311	$84	27%	$395	2.3%	$318	$86	$404	$0	2026Q3	52.0%	$484	$131	$614
0.031	Project Management		$804	$217	27%	$1,021	2.3%	$823	$222	$1,045	$0	2026Q3	52.0%	$1,250	$338	$1,588
0.09	NON-FED Construction Management (Relocations)		$761	$205	27%	$966	2.3%	$779	$210	$989	$0	2026Q3	52.0%	$1,183	$319	$1,503
	CONTRACT COST TOTALS:		$47,853	$12,347		**$60,199**		$48,216	$12,441	$60,657	$0			$60,710	$15,719	**$76,428**

PROJECT: American River Common Features GRR - Alt 1 - NED

PROJECT NUMBER: P2 # 149827

LOCATION: Sacramento, CA

This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015

POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):				2016						
							Effective Price Level Date:				1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARN, Reach F																
02	RELOCATIONS *		$4,237	$1,144	27%	$5,381	0.8%	$4,271	$1,153	$5,424		0	$5,424	27.4%	$5,439	$1,469	$6,908
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$100	$27	27%	$127	0.4%	$100	$27	$128		0	$128	22.6%	$123	$33	$156
11	LEVEES & FLOODWALLS	Levees	$16,597	$4,481	27%	$21,078	0.4%	$16,663	$4,499	$21,162		0	$21,162	22.6%	$20,434	$5,517	$25,951
	CONSTRUCTION ESTIMATE TOTALS:		$20,934	$5,652		$26,586	0.5%	$21,034	$5,679	$26,713		0	$26,713	23.6%	$25,996	$7,019	$33,016
01	LANDS AND DAMAGES		$466	$68	15%	$534	0.6%	$468	$68	$536		0	$536	19.0%	$557	$81	$639
30	PLANNING, ENGINEERING & DESIGN *		$2,838	$766	27%	$3,604	2.3%	$2,903	$784	$3,687		0	$3,687	43.8%	$4,176	$1,127	$5,303
31	CONSTRUCTION MANAGEMENT *		$1,503	$406	27%	$1,909	2.3%	$1,538	$415	$1,953		0	$1,953	52.0%	$2,337	$631	$2,968
18	CULTURAL RESOURCE PRESERVATION		$162	$44	27%	$205	0.8%	$160	$43	$203		0	$203	19.0%	$191	$51	$242
	PROJECT COST TOTALS:		$25,902	$6,936	27%	$32,838		$26,103	$6,990	**$33,093**		0	**$33,093**	27.4%	$33,257	$8,910	$42,167

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	65%	**$27,409**
ESTIMATED NON-FEDERAL COST:	35%	**$14,759**
ESTIMATED TOTAL PROJECT COST:		**$42,167**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARN, Reach F, Levee Improvements															
02	RELOCATIONS		$3,390	$915	27%	$4,306	0.4%	$3,404	$919	$4,323	$0	2026Q3	22.6%	$4,175	$1,127	$5,302
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$100	$27	27%	$127	0.4%	$100	$27	$128	$0	2026Q3	22.6%	$123	$33	$156
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$16,597	$4,481	27%	$21,078	0.4%	$16,663	$4,499	$21,162	$0	2026Q3	22.6%	$20,434	$5,517	$25,951
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$20,087	$5,423	27%	**$25,510**		$20,167	$5,445	$25,613	$0			$24,732	$6,678	$31,409
01	LANDS AND DAMAGES	Fed	$71	$4	5%	$75	0.6%	$72	$4	$75	$0	2025Q1	19.0%	$85	$4	$90
01	LANDS AND DAMAGES	Non-Fed	$395	$64	16%	$459	0.6%	$397	$64	$461	$0	2025Q1	19.0%	$472	$77	$549
18	CULTURAL RESOURCE PRESERVATION		$162	$44	27%	$205	-1.0%	$160	$43	$203	$0	2025Q1	19.0%	$191	$51	$242
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$267	$72	27%	$339	2.3%	$273	$74	$347	$0	2025Q1	42.5%	$389	$105	$494
0.006	Planning & Environmental Compliance		$100	$27	27%	$127	2.3%	$102	$28	$130	$0	2025Q1	42.5%	$146	$39	$185
0.082	Engineering & Design		$1,369	$370	27%	$1,739	2.3%	$1,401	$378	$1,779	$0	2025Q1	42.5%	$1,996	$539	$2,535
0.003	Reviews, ATRs, IEPRs, VE		$50	$14	27%	$64	2.3%	$51	$14	$65	$0	2025Q1	42.5%	$73	$20	$93
0.007	Life Cycle Updates (cost, schedule, risks)		$117	$32	27%	$149	2.3%	$120	$32	$152	$0	2025Q1	42.5%	$171	$46	$217
0.01	Contracting & Reprographics		$167	$45	27%	$212	2.3%	$171	$46	$217	$0	2025Q1	42.5%	$244	$66	$309
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$167	$45	27%	$212	2.3%	$171	$46	$217	$0	2025Q1	42.5%	$244	$66	$309
0.02	Engineering During Construction		$334	$90	27%	$424	2.3%	$342	$92	$434	$0	2026Q3	52.0%	$519	$140	$660
0.003	Planning During Construction		$50	$14	27%	$64	2.3%	$51	$14	$65	$0	2026Q3	52.0%	$78	$21	$99
0.013	Project Operations		$217	$59	27%	$276	2.3%	$222	$60	$282	$0	2025Q1	42.5%	$316	$85	$402
0.16	NON-FED Planning, Engineering & Design (Relocations)		$542	$146	27%	$688	2.3%	$554	$150	$704	$0	2025Q1	42.5%	$790	$213	$1,004
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$785	$212	27%	$997	2.3%	$803	$217	$1,020	$0	2026Q3	52.0%	$1,221	$330	$1,550
0.012	Project Operation:		$200	$54	27%	$254	2.3%	$205	$55	$260	$0	2026Q3	52.0%	$311	$84	$395
0.031	Project Management		$518	$140	27%	$658	2.3%	$530	$143	$673	$0	2026Q3	52.0%	$805	$217	$1,023
0.09	NON-FED Construction Management (Relocations)		$305	$82	27%	$387	2.3%	$312	$84	$396	$0	2026Q3	52.0%	$474	$128	$602
	CONTRACT COST TOTALS:		$25,902	$6,936		**$32,838**		$26,103	$6,990	$33,093	$0			$33,257	$8,910	**$42,167**

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)							TOTAL PROJECT COST (FULLY FUNDED)				
							Program Year (Budget EC):					2016						
							Effective Price Level Date:					1 OCT 15						
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B		COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J		Spent Thru: 10/1/2014 ($K)	TOTAL FIRST COST ($K)	ESC (%)	COST ($K) M	CNTG ($K) N	FULL ($K) O	
	ARN, Reach I																	
02	RELOCATIONS *		$50	$14	27%	$64	0.8%	$50	$14	$64		0	$64	30.1%	$66	$18	$83	
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$275	$74	27%	$349	0.4%	$276	$75	$351		0	$351	24.5%	$344	$93	$437	
11	LEVEES & FLOODWALLS	Levees	$1,950	$527	27%	$2,477	0.4%	$1,958	$529	$2,487		0	$2,487	24.5%	$2,437	$658	$3,095	
	CONSTRUCTION ESTIMATE TOTALS:		$2,276	$614		$2,890	0.4%	$2,285	$617	$2,902		0	$2,902	24.6%	$2,847	$769	$3,615	
01	LANDS AND DAMAGES		$20,492	$11,788	58%	$32,280	0.6%	$20,606	$11,853	$32,459		0	$32,459	21.4%	$25,017	$14,391	$39,408	
30	PLANNING, ENGINEERING & DESIGN *		$379	$102	27%	$481	2.3%	$388	$105	$492		0	$492	49.9%	$581	$157	$738	
31	CONSTRUCTION MANAGEMENT *		$201	$54	27%	$255	2.3%	$206	$56	$261		0	$261	56.9%	$323	$87	$410	
18	CULTURAL RESOURCE PRESERVATION		$152	$41	27%	$193	0.8%	$150	$41	$191		0	$191	21.4%	$182	$49	$232	
	PROJECT COST TOTALS:		$23,499	$12,600	54%	$36,099		$23,634	$12,671	**$36,305**		0	**$36,305**	22.3%	$28,950	$15,453	$44,403	

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST: 65% **$28,862**
ESTIMATED NON-FEDERAL COST: 35% **$15,541**

ESTIMATED TOTAL PROJECT COST: $44,403

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 1 - NED
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach I, Levee Improvements															
02	RELOCATIONS		$40	$11	27%	$51	0.4%	$40	$11	$51	$0	2027Q2	24.5%	$50	$14	$64
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$275	$74	27%	$349	0.4%	$276	$75	$351	$0	2027Q2	24.5%	$344	$93	$437
09	CHANNELS & CANALS		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$1,950	$527	27%	$2,477	0.4%	$1,958	$529	$2,487	$0	2027Q2	24.5%	$2,437	$658	$3,095
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	27%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,266	$612	27%	**$2,877**		$2,275	$614	$2,889	$0			$2,831	$764	$3,595
01	LANDS AND DAMAGES	Fed	$713	$38	5%	$750	0.6%	$716	$38	$754	$0	2026Q1	21.4%	$870	$46	$916
01	LANDS AND DAMAGES	Non-Fed	$19,780	$11,750	59%	$31,530	0.6%	$19,889	$11,816	$31,705	$0	2026Q1	21.4%	$24,147	$14,345	$38,493
18	CULTURAL RESOURCE PRESERVATION		$152	$41	27%	$193	-1.0%	$150	$41	$191	$0	2026Q1	21.4%	$182	$49	$232
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$36	$10	27%	$46	2.3%	$37	$10	$47	$0	2026Q1	48.7%	$55	$15	$70
0.006	Planning & Environmental Compliance		$13	$4	27%	$17	2.3%	$13	$4	$17	$0	2026Q1	48.7%	$20	$5	$25
0.082	Engineering & Design		$182	$49	27%	$231	2.3%	$186	$50	$236	$0	2026Q1	48.7%	$277	$75	$352
0.003	Reviews, ATRs, IEPRs, VE		$7	$2	27%	$9	2.3%	$7	$2	$9	$0	2026Q1	48.7%	$11	$3	$14
0.007	Life Cycle Updates (cost, schedule, risks)		$16	$4	27%	$20	2.3%	$16	$4	$21	$0	2026Q1	48.7%	$24	$7	$31
0.01	Contracting & Reprographics		$22	$6	27%	$28	2.3%	$23	$6	$29	$0	2026Q1	48.7%	$33	$9	$43
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$22	$6	27%	$28	2.3%	$23	$6	$29	$0	2026Q1	48.7%	$33	$9	$43
0.02	Engineering During Construction		$45	$12	27%	$57	2.3%	$46	$12	$58	$0	2027Q2	56.9%	$72	$20	$92
0.003	Planning During Construction		$7	$2	27%	$9	2.3%	$7	$2	$9	$0	2027Q2	56.9%	$11	$3	$14
0.013	Project Operations		$29	$8	27%	$37	2.3%	$30	$8	$38	$0	2026Q1	48.7%	$44	$12	$56
0.16	NON-FED Planning, Engineering & Design (Relocations)		$6	$2	27%	$8	2.3%	$6	$2	$8	$0	2026Q1	48.7%	$9	$2	$12
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$105	$28	27%	$133	2.3%	$107	$29	$136	$0	2027Q2	56.9%	$169	$46	$214
0.012	Project Operation:		$27	$7	27%	$34	2.3%	$28	$7	$35	$0	2027Q2	56.9%	$43	$12	$55
0.031	Project Management		$69	$19	27%	$88	2.3%	$71	$19	$90	$0	2027Q2	56.9%	$111	$30	$141
0.09	NON-FED Construction Management (Relocations)		$4	$1	27%	$5	2.3%	$4	$1	$5	$0	2027Q2	56.9%	$6	$2	$8
	CONTRACT COST TOTALS:		$23,499	$12,600		**$36,099**		$23,634	$12,671	$36,305	$0			$28,950	$15,453	**$44,403**

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NO: P2 # 149827
LOCATION: Sacramento, CA

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

This Estimate reflects the scope and schedule in report; Feasibility Report

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
							Program Year (Budget EC): 2016									
							Effective Price Level Date: 1 OCT 15									
											Spent Thru:	TOTAL				
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	**10/1/2014** ($K)	**FIRST COST** ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*				*M*	*N*	*O*
02	RELOCATIONS *		$122,813	$34,388	28%	$157,201	0.8%	$123,779	$34,658	$158,437	$0	$158,437	21.4%	$150,279	$42,078	$192,357
06	FISH & WILDLIFE FACILITIES	Construction	$19,020	$5,326	28%	$24,346	0.4%	$19,103	$5,349	$24,452	$0	$24,452	20.5%	$23,017	$6,445	$29,462
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$55,826	$15,631	28%	$71,457	0.4%	$56,069	$15,699	$71,768	$0	$71,768	14.7%	$64,294	$18,002	$82,297
08	ROADS, RAILROADS & BRIDGES		$20,073	$5,620	28%	$25,693	0.4%	$20,155	$5,643	$25,798	$0	$25,798	5.1%	$21,192	$5,934	$27,126
11	LEVEES & FLOODWALLS	Levees	$362,348	$101,458	28%	$463,806	0.4%	$363,794	$101,862	$465,656	$0	$465,656	16.6%	$424,199	$118,776	$542,975
16	BANK STABILIZATION		$292,672	$81,948	28%	$374,620	1.8%	$297,828	$83,392	$381,220	$0	$381,220	14.7%	$341,678	$95,670	$437,347
15	FLOODWAY CONTROL & DIVERSION STRUCTURE		$42,316	$11,849	28%	$54,165	0.4%	$42,501	$11,900	$54,401	$0	$54,401	13.9%	$48,391	$13,549	$61,941
	CONSTRUCTION ESTIMATE TOTALS:		$915,069	$256,219		$1,171,289	0.9%	$923,228	$258,504	$1,181,732	$0	$1,181,732	16.2%	$1,073,050	$300,454	$1,373,504
01	LANDS AND DAMAGES		$71,078	$24,255	34%	$95,333	0.6%	$71,472	$24,389	$95,862	$0	$95,862	14.2%	$81,345	$28,148	$109,494
30	PLANNING, ENGINEERING & DESIGN *		$142,464	$39,890	28%	$182,354	2.3%	$145,743	$40,808	$186,551	$0	$186,551	25.4%	$182,808	$51,186	$233,994
31	CONSTRUCTION MANAGEMENT *		$71,303	$19,965	28%	$91,268	2.3%	$72,944	$20,424	$93,368	$0	$93,368	34.7%	$98,235	$27,506	$125,741
18	CULTURAL RESOURCE PRESERVATION		$6,550	$1,768	27%	$8,318	0.8%	$6,486	$1,751	$8,237	$0	$8,237	12.4%	$7,292	$1,969	$9,260
	PROJECT COST TOTALS:		$1,206,465	$342,097	28%	$1,548,562		$1,219,873	$345,877	**$1,565,750**	$0	**$1,565,750**	18.3%	$1,442,730	$409,263	$1,851,993

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CHIEF, COST ENGINEERING, Jeremiah Frost

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PROJECT MANAGER, Dan Tibbitts

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CHIEF, REAL ESTATE, Diane Simpson

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CHIEF, ENGINEERING, Rick Poeppelman

ESTIMATED FEDERAL COST:	**56%**	**$1,038,310**
ESTIMATED NON-FEDERAL COST:	**44%**	**$813,683**
ESTIMATED TOTAL PROJECT COST:		**$1,851,993**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account.

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:		TOTAL					
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J						M	N	O
	ARS, Reach A																	
02	RELOCATIONS *		$4,899	$1,372	28%	$6,271	0.8%	$4,937	$1,382	$6,320			0	$6,320	9.8%	$5,419	$1,517	$6,936
06	FISH & WILDLIFE FACILITIES	Construction	$4,251	$1,190	28%	$5,441	0.4%	$4,270	$1,195	$5,465			0	$5,465	13.3%	$4,837	$1,354	$6,192
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$9,182	$2,571	28%	$11,753	0.4%	$9,222	$2,582	$11,805			0	$11,805	8.9%	$10,043	$2,812	$12,855
16	BANK STABILIZATION		$91,765	$25,694	28%	$117,459	1.8%	$93,382	$26,147	$119,528			0	$119,528	8.9%	$101,688	$28,473	$130,160
	CONSTRUCTION ESTIMATE TOTALS:		$110,097	$30,827		$140,925	1.6%	$111,811	$31,307	$143,118			0	$143,118	9.1%	$121,987	$34,156	$156,143
01	LANDS AND DAMAGES		$2,002	$832	42%	$2,834	0.6%	$2,013	$836	$2,850			0	$2,850	4.7%	$2,107	$875	$2,982
30	PLANNING, ENGINEERING & DESIGN *		$18,858	$5,280	28%	$24,138	2.3%	$19,292	$5,402	$24,694			0	$24,694	11.1%	$21,431	$6,001	$27,432
31	CONSTRUCTION MANAGEMENT *		$9,468	$2,651	28%	$12,119	2.3%	$9,686	$2,712	$12,398			0	$12,398	19.3%	$11,551	$3,234	$14,785
18	CULTURAL RESOURCE PRESERVATION		$906	$245	27%	$1,151	0.8%	$898	$242	$1,140			0	$1,140	4.7%	$940	$254	$1,194
	PROJECT COST TOTALS:		$141,332	$39,835	28%	$181,167		$143,700	$40,500	**$184,199**			0	**$184,199**	10.0%	$158,015	$44,520	$202,535

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED TOTAL PROJECT COST: **$202,535**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
						RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach A, Erosion Protection															
02	RELOCATIONS		$3,919	$1,097	28%	$5,016	0.4%	$3,935	$1,102	$5,037	$0	2020Q3	8.9%	$4,285	$1,200	$5,485
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$9,182	$2,571	28%	$11,753	0.4%	$9,222	$2,582	$11,805	$0	2020Q3	8.9%	$10,043	$2,812	$12,855
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$91,765	$25,694	28%	$117,459	1.8%	$93,382	$26,147	$119,528	$0	2020Q3	8.9%	$101,688	$28,473	$130,160
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$104,866	$29,363	28%	**$134,229**		$106,539	$29,831	$136,370	$0			$116,015	$32,484	$148,500
01	LANDS AND DAMAGES	Fed	$95	$5	5%	$100	0.6%	$96	$5	$101	$0	2018Q3	4.7%	$100	$5	$105
01	LANDS AND DAMAGES	Non-Fed	$1,907	$827	43%	$2,734	0.6%	$1,918	$831	$2,749	$0	2018Q3	4.7%	$2,007	$870	$2,877
18	CULTURAL RESOURCE PRESERVATION		$872	$235	27%	$1,107	-1.0%	$863	$233	$1,096	$0	2018Q3	4.7%	$903	$244	$1,147
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$1,615	$452	28%	$2,067	2.3%	$1,652	$463	$2,115	$0	2018Q3	9.9%	$1,815	$508	$2,324
0.006	Planning & Environmental Compliance		$1,578	$442	28%	$2,020	2.3%	$1,614	$452	$2,066	$0	2018Q3	9.9%	$1,774	$497	$2,271
0.082	Engineering & Design		$8,278	$2,318	28%	$10,596	2.3%	$8,469	$2,371	$10,840	$0	2018Q3	9.9%	$9,306	$2,606	$11,911
0.003	Reviews, ATRs, IEPRs, VE		$303	$85	28%	$388	2.3%	$310	$87	$397	$0	2018Q3	9.9%	$341	$95	$436
0.007	Life Cycle Updates (cost, schedule, risks)		$707	$198	28%	$905	2.3%	$723	$203	$926	$0	2018Q3	9.9%	$795	$223	$1,017
0.01	Contracting & Reprographics		$1,009	$283	28%	$1,292	2.3%	$1,032	$289	$1,321	$0	2018Q3	9.9%	$1,134	$318	$1,452
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$1,009	$283	28%	$1,292	2.3%	$1,032	$289	$1,321	$0	2018Q3	9.9%	$1,134	$318	$1,452
0.02	Engineering During Construction		$2,019	$565	28%	$2,584	2.3%	$2,065	$578	$2,644	$0	2020Q3	18.9%	$2,455	$687	$3,142
0.003	Planning During Construction		$303	$85	28%	$388	2.3%	$310	$87	$397	$0	2020Q3	18.9%	$368	$103	$472
0.013	Project Operations		$1,312	$367	28%	$1,679	2.3%	$1,342	$376	$1,718	$0	2018Q3	9.9%	$1,475	$413	$1,888
0.16	NON-FED Planning, Engineering & Design (Relocations)		$627	$176	28%	$803	2.3%	$641	$180	$821	$0	2018Q3	9.9%	$705	$197	$902
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$4,745	$1,329	28%	$6,074	2.3%	$4,854	$1,359	$6,213	$0	2020Q3	18.9%	$5,769	$1,615	$7,385
0.012	Project Operation:		$1,211	$339	28%	$1,550	2.3%	$1,239	$347	$1,586	$0	2020Q3	18.9%	$1,472	$412	$1,885
0.031	Project Management		$3,129	$876	28%	$4,005	2.3%	$3,201	$896	$4,097	$0	2020Q3	18.9%	$3,804	$1,065	$4,870
0.09	NON-FED Construction Management (Relocations)		$353	$99	28%	$452	2.3%	$361	$101	$462	$0	2020Q3	18.9%	$429	$120	$549
	CONTRACT COST TOTALS:		$135,938	$38,325		**$174,263**		$138,262	$38,977	$177,240	$0			$151,803	$42,781	**$194,584**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach A, Erosion Protection, Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$4,251	$1,190	28%	$5,441	0.4%	$4,270	$1,195	$5,465	$0	2022Q3	13.3%	$4,837	$1,354	$6,192
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$4,251	$1,190	28%	**$5,441**		$4,270	$1,195	$5,465	$0			$4,837	$1,354	$6,192
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$35	$9	27%	$44	-1.0%	$34	$9	$44	$0	2019Q3	6.8%	$37	$10	$47
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$68	$19	28%	$87	2.3%	$70	$19	$89	$0	2018Q3	9.9%	$76	$21	$98
0.006	Planning & Environmental Compliance		$26	$7	28%	$33	2.3%	$27	$7	$34	$0	2018Q3	9.9%	$29	$8	$37
0.082	Engineering & Design		$349	$98	28%	$447	2.3%	$357	$100	$457	$0	2018Q3	9.9%	$392	$110	$502
0.003	Reviews, ATRs, IEPRs, VE		$13	$4	28%	$17	2.3%	$13	$4	$17	$0	2018Q3	9.9%	$15	$4	$19
0.007	Life Cycle Updates (cost, schedule, risks)		$30	$8	28%	$38	2.3%	$31	$9	$39	$0	2018Q3	9.9%	$34	$9	$43
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$43	$12	28%	$55	2.3%	$44	$12	$56	$0	2018Q3	9.9%	$48	$14	$62
0.01	Contracting & Reprographics		$43	$12	28%	$55	2.3%	$44	$12	$56	$0	2018Q3	9.9%	$48	$14	$62
0.02	Engineering During Construction		$85	$24	28%	$109	2.3%	$87	$24	$111	$0	2022Q3	28.7%	$112	$31	$143
0.003	Planning During Construction		$13	$4	28%	$17	2.3%	$13	$4	$17	$0	2022Q3	28.7%	$17	$5	$22
0.013	Project Operations		$55	$15	28%	$70	2.3%	$56	$16	$72	$0	2018Q3	9.9%	$62	$17	$79
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$200	$56	28%	$256	2.3%	$205	$57	$262	$0	2022Q3	28.7%	$263	$74	$337
0.012	Project Operation:		$51	$14	28%	$65	2.3%	$52	$15	$67	$0	2022Q3	28.7%	$67	$19	$86
0.031	Project Management		$132	$37	28%	$169	2.3%	$135	$38	$173	$0	2022Q3	28.7%	$174	$49	$222
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$5,394	$1,510		**$6,904**		$5,438	$1,522	$6,960	$0			$6,212	$1,739	**$7,951**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:		TOTAL					
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)	FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach B																
02	RELOCATIONS *		$2,313	$648	28%	$2,961	0.8%	$2,332	$653	$2,984		0	$2,984	15.8%	$2,699	$756	$3,455
06	FISH & WILDLIFE FACILITIES	Construction	$1,170	$328	28%	$1,497	0.4%	$1,175	$329	$1,504		0	$1,504	17.9%	$1,385	$388	$1,773
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$3,218	$901	28%	$4,119	0.4%	$3,232	$905	$4,137		0	$4,137	13.3%	$3,661	$1,025	$4,687
16	BANK STABILIZATION		$21,641	$6,060	28%	$27,701	1.8%	$22,022	$6,166	$28,189		0	$28,189	13.3%	$24,950	$6,986	$31,936
	CONSTRUCTION ESTIMATE TOTALS:		$28,342	$7,936		$36,278	1.5%	$28,761	$8,053	$36,814		0	$36,814	13.7%	$32,696	$9,155	$41,850
01	LANDS AND DAMAGES		$1,011	$208	21%	$1,219	0.6%	$1,017	$209	$1,226		0	$1,226	11.1%	$1,129	$232	$1,361
30	PLANNING, ENGINEERING & DESIGN *		$5,399	$1,512	28%	$6,911	2.3%	$5,523	$1,547	$7,070		0	$7,070	24.3%	$6,863	$1,922	$8,784
31	CONSTRUCTION MANAGEMENT *		$2,342	$656	28%	$2,998	2.3%	$2,396	$671	$3,067		0	$3,067	29.2%	$3,095	$867	$3,962
18	CULTURAL RESOURCE PRESERVATION		$238	$64	27%	$302	0.8%	$236	$64	$299		0	$299	11.2%	$262	$71	$333
	PROJECT COST TOTALS:		$37,332	$10,376	28%	$47,708		$37,932	$10,543	**$48,475**		0	**$48,475**	16.1%	$44,045	$12,246	$56,291

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED TOTAL PROJECT COST: **$56,291**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach B, Erosion Protection															
02	RELOCATIONS		$1,850	$518	28%	$2,368	0.4%	$1,858	$520	$2,378	$0	2022Q3	13.3%	$2,105	$589	$2,694
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$3,218	$901	28%	$4,119	0.4%	$3,232	$905	$4,137	$0	2022Q3	13.3%	$3,661	$1,025	$4,687
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$21,641	$6,060	28%	$27,701	1.8%	$22,022	$6,166	$28,189	$0	2022Q3	13.3%	$24,950	$6,986	$31,936
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$26,709	$7,479	28%	**$34,188**		$27,112	$7,591	$34,704	$0			$30,717	$8,601	$39,317
01	LANDS AND DAMAGES	Fed	$166	$9	5%	$175	0.6%	$167	$9	$176	$0	2021Q3	11.1%	$186	$10	$195
01	LANDS AND DAMAGES	Non-Fed	$845	$199	24%	$1,044	0.6%	$849	$200	$1,050	$0	2021Q3	11.1%	$943	$223	$1,166
18	CULTURAL RESOURCE PRESERVATION		$229	$62	27%	$290	-1.0%	$226	$61	$287	$0	2021Q3	11.1%	$251	$68	$319
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$398	$111	28%	$509	2.3%	$407	$114	$521	$0	2021Q3	23.6%	$503	$141	$644
0.006	Planning & Environmental Compliance		$1,121	$314	28%	$1,435	2.3%	$1,147	$321	$1,468	$0	2021Q3	23.6%	$1,418	$397	$1,815
0.082	Engineering & Design		$2,038	$571	28%	$2,609	2.3%	$2,085	$584	$2,669	$0	2021Q3	23.6%	$2,578	$722	$3,299
0.003	Reviews, ATRs, IEPRs, VE		$75	$21	28%	$96	2.3%	$77	$21	$98	$0	2021Q3	23.6%	$95	$27	$121
0.007	Life Cycle Updates (cost, schedule, risks)		$174	$49	28%	$223	2.3%	$178	$50	$228	$0	2021Q3	23.6%	$220	$62	$282
0.01	Contracting & Reprographics		$249	$70	28%	$319	2.3%	$255	$71	$326	$0	2021Q3	23.6%	$315	$88	$403
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$249	$70	28%	$319	2.3%	$255	$71	$326	$0	2021Q3	23.6%	$315	$88	$403
0.02	Engineering During Construction		$497	$139	28%	$636	2.3%	$508	$142	$651	$0	2022Q3	28.7%	$654	$183	$838
0.003	Planning During Construction		$75	$21	28%	$96	2.3%	$77	$21	$98	$0	2022Q3	28.7%	$99	$28	$126
0.013	Project Operations		$323	$90	28%	$413	2.3%	$330	$93	$423	$0	2021Q3	23.6%	$409	$114	$523
0.16	NON-FED Planning, Engineering & Design (Relocations)		$296	$83	28%	$379	2.3%	$303	$85	$388	$0	2021Q3	23.6%	$374	$105	$479
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,168	$327	28%	$1,495	2.3%	$1,195	$335	$1,529	$0	2022Q3	28.7%	$1,538	$431	$1,968
0.012	Project Operation:		$298	$83	28%	$381	2.3%	$305	$85	$390	$0	2022Q3	28.7%	$392	$110	$502
0.031	Project Management		$771	$216	28%	$987	2.3%	$789	$221	$1,010	$0	2022Q3	28.7%	$1,015	$284	$1,299
0.09	NON-FED Construction Management (Relocations)		$167	$47	28%	$214	2.3%	$171	$48	$219	$0	2022Q3	28.7%	$220	$62	$281
	CONTRACT COST TOTALS:		$35,848	$9,960		**$45,808**		$36,436	$10,124	$46,560	$0			$42,242	$11,742	**$53,984**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach B, Erosion Protection, Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$1,170	$328	28%	$1,497	0.4%	$1,175	$329	$1,504	$0	2024Q3	17.9%	$1,385	$388	$1,773
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$1,170	$328	28%	**$1,497**		$1,175	$329	$1,504	$0			$1,385	$388	$1,773
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$10	$3	27%	$12	-1.0%	$9	$3	$12	$0	2022Q3	13.3%	$11	$3	$14
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$19	$5	28%	$24	2.3%	$19	$5	$25	$0	2021Q3	23.6%	$24	$7	$31
0.006	Planning & Environmental Compliance		$7	$2	28%	$9	2.3%	$7	$2	$9	$0	2021Q3	23.6%	$9	$2	$11
0.082	Engineering & Design		$96	$27	28%	$123	2.3%	$98	$27	$126	$0	2021Q3	23.6%	$121	$34	$155
0.003	Reviews, ATRs, IEPRs, VE		$4	$1	28%	$5	2.3%	$4	$1	$5	$0	2021Q3	23.6%	$5	$1	$6
0.007	Life Cycle Updates (cost, schedule, risks)		$8	$2	28%	$10	2.3%	$8	$2	$10	$0	2021Q3	23.6%	$10	$3	$13
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$12	$3	28%	$15	2.3%	$12	$3	$16	$0	2021Q3	23.6%	$15	$4	$19
0.01	Contracting & Reprographics		$12	$3	28%	$15	2.3%	$12	$3	$16	$0	2021Q3	23.6%	$15	$4	$19
0.02	Engineering During Construction		$23	$6	28%	$29	2.3%	$24	$7	$30	$0	2024Q3	39.6%	$33	$9	$42
0.003	Planning During Construction		$4	$1	28%	$5	2.3%	$4	$1	$5	$0	2024Q3	39.6%	$6	$2	$7
0.013	Project Operations		$15	$4	28%	$19	2.3%	$15	$4	$20	$0	2021Q3	23.6%	$19	$5	$24
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$55	$15	28%	$70	2.3%	$56	$16	$72	$0	2024Q3	39.6%	$79	$22	$101
0.012	Project Operation:		$14	$4	28%	$18	2.3%	$14	$4	$18	$0	2024Q3	39.6%	$20	$6	$26
0.031	Project Management		$36	$10	28%	$46	2.3%	$37	$10	$47	$0	2024Q3	39.6%	$51	$14	$66
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$1,484	$416		**$1,900**		$1,496	$419	$1,915	$0			$1,803	$505	**$2,308**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:		TOTAL					
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J						M	N	O
	ARS, Reach C																	
02	RELOCATIONS *		$500	$140	28%	$640	0.8%	$504	$141	$645		0		$645	24.6%	$627	$176	$803
06	FISH & WILDLIFE FACILITIES	Construction	$1,164	$326	28%	$1,491	0.4%	$1,170	$327	$1,497		0		$1,497	25.1%	$1,463	$410	$1,873
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$1,128	$316	28%	$1,444	0.4%	$1,133	$317	$1,450		0		$1,450	20.2%	$1,362	$381	$1,743
16	BANK STABILIZATION		$14,915	$4,176	28%	$19,091	1.8%	$15,177	$4,250	$19,427		0		$19,427	20.2%	$18,248	$5,109	$23,357
	CONSTRUCTION ESTIMATE TOTALS:		$17,707	$4,958		$22,665	1.6%	$17,983	$5,035	$23,019		0		$23,019	20.7%	$21,700	$6,076	$27,776
01	LANDS AND DAMAGES		$875	$183	21%	$1,058	0.6%	$880	$184	$1,064		0		$1,064	17.9%	$1,037	$217	$1,254
30	PLANNING, ENGINEERING & DESIGN *		$3,896	$1,091	28%	$4,987	2.3%	$3,986	$1,116	$5,102		0		$5,102	40.3%	$5,593	$1,566	$7,159
31	CONSTRUCTION MANAGEMENT *		$1,549	$434	28%	$1,983	2.3%	$1,585	$444	$2,028		0		$2,028	46.5%	$2,321	$650	$2,971
18	CULTURAL RESOURCE PRESERVATION		$156	$42	27%	$198	0.8%	$154	$42	$196		0		$196	18.0%	$182	$49	$231
	PROJECT COST TOTALS:		$24,182	$6,707	28%	$30,890		$24,588	$6,820	**$31,408**		0		**$31,408**	25.4%	$30,833	$8,558	$39,391

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED TOTAL PROJECT COST: $39,391

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
			RISK BASED													
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach C, Erosion Protection															
02	RELOCATIONS		$400	$112	28%	$512	0.4%	$401	$112	$514	$0	2025Q3	20.2%	$482	$135	$618
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$1,128	$316	28%	$1,444	0.4%	$1,133	$317	$1,450	$0	2025Q3	20.2%	$1,362	$381	$1,743
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$14,915	$4,176	28%	$19,091	1.8%	$15,177	$4,250	$19,427	$0	2025Q3	20.2%	$18,248	$5,109	$23,357
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$16,442	$4,604	28%	**$21,046**		$16,711	$4,679	$21,391	$0			$20,092	$5,626	$25,718
01	LANDS AND DAMAGES	Fed	$143	$7	5%	$150	0.6%	$143	$8	$151	$0	2024Q3	17.9%	$169	$9	$178
01	LANDS AND DAMAGES	Non-Fed	$733	$175	24%	$908	0.6%	$737	$176	$913	$0	2024Q3	17.9%	$868	$208	$1,076
18	CULTURAL RESOURCE PRESERVATION		$146	$39	27%	$185	-1.0%	$145	$39	$184	$0	2024Q3	17.9%	$170	$46	$216
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$257	$72	28%	$329	2.3%	$263	$74	$337	$0	2024Q3	39.6%	$367	$103	$470
0.006	Planning & Environmental Compliance		$1,069	$299	28%	$1,368	2.3%	$1,094	$306	$1,400	$0	2024Q3	39.6%	$1,527	$428	$1,955
0.082	Engineering & Design		$1,315	$368	28%	$1,683	2.3%	$1,345	$377	$1,722	$0	2024Q3	39.6%	$1,879	$526	$2,405
0.003	Reviews, ATRs, IEPRs, VE		$48	$13	28%	$61	2.3%	$49	$14	$63	$0	2024Q3	39.6%	$69	$19	$88
0.007	Life Cycle Updates (cost, schedule, risks)		$112	$31	28%	$143	2.3%	$115	$32	$147	$0	2024Q3	39.6%	$160	$45	$205
0.01	Contracting & Reprographics		$160	$45	28%	$205	2.3%	$164	$46	$210	$0	2024Q3	39.6%	$229	$64	$293
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$160	$45	28%	$205	2.3%	$164	$46	$210	$0	2024Q3	39.6%	$229	$64	$293
0.02	Engineering During Construction		$321	$90	28%	$411	2.3%	$328	$92	$420	$0	2025Q3	45.6%	$478	$134	$612
0.003	Planning During Construction		$48	$13	28%	$61	2.3%	$49	$14	$63	$0	2025Q3	45.6%	$71	$20	$92
0.013	Project Operations		$209	$59	28%	$268	2.3%	$214	$60	$274	$0	2024Q3	39.6%	$299	$84	$382
0.16	NON-FED Planning, Engineering & Design (Relocations)		$64	$18	28%	$82	2.3%	$65	$18	$84	$0	2024Q3	39.6%	$91	$26	$117
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$754	$211	28%	$965	2.3%	$771	$216	$987	$0	2025Q3	45.6%	$1,123	$314	$1,437
0.012	Project Operation:		$193	$54	28%	$247	2.3%	$197	$55	$253	$0	2025Q3	45.6%	$287	$80	$368
0.031	Project Management		$497	$139	28%	$636	2.3%	$508	$142	$651	$0	2025Q3	45.6%	$740	$207	$947
0.09	NON-FED Construction Management (Relocations)		$36	$10	28%	$46	2.3%	$37	$10	$47	$0	2025Q3	45.6%	$54	$15	$69
	CONTRACT COST TOTALS:		$22,706	$6,294		**$29,000**		$23,100	$6,404	$29,504	$0			$28,902	$8,017	**$36,919**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015 Effective Price Level: 10/1/2014				Program Year (Budget EC): 2016 Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach C, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$1,164	$326	28%	$1,491	0.4%	$1,170	$327	$1,497	$0	2027Q3	25.1%	$1,463	$410	$1,873
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$1,164	$326	28%	**$1,491**		$1,170	$327	$1,497	$0			$1,463	$410	$1,873
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$10	$3	27%	$12	-1.0%	$9	$3	$12	$0	2025Q3	20.2%	$11	$3	$14
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$19	$5	28%	$24	2.3%	$19	$5	$25	$0	2024Q3	39.6%	$27	$8	$35
0.006	Planning & Environmental Compliance		$7	$2	28%	$9	2.3%	$7	$2	$9	$0	2024Q3	39.6%	$10	$3	$13
0.082	Engineering & Design		$95	$27	28%	$122	2.3%	$97	$27	$124	$0	2024Q3	39.6%	$136	$38	$174
0.003	Reviews, ATRs, IEPRs, VE		$3	$1	28%	$4	2.3%	$3	$1	$4	$0	2024Q3	39.6%	$4	$1	$5
0.007	Life Cycle Updates (cost, schedule, risks)		$8	$2	28%	$10	2.3%	$8	$2	$10	$0	2024Q3	39.6%	$11	$3	$15
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$12	$3	28%	$15	2.3%	$12	$3	$16	$0	2024Q3	39.6%	$17	$5	$22
0.01	Contracting & Reprographics		$12	$3	28%	$15	2.3%	$12	$3	$16	$0	2024Q3	39.6%	$17	$5	$22
0.02	Engineering During Construction		$23	$6	28%	$29	2.3%	$24	$7	$30	$0	2027Q3	58.7%	$37	$10	$48
0.003	Planning During Construction		$3	$1	28%	$4	2.3%	$3	$1	$4	$0	2027Q3	58.7%	$5	$1	$6
0.013	Project Operations		$15	$4	28%	$19	2.3%	$15	$4	$20	$0	2024Q3	39.6%	$21	$6	$27
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$55	$15	28%	$70	2.3%	$56	$16	$72	$0	2027Q3	58.7%	$89	$25	$114
0.012	Project Operation:		$14	$4	28%	$18	2.3%	$14	$4	$18	$0	2027Q3	58.7%	$23	$6	$29
0.031	Project Management		$36	$10	28%	$46	2.3%	$37	$10	$47	$0	2027Q3	58.7%	$58	$16	$75
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$1,476	$413		**$1,889**		$1,488	$417	$1,904	$0			$1,931	$541	**$2,472**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**		10/1/2014 ($K)	**FIRST COST ($K)**	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach D																
02	RELOCATIONS *		$25,524	$7,147	28%	$32,670	0.8%	$25,724	$7,203	$32,927		0	$32,927	27.4%	$32,764	$9,174	$41,938
06	FISH & WILDLIFE FACILITIES	Construction	$2,102	$589	28%	$2,691	0.4%	$2,111	$591	$2,702		0	$2,702	27.6%	$2,694	$754	$3,448
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$5,671	$1,588	28%	$7,259	0.4%	$5,696	$1,595	$7,291		0	$7,291	22.6%	$6,985	$1,956	$8,941
11	LEVEES & FLOODWALLS	Levees	$41,817	$11,709	28%	$53,526	0.4%	$41,984	$11,755	$53,739		0	$53,739	22.6%	$51,486	$14,416	$65,902
16	BANK STABILIZATION		$20,205	$5,657	28%	$25,863	1.8%	$20,561	$5,757	$26,318		0	$26,318	22.6%	$25,215	$7,060	$32,275
	CONSTRUCTION ESTIMATE TOTALS:		$95,319	$26,689		$122,008	0.8%	$96,076	$26,901	$122,978		0	$122,978	24.0%	$119,144	$33,360	$152,504
01	LANDS AND DAMAGES		$1,405	$375	27%	$1,780	0.6%	$1,413	$377	$1,790		0	$1,790	19.0%	$1,682	$449	$2,130
30	PLANNING, ENGINEERING & DESIGN *		$12,836	$3,594	28%	$16,430	2.3%	$13,131	$3,677	$16,808		0	$16,808	44.6%	$18,982	$5,315	$24,297
31	CONSTRUCTION MANAGEMENT *		$6,281	$1,759	28%	$8,040	2.3%	$6,426	$1,799	$8,225		0	$8,225	52.4%	$9,793	$2,742	$12,535
18	CULTURAL RESOURCE PRESERVATION		$752	$203	27%	$955	0.8%	$745	$201	$946		0	$946	19.9%	$893	$241	$1,134
	PROJECT COST TOTALS:		$116,593	$32,620	28%	$149,214		$117,791	$32,956	**$150,747**		0	**$150,747**	27.8%	$150,493	$42,107	$192,600

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: $192,600

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

NOTE - Estimated Federal Cost based on NED Plan so appears greater than 65%

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach D, Levee Improvements															
02	RELOCATIONS		$20,419	$5,717	28%	$26,136	0.4%	$20,502	$5,740	$26,242	$0	2026Q3	22.6%	$25,142	$7,040	$32,182
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$5,671	$1,588	28%	$7,259	0.4%	$5,696	$1,595	$7,291	$0	2026Q3	22.6%	$6,985	$1,956	$8,941
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$41,817	$11,709	28%	$53,526	0.4%	$41,984	$11,755	$53,739	$0	2026Q3	22.6%	$51,486	$14,416	$65,902
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$67,907	$19,014	28%	**$86,921**		$68,181	$19,091	$87,272	$0			$83,613	$23,412	$107,025
01	LANDS AND DAMAGES	Fed	$214	$11	5%	$225	0.6%	$215	$11	$226	$0	2025Q1	19.0%	$256	$13	$269
01	LANDS AND DAMAGES	Non-Fed	$1,191	$364	31%	$1,555	0.6%	$1,198	$366	$1,564	$0	2025Q1	19.0%	$1,426	$435	$1,861
18	CULTURAL RESOURCE PRESERVATION		$570	$154	27%	$723	-1.0%	$564	$152	$716	$0	2025Q1	19.0%	$671	$181	$853
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$760	$213	28%	$973	2.3%	$777	$218	$995	$0	2025Q1	42.5%	$1,108	$310	$1,419
0.006	Planning & Environmental Compliance		$1,257	$352	28%	$1,609	2.3%	$1,286	$360	$1,646	$0	2025Q1	42.5%	$1,833	$513	$2,346
0.082	Engineering & Design		$3,894	$1,090	28%	$4,984	2.3%	$3,984	$1,115	$5,099	$0	2025Q1	42.5%	$5,679	$1,590	$7,269
0.003	Reviews, ATRs, IEPRs, VE		$142	$40	28%	$182	2.3%	$145	$41	$186	$0	2025Q1	42.5%	$207	$58	$265
0.007	Life Cycle Updates (cost, schedule, risks)		$332	$93	28%	$425	2.3%	$340	$95	$435	$0	2025Q1	42.5%	$484	$136	$620
0.01	Contracting & Reprographics		$475	$133	28%	$608	2.3%	$486	$136	$622	$0	2025Q1	42.5%	$693	$194	$887
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$475	$133	28%	$608	2.3%	$486	$136	$622	$0	2025Q1	42.5%	$693	$194	$887
0.02	Engineering During Construction		$950	$266	28%	$1,216	2.3%	$972	$272	$1,244	$0	2026Q3	52.0%	$1,477	$414	$1,891
0.003	Planning During Construction		$142	$40	28%	$182	2.3%	$145	$41	$186	$0	2026Q3	52.0%	$221	$62	$283
0.013	Project Operations		$617	$173	28%	$790	2.3%	$631	$177	$808	$0	2025Q1	42.5%	$900	$252	$1,152
0.16	NON-FED Planning, Engineering & Design (Relocations)		$3,267	$915	28%	$4,182	2.3%	$3,342	$936	$4,278	$0	2025Q1	42.5%	$4,764	$1,334	$6,098
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$2,232	$625	28%	$2,857	2.3%	$2,283	$639	$2,923	$0	2026Q3	52.0%	$3,470	$972	$4,442
0.012	Project Operation:		$570	$160	28%	$730	2.3%	$583	$163	$746	$0	2026Q3	52.0%	$886	$248	$1,134
0.031	Project Management		$1,472	$412	28%	$1,884	2.3%	$1,506	$422	$1,928	$0	2026Q3	52.0%	$2,289	$641	$2,930
0.09	NON-FED Construction Management (Relocations)		$1,838	$515	28%	$2,353	2.3%	$1,880	$526	$2,407	$0	2026Q3	52.0%	$2,858	$800	$3,658
	CONTRACT COST TOTALS:		$88,304	$24,701		**$113,005**		$89,005	$24,897	$113,902	$0			$113,527	$31,759	**$145,286**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach D, Erosion Protection															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$20,205	$5,657	28%	$25,863	1.8%	$20,561	$5,757	$26,318	$0	2026Q3	22.6%	$25,215	$7,060	$32,275
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$20,205	$5,657	28%	**$25,863**		$20,561	$5,757	$26,318	$0			$25,215	$7,060	$32,275
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$165	$45	27%	$210	-1.0%	$164	$44	$208	$0	2026Q3	22.6%	$201	$54	$255
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$323	$90	28%	$413	2.3%	$330	$93	$423	$0	2025Q3	45.6%	$481	$135	$616
0.006	Planning & Environmental Compliance		$121	$34	28%	$155	2.3%	$124	$35	$158	$0	2025Q3	45.6%	$180	$50	$231
0.082	Engineering & Design		$1,657	$464	28%	$2,121	2.3%	$1,695	$475	$2,170	$0	2025Q3	45.6%	$2,468	$691	$3,159
0.003	Reviews, ATRs, IEPRs, VE		$61	$17	28%	$78	2.3%	$62	$17	$80	$0	2025Q3	45.6%	$91	$25	$116
0.007	Life Cycle Updates (cost, schedule, risks)		$141	$39	28%	$180	2.3%	$144	$40	$185	$0	2025Q3	45.6%	$210	$59	$269
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$202	$57	28%	$259	2.3%	$207	$58	$265	$0	2025Q3	45.6%	$301	$84	$385
0.01	Contracting & Reprographics		$202	$57	28%	$259	2.3%	$207	$58	$265	$0	2025Q3	45.6%	$301	$84	$385
0.02	Engineering During Construction		$404	$113	28%	$517	2.3%	$413	$116	$529	$0	2026Q3	52.0%	$628	$176	$804
0.003	Planning During Construction		$61	$17	28%	$78	2.3%	$62	$17	$80	$0	2026Q3	52.0%	$95	$27	$121
0.013	Project Operations		$263	$74	28%	$337	2.3%	$269	$75	$344	$0	2025Q3	45.6%	$392	$110	$501
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$950	$266	28%	$1,216	2.3%	$972	$272	$1,244	$0	2026Q3	52.0%	$1,477	$414	$1,891
0.012	Project Operation:		$242	$68	28%	$310	2.3%	$248	$69	$317	$0	2026Q3	52.0%	$376	$105	$482
0.031	Project Management		$626	$175	28%	$801	2.3%	$640	$179	$820	$0	2026Q3	52.0%	$973	$273	$1,246
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$25,624	$7,173		**$32,797**		$26,099	$7,306	$33,405	$0			$33,389	$9,347	**$42,736**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach D, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$2,102	$589	28%	$2,691	0.4%	$2,111	$591	$2,702	$0	2028Q3	27.6%	$2,694	$754	$3,448
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,102	$589	28%	**$2,691**		$2,111	$591	$2,702	$0			$2,694	$754	$3,448
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$17	$5	27%	$22	-1.0%	$17	$5	$22	$0	2026Q3	22.6%	$21	$6	$27
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$34	$10	28%	$44	2.3%	$35	$10	$45	$0	2025Q3	45.6%	$51	$14	$65
0.006	Planning & Environmental Compliance		$13	$4	28%	$17	2.3%	$13	$4	$17	$0	2025Q3	45.6%	$19	$5	$25
0.082	Engineering & Design		$172	$48	28%	$220	2.3%	$176	$49	$225	$0	2025Q3	45.6%	$256	$72	$328
0.003	Reviews, ATRs, IEPRs, VE		$6	$2	28%	$8	2.3%	$6	$2	$8	$0	2025Q3	45.6%	$9	$3	$11
0.007	Life Cycle Updates (cost, schedule, risks)		$15	$4	28%	$19	2.3%	$15	$4	$20	$0	2025Q3	45.6%	$22	$6	$29
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$21	$6	28%	$27	2.3%	$21	$6	$27	$0	2025Q3	45.6%	$31	$9	$40
0.01	Contracting & Reprographics		$21	$6	28%	$27	2.3%	$21	$6	$27	$0	2025Q3	45.6%	$31	$9	$40
0.02	Engineering During Construction		$42	$12	28%	$54	2.3%	$43	$12	$55	$0	2028Q3	65.9%	$71	$20	$91
0.003	Planning During Construction		$6	$2	28%	$8	2.3%	$6	$2	$8	$0	2028Q3	65.9%	$10	$3	$13
0.013	Project Operations		$27	$8	28%	$35	2.3%	$28	$8	$35	$0	2025Q3	45.6%	$40	$11	$51
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$99	$28	28%	$127	2.3%	$101	$28	$130	$0	2028Q3	65.9%	$168	$47	$215
0.012	Project Operation:		$25	$7	28%	$32	2.3%	$26	$7	$33	$0	2028Q3	65.9%	$42	$12	$54
0.031	Project Management		$65	$18	28%	$83	2.3%	$66	$19	$85	$0	2028Q3	65.9%	$110	$31	$141
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$2,665	$746		**$3,412**		$2,687	$752	$3,439	$0			$3,577	$1,001	**$4,578**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):				2016						
							Effective Price Level Date:				1 OCT 15						
											Spent Thru:						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach E																
02	RELOCATIONS *		$4,143	$1,160	28%	$5,303	0.8%	$4,176	$1,169	$5,345		0	$5,345	19.4%	$4,986	$1,396	$6,381
06	FISH & WILDLIFE FACILITIES	Construction	$2,061	$577	28%	$2,639	0.4%	$2,070	$580	$2,650		0	$2,650	23.8%	$2,564	$718	$3,282
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$4,694	$1,314	28%	$6,008	0.4%	$4,715	$1,320	$6,035		0	$6,035	16.7%	$5,502	$1,540	$7,042
11	LEVEES & FLOODWALLS	Levees	$39,601	$11,088	28%	$50,689	0.4%	$39,759	$11,132	$50,891		0	$50,891	16.7%	$46,396	$12,991	$59,387
16	BANK STABILIZATION		$15,001	$4,200	28%	$19,201	1.8%	$15,265	$4,274	$19,539		0	$19,539	19.0%	$18,170	$5,088	$23,258
	CONSTRUCTION ESTIMATE TOTALS:		$65,500	$18,340		$83,840	0.7%	$65,984	$18,476	$84,460		0	$84,460	17.6%	$77,617	$21,733	$99,350
01	LANDS AND DAMAGES		$6,431	$700	11%	$7,131	0.6%	$6,466	$704	$7,170		0	$7,170	12.2%	$7,253	$790	$8,042
30	PLANNING, ENGINEERING & DESIGN *		$11,403	$3,193	28%	$14,596	2.3%	$11,665	$3,266	$14,932		0	$14,932	29.4%	$15,100	$4,228	$19,328
31	CONSTRUCTION MANAGEMENT *		$5,523	$1,546	28%	$7,069	2.3%	$5,650	$1,582	$7,232		0	$7,232	38.8%	$7,844	$2,196	$10,040
18	CULTURAL RESOURCE PRESERVATION		$581	$157	27%	$738	0.8%	$576	$155	$731		0	$731	12.7%	$649	$175	$824
	PROJECT COST TOTALS:		$89,438	$23,936	27%	$113,375		$90,342	$24,183	**$114,525**		0	**$114,525**	20.1%	$108,463	$29,122	$137,585

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: $137,585

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

NOTE - Estimated Federal Cost based on NED Plan so appears greater than 65%

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach E, Levee Improvements															
02	RELOCATIONS		$3,315	$928	28%	$4,244	0.4%	$3,329	$932	$4,261	$0	2024Q1	16.7%	$3,884	$1,088	$4,972
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$4,694	$1,314	28%	$6,008	0.4%	$4,715	$1,320	$6,035	$0	2024Q1	16.7%	$5,502	$1,540	$7,042
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$39,601	$11,088	28%	$50,689	0.4%	$39,759	$11,132	$50,891	$0	2024Q1	16.7%	$46,396	$12,991	$59,387
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$47,610	$13,331	28%	**$60,941**		$47,802	$13,385	$61,186	$0			$55,782	$15,619	$71,401
01	LANDS AND DAMAGES	Fed	$1,401	$74	5%	$1,475	0.6%	$1,409	$74	$1,483	$0	2022Q1	12.2%	$1,580	$83	$1,664
01	LANDS AND DAMAGES	Non-Fed	$5,029	$626	12%	$5,656	0.6%	$5,057	$630	$5,687	$0	2022Q1	12.2%	$5,672	$706	$6,379
18	CULTURAL RESOURCE PRESERVATION		$442	$119	27%	$561	-1.0%	$437	$118	$555	$0	2022Q1	12.2%	$491	$132	$623
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$709	$199	28%	$908	2.3%	$725	$203	$928	$0	2022Q1	26.1%	$915	$256	$1,171
0.006	Planning & Environmental Compliance		$1,238	$347	28%	$1,585	2.3%	$1,266	$355	$1,621	$0	2022Q1	26.1%	$1,598	$447	$2,045
0.082	Engineering & Design		$3,632	$1,017	28%	$4,649	2.3%	$3,716	$1,040	$4,756	$0	2022Q1	26.1%	$4,687	$1,312	$5,999
0.003	Reviews, ATRs, IEPRs, VE		$133	$37	28%	$170	2.3%	$136	$38	$174	$0	2022Q1	26.1%	$172	$48	$220
0.007	Life Cycle Updates (cost, schedule, risks)		$310	$87	28%	$397	2.3%	$317	$89	$406	$0	2022Q1	26.1%	$400	$112	$512
0.01	Contracting & Reprographics		$443	$124	28%	$567	2.3%	$453	$127	$580	$0	2022Q1	26.1%	$572	$160	$732
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$443	$124	28%	$567	2.3%	$453	$127	$580	$0	2022Q1	26.1%	$572	$160	$732
0.02	Engineering During Construction		$886	$248	28%	$1,134	2.3%	$906	$254	$1,160	$0	2024Q1	36.8%	$1,240	$347	$1,587
0.003	Planning During Construction		$133	$37	28%	$170	2.3%	$136	$38	$174	$0	2024Q1	36.8%	$186	$52	$238
0.013	Project Operations		$576	$161	28%	$737	2.3%	$589	$165	$754	$0	2022Q1	26.1%	$743	$208	$951
0.16	NON-FED Planning, Engineering & Design (Relocations)		$530	$148	28%	$678	2.3%	$542	$152	$694	$0	2022Q1	26.1%	$684	$192	$875
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$2,082	$583	28%	$2,665	2.3%	$2,130	$596	$2,726	$0	2024Q1	36.8%	$2,914	$816	$3,730
0.012	Project Operation:		$532	$149	28%	$681	2.3%	$544	$152	$697	$0	2024Q1	36.8%	$745	$208	$953
0.031	Project Management		$1,373	$384	28%	$1,757	2.3%	$1,405	$393	$1,798	$0	2024Q1	36.8%	$1,922	$538	$2,460
0.09	NON-FED Construction Management (Relocations)		$298	$83	28%	$381	2.3%	$305	$85	$390	$0	2024Q1	36.8%	$417	$117	$534
	CONTRACT COST TOTALS:		$67,800	$17,879		**$85,679**		$68,330	$18,021	$86,351	$0			$81,291	$21,515	**$102,806**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach E, Erosion Protection															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$15,001	$4,200	28%	$19,201	1.8%	$15,265	$4,274	$19,539	$0	2025Q1	19.0%	$18,170	$5,088	$23,258
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$15,001	$4,200	28%	**$19,201**		$15,265	$4,274	$19,539	$0			$18,170	$5,088	$23,258
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$123	$33	27%	$156	-1.0%	$122	$33	$154	$0	2023Q3	15.6%	$141	$38	$179
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$240	$67	28%	$307	2.3%	$246	$69	$314	$0	2023Q3	34.0%	$329	$92	$421
0.006	Planning & Environmental Compliance		$90	$25	28%	$115	2.3%	$92	$26	$118	$0	2023Q3	34.0%	$123	$35	$158
0.082	Engineering & Design		$1,230	$344	28%	$1,574	2.3%	$1,258	$352	$1,611	$0	2023Q3	34.0%	$1,686	$472	$2,159
0.003	Reviews, ATRs, IEPRs, VE		$45	$13	28%	$58	2.3%	$46	$13	$59	$0	2023Q3	34.0%	$62	$17	$79
0.007	Life Cycle Updates (cost, schedule, risks)		$105	$29	28%	$134	2.3%	$107	$30	$137	$0	2023Q3	34.0%	$144	$40	$184
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$150	$42	28%	$192	2.3%	$153	$43	$196	$0	2023Q3	34.0%	$206	$58	$263
0.01	Contracting & Reprographics		$150	$42	28%	$192	2.3%	$153	$43	$196	$0	2023Q3	34.0%	$206	$58	$263
0.02	Engineering During Construction		$300	$84	28%	$384	2.3%	$307	$86	$393	$0	2025Q1	42.5%	$437	$122	$560
0.003	Planning During Construction		$45	$13	28%	$58	2.3%	$46	$13	$59	$0	2025Q1	42.5%	$66	$18	$84
0.013	Project Operations		$195	$55	28%	$250	2.3%	$199	$56	$255	$0	2023Q3	34.0%	$267	$75	$342
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$705	$197	28%	$902	2.3%	$721	$202	$923	$0	2025Q1	42.5%	$1,028	$288	$1,316
0.012	Project Operation:		$180	$50	28%	$230	2.3%	$184	$52	$236	$0	2025Q1	42.5%	$262	$73	$336
0.031	Project Management		$465	$130	28%	$595	2.3%	$476	$133	$609	$0	2025Q1	42.5%	$678	$190	$868
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$19,024	$5,325		**$24,349**		$19,377	$5,424	$24,801	$0			$23,805	$6,664	**$30,470**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach E, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$2,061	$577	28%	$2,639	0.4%	$2,070	$580	$2,650	$0	2027Q1	23.8%	$2,564	$718	$3,282
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,061	$577	28%	**$2,639**		$2,070	$580	$2,650	$0			$2,564	$718	$3,282
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$17	$5	27%	$21	-1.0%	$17	$5	$21	$0	2018Q4	5.1%	$18	$5	$22
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$33	$9	28%	$42	2.3%	$34	$9	$43	$0	2023Q3	34.0%	$45	$13	$58
0.006	Planning & Environmental Compliance		$12	$3	28%	$15	2.3%	$12	$3	$16	$0	2023Q3	34.0%	$16	$5	$21
0.082	Engineering & Design		$169	$47	28%	$216	2.3%	$173	$48	$221	$0	2023Q3	34.0%	$232	$65	$297
0.003	Reviews, ATRs, IEPRs, VE		$6	$2	28%	$8	2.3%	$6	$2	$8	$0	2023Q3	34.0%	$8	$2	$11
0.007	Life Cycle Updates (cost, schedule, risks)		$14	$4	28%	$18	2.3%	$14	$4	$18	$0	2023Q3	34.0%	$19	$5	$25
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$21	$6	28%	$27	2.3%	$21	$6	$27	$0	2023Q3	34.0%	$29	$8	$37
0.01	Contracting & Reprographics		$21	$6	28%	$27	2.3%	$21	$6	$27	$0	2023Q3	34.0%	$29	$8	$37
0.02	Engineering During Construction		$41	$11	28%	$52	2.3%	$42	$12	$54	$0	2027Q1	55.3%	$65	$18	$83
0.003	Planning During Construction		$6	$2	28%	$8	2.3%	$6	$2	$8	$0	2027Q1	55.3%	$10	$3	$12
0.013	Project Operations		$27	$8	28%	$35	2.3%	$28	$8	$35	$0	2023Q3	34.0%	$37	$10	$47
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$97	$27	28%	$124	2.3%	$99	$28	$127	$0	2027Q1	55.3%	$154	$43	$197
0.012	Project Operation:		$25	$7	28%	$32	2.3%	$26	$7	$33	$0	2027Q1	55.3%	$40	$11	$51
0.031	Project Management		$64	$18	28%	$82	2.3%	$65	$18	$84	$0	2027Q1	55.3%	$102	$28	$130
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$2,614	$732		**$3,346**		$2,635	$738	$3,373	$0			$3,367	$943	**$4,310**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

NOTE - Estimated Federal Cost based on NED Plan so appears greater than 65%

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST						TOTAL PROJECT COST			
							Program Year (Budget EC):			2016						
							Effective Price Level Date:			1 OCT 15						
										Spent Thru:						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)	FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach F															
02	RELOCATIONS *		$11,421	$3,198	28%	$14,619	0.8%	$11,511	$3,223	$14,733		0	$14,733	12.7%	$12,972	$3,632	$16,605
06	FISH & WILDLIFE FACILITIES	Construction	$3,156	$884	28%	$4,040	0.4%	$3,170	$888	$4,058		0	$4,058	17.9%	$3,737	$1,046	$4,783
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$10,082	$2,823	28%	$12,905	0.4%	$10,126	$2,835	$12,962		0	$12,962	11.1%	$11,248	$3,149	$14,397
11	LEVEES & FLOODWALLS	Levees	$99,821	$27,950	28%	$127,771	0.4%	$100,219	$28,061	$128,280		0	$128,280	11.1%	$111,315	$31,168	$142,484
16	BANK STABILIZATION		$37,099	$10,388	28%	$47,487	1.8%	$37,752	$10,571	$48,323		0	$48,323	13.3%	$42,771	$11,976	$54,747
	CONSTRUCTION ESTIMATE TOTALS:		$161,579	$45,242		$206,821	0.7%	$162,778	$45,578	$208,356		0	$208,356	11.8%	$182,044	$50,972	$233,016
01	LANDS AND DAMAGES		$21,396	$6,099	29%	$27,495	0.6%	$21,514	$6,133	$27,647		0	$27,647	7.8%	$23,194	$6,612	$29,806
30	PLANNING, ENGINEERING & DESIGN *		$26,500	$7,420	28%	$33,920	2.3%	$27,110	$7,591	$34,701		0	$34,701	18.2%	$32,041	$8,972	$41,013
31	CONSTRUCTION MANAGEMENT *		$13,514	$3,784	28%	$17,298	2.3%	$13,825	$3,871	$17,696		0	$17,696	25.2%	$17,312	$4,847	$22,160
18	CULTURAL RESOURCE PRESERVATION		$1,628	$440	27%	$2,067	0.8%	$1,612	$435	$2,047		0	$2,047	8.0%	$1,740	$470	$2,210
	PROJECT COST TOTALS:		$224,617	$62,985	28%	$287,602		$226,840	$63,608	**$290,448**		0	**$290,448**	13.0%	$256,332	$71,873	$328,205

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED FEDERAL COST:	75%	**$244,697**
ESTIMATED NON-FEDERAL COST:	25%	**$83,508**
ESTIMATED TOTAL PROJECT COST:		**$328,205**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach F, Levee Improvements															
02	RELOCATIONS		$9,137	$2,558	28%	$11,695	0.4%	$9,174	$2,569	$11,743	$0	2021Q3	11.1%	$10,190	$2,853	$13,043
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$10,082	$2,823	28%	$12,905	0.4%	$10,126	$2,835	$12,962	$0	2021Q3	11.1%	$11,248	$3,149	$14,397
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$99,821	$27,950	28%	$127,771	0.4%	$100,219	$28,061	$128,280	$0	2021Q3	11.1%	$111,315	$31,168	$142,484
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$119,040	$33,331	28%	**$152,371**		$119,519	$33,465	$152,985	$0			$132,753	$37,171	$169,924
01	LANDS AND DAMAGES	Fed	$3,040	$160	5%	$3,200	0.6%	$3,057	$161	$3,218	$0	2020Q1	7.8%	$3,296	$173	$3,469
01	LANDS AND DAMAGES	Non-Fed	$18,356	$5,939	32%	$24,295	0.6%	$18,458	$5,972	$24,430	$0	2020Q1	7.8%	$19,899	$6,439	$26,337
18	CULTURAL RESOURCE PRESERVATION		$1,298	$351	27%	$1,649	-1.0%	$1,285	$347	$1,633	$0	2020Q1	7.8%	$1,386	$374	$1,760
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$1,758	$492	28%	$2,250	2.3%	$1,798	$504	$2,302	$0	2020Q1	16.5%	$2,096	$587	$2,683
0.006	Planning & Environmental Compliance		$1,632	$457	28%	$2,089	2.3%	$1,670	$467	$2,137	$0	2020Q1	16.5%	$1,946	$545	$2,491
0.082	Engineering & Design		$9,012	$2,523	28%	$11,535	2.3%	$9,219	$2,581	$11,801	$0	2020Q1	16.5%	$10,745	$3,009	$13,753
0.003	Reviews, ATRs, IEPRs, VE		$330	$92	28%	$422	2.3%	$338	$95	$432	$0	2020Q1	16.5%	$393	$110	$504
0.007	Life Cycle Updates (cost, schedule, risks)		$769	$215	28%	$984	2.3%	$787	$220	$1,007	$0	2020Q1	16.5%	$917	$257	$1,174
0.01	Contracting & Reprographics		$1,099	$308	28%	$1,407	2.3%	$1,124	$315	$1,439	$0	2020Q1	16.5%	$1,310	$367	$1,677
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$1,099	$308	28%	$1,407	2.3%	$1,124	$315	$1,439	$0	2020Q1	16.5%	$1,310	$367	$1,677
0.02	Engineering During Construction		$2,198	$615	28%	$2,813	2.3%	$2,249	$630	$2,878	$0	2021Q3	23.6%	$2,780	$778	$3,559
0.003	Planning During Construction		$330	$92	28%	$422	2.3%	$338	$95	$432	$0	2021Q3	23.6%	$417	$117	$534
0.013	Project Operations		$1,429	$400	28%	$1,829	2.3%	$1,462	$409	$1,871	$0	2020Q1	16.5%	$1,704	$477	$2,181
0.16	NON-FED Planning, Engineering & Design (Relocations)		$1,462	$409	28%	$1,871	2.3%	$1,496	$419	$1,914	$0	2020Q1	16.5%	$1,743	$488	$2,231
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$5,165	$1,446	28%	$6,611	2.3%	$5,284	$1,479	$6,763	$0	2021Q3	23.6%	$6,533	$1,829	$8,362
0.012	Project Operation:		$1,319	$369	28%	$1,688	2.3%	$1,349	$378	$1,727	$0	2021Q3	23.6%	$1,668	$467	$2,135
0.031	Project Management		$3,407	$954	28%	$4,361	2.3%	$3,485	$976	$4,461	$0	2021Q3	23.6%	$4,309	$1,207	$5,516
0.09	NON-FED Construction Management (Relocations)		$822	$230	28%	$1,052	2.3%	$841	$235	$1,076	$0	2021Q3	23.6%	$1,040	$291	$1,331
	CONTRACT COST TOTALS:		$173,565	$48,694		**$222,258**		$174,883	$49,063	$223,946	$0			$196,245	$55,052	**$251,297**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach F, Erosion Protection															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$37,099	$10,388	28%	$47,487	1.8%	$37,752	$10,571	$48,323	$0	2022Q3	13.3%	$42,771	$11,976	$54,747
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$37,099	$10,388	28%	**$47,487**		$37,752	$10,571	$48,323	$0			$42,771	$11,976	$54,747
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$304	$82	27%	$386	-1.0%	$301	$81	$382	$0	2020Q3	8.9%	$328	$88	$416
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$594	$166	28%	$760	2.3%	$608	$170	$778	$0	2020Q3	18.9%	$722	$202	$924
0.006	Planning & Environmental Compliance		$223	$62	28%	$285	2.3%	$228	$64	$292	$0	2020Q3	18.9%	$271	$76	$347
0.082	Engineering & Design		$3,042	$852	28%	$3,894	2.3%	$3,112	$871	$3,983	$0	2020Q3	18.9%	$3,699	$1,036	$4,734
0.003	Reviews, ATRs, IEPRs, VE		$111	$31	28%	$142	2.3%	$114	$32	$145	$0	2020Q3	18.9%	$135	$38	$173
0.007	Life Cycle Updates (cost, schedule, risks)		$260	$73	28%	$333	2.3%	$266	$74	$340	$0	2020Q3	18.9%	$316	$89	$405
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$371	$104	28%	$475	2.3%	$380	$106	$486	$0	2020Q3	18.9%	$451	$126	$577
0.01	Contracting & Reprographics		$371	$104	28%	$475	2.3%	$380	$106	$486	$0	2020Q3	18.9%	$451	$126	$577
0.02	Engineering During Construction		$742	$208	28%	$950	2.3%	$759	$213	$972	$0	2022Q3	28.7%	$977	$274	$1,251
0.003	Planning During Construction		$111	$31	28%	$142	2.3%	$114	$32	$145	$0	2022Q3	28.7%	$146	$41	$187
0.013	Project Operations		$482	$135	28%	$617	2.3%	$493	$138	$631	$0	2020Q3	18.9%	$586	$164	$750
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,744	$488	28%	$2,232	2.3%	$1,784	$500	$2,284	$0	2022Q3	28.7%	$2,296	$643	$2,939
0.012	Project Operation:		$445	$125	28%	$570	2.3%	$455	$127	$583	$0	2022Q3	28.7%	$586	$164	$750
0.031	Project Management		$1,150	$322	28%	$1,472	2.3%	$1,176	$329	$1,506	$0	2022Q3	28.7%	$1,514	$424	$1,938
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$47,049	$13,171		**$60,219**		$47,921	$13,415	$61,336	$0			$55,250	$15,467	**$70,716**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach F, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$3,156	$884	28%	$4,040	0.4%	$3,170	$888	$4,058	$0	2024Q3	17.9%	$3,737	$1,046	$4,783
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$3,156	$884	28%	**$4,040**		$3,170	$888	$4,058	$0			$3,737	$1,046	$4,783
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$26	$7	27%	$33	-1.0%	$26	$7	$33	$0	2018Q4	5.1%	$27	$7	$34
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$51	$14	28%	$65	2.3%	$52	$15	$67	$0	2020Q3	18.9%	$62	$17	$79
0.006	Planning & Environmental Compliance		$19	$5	28%	$24	2.3%	$19	$5	$25	$0	2020Q3	18.9%	$23	$6	$30
0.082	Engineering & Design		$259	$73	28%	$332	2.3%	$265	$74	$339	$0	2020Q3	18.9%	$315	$88	$403
0.003	Reviews, ATRs, IEPRs, VE		$9	$3	28%	$12	2.3%	$9	$3	$12	$0	2020Q3	18.9%	$11	$3	$14
0.007	Life Cycle Updates (cost, schedule, risks)		$22	$6	28%	$28	2.3%	$23	$6	$29	$0	2020Q3	18.9%	$27	$7	$34
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$32	$9	28%	$41	2.3%	$33	$9	$42	$0	2020Q3	18.9%	$39	$11	$50
0.01	Contracting & Reprographics		$32	$9	28%	$41	2.3%	$33	$9	$42	$0	2020Q3	18.9%	$39	$11	$50
0.02	Engineering During Construction		$63	$18	28%	$81	2.3%	$64	$18	$82	$0	2024Q3	39.6%	$90	$25	$115
0.003	Planning During Construction		$9	$3	28%	$12	2.3%	$9	$3	$12	$0	2024Q3	39.6%	$13	$4	$16
0.013	Project Operations		$41	$11	28%	$52	2.3%	$42	$12	$54	$0	2020Q3	18.9%	$50	$14	$64
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$148	$41	28%	$189	2.3%	$151	$42	$194	$0	2024Q3	39.6%	$211	$59	$271
0.012	Project Operation:		$38	$11	28%	$49	2.3%	$39	$11	$50	$0	2024Q3	39.6%	$54	$15	$69
0.031	Project Management		$98	$27	28%	$125	2.3%	$100	$28	$128	$0	2024Q3	39.6%	$140	$39	$179
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$4,003	$1,121		**$5,124**		$4,036	$1,130	$5,165	$0			$4,838	$1,354	**$6,192**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST						TOTAL PROJECT COST			
							Program Year (Budget EC):			2016						
							Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARS, Reach G																
02	RELOCATIONS *		$26,383	$7,387	28%	$33,771	0.8%	$26,591	$7,445	$34,036		0	$34,036	23.5%	$32,845	$9,197	$42,042
06	FISH & WILDLIFE FACILITIES	Construction	$2,211	$619	28%	$2,830	0.4%	$2,221	$622	$2,843		0	$2,843	27.6%	$2,833	$793	$3,627
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$3,210	$899	28%	$4,109	0.4%	$3,224	$903	$4,126		0	$4,126	20.2%	$3,876	$1,085	$4,961
11	LEVEES & FLOODWALLS	Levees	$28,030	$7,848	28%	$35,879	0.4%	$28,142	$7,880	$36,022		0	$36,022	20.2%	$33,835	$9,474	$43,309
16	BANK STABILIZATION		$18,457	$5,168	28%	$23,625	1.8%	$18,782	$5,259	$24,042		0	$24,042	22.6%	$23,034	$6,449	$29,483
	CONSTRUCTION ESTIMATE TOTALS:		$78,292	$21,922		$100,214	0.9%	$78,960	$22,109	$101,069		0	$101,069	22.1%	$96,423	$26,999	$123,422
01	LANDS AND DAMAGES		$4,037	$1,046	26%	$5,083	0.6%	$4,059	$1,052	$5,111		0	$5,111	14.4%	$4,644	$1,204	$5,848
30	PLANNING, ENGINEERING & DESIGN *		$9,797	$2,743	28%	$12,540	2.3%	$10,022	$2,806	$12,829		0	$12,829	37.9%	$13,817	$3,869	$17,686
31	CONSTRUCTION MANAGEMENT *		$4,671	$1,308	28%	$5,979	2.3%	$4,779	$1,338	$6,116		0	$6,116	48.7%	$7,107	$1,990	$9,097
18	CULTURAL RESOURCE PRESERVATION		$644	$174	27%	$817	0.8%	$637	$172	$809		0	$809	15.9%	$739	$200	$938
	PROJECT COST TOTALS:		$97,441	$27,193	28%	$124,633		$98,458	$27,477	**$125,935**		0	**$125,935**	24.7%	$122,730	$34,260	$156,991

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: $156,991

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

NOTE - Estimated Federal Cost based on NED Plan so appears greater than 65%

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARS, Reach G, Levee Improvements															
02	RELOCATIONS		$21,106	$5,910	28%	$27,016	0.4%	$21,192	$5,934	$27,126	$0	2025Q3	20.2%	$25,479	$7,134	$32,613
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$3,210	$899	28%	$4,109	0.4%	$3,224	$903	$4,126	$0	2025Q3	20.2%	$3,876	$1,085	$4,961
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$28,030	$7,848	28%	$35,879	0.4%	$28,142	$7,880	$36,022	$0	2025Q3	20.2%	$33,835	$9,474	$43,309
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$52,347	$14,657	28%	**$67,004**		$52,558	$14,716	$67,275	$0			$63,190	$17,693	$80,883
01	LANDS AND DAMAGES	Fed	$475	$25	5%	$500	0.6%	$478	$25	$503	$0	2023Q1	14.4%	$546	$29	$575
01	LANDS AND DAMAGES	Non-Fed	$3,562	$1,021	29%	$4,583	0.6%	$3,582	$1,027	$4,608	$0	2023Q1	14.4%	$4,098	$1,175	$5,272
18	CULTURAL RESOURCE PRESERVATION		$474	$128	27%	$603	-1.0%	$470	$127	$597	$0	2023Q1	14.4%	$537	$145	$683
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$500	$140	28%	$640	2.3%	$512	$143	$655	$0	2023Q1	31.3%	$672	$188	$860
0.006	Planning & Environmental Compliance		$1,160	$325	28%	$1,485	2.3%	$1,187	$332	$1,519	$0	2023Q1	31.3%	$1,558	$436	$1,995
0.082	Engineering & Design		$2,562	$717	28%	$3,279	2.3%	$2,621	$734	$3,355	$0	2023Q1	31.3%	$3,442	$964	$4,405
0.003	Reviews, ATRs, IEPRs, VE		$94	$26	28%	$120	2.3%	$96	$27	$123	$0	2023Q1	31.3%	$126	$35	$162
0.007	Life Cycle Updates (cost, schedule, risks)		$219	$61	28%	$280	2.3%	$224	$63	$287	$0	2023Q1	31.3%	$294	$82	$377
0.01	Contracting & Reprographics		$312	$87	28%	$399	2.3%	$319	$89	$409	$0	2023Q1	31.3%	$419	$117	$536
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$312	$87	28%	$399	2.3%	$319	$89	$409	$0	2023Q1	31.3%	$419	$117	$536
0.02	Engineering During Construction		$625	$175	28%	$800	2.3%	$639	$179	$818	$0	2025Q3	45.6%	$931	$261	$1,191
0.003	Planning During Construction		$94	$26	28%	$120	2.3%	$96	$27	$123	$0	2025Q3	45.6%	$140	$39	$179
0.013	Project Operations		$406	$114	28%	$520	2.3%	$415	$116	$532	$0	2023Q1	31.3%	$545	$153	$698
0.16	NON-FED Planning, Engineering & Design (Relocations)		$3,377	$946	28%	$4,323	2.3%	$3,455	$967	$4,422	$0	2023Q1	31.3%	$4,537	$1,270	$5,807
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,468	$411	28%	$1,879	2.3%	$1,502	$420	$1,922	$0	2025Q3	45.6%	$2,186	$612	$2,798
0.012	Project Operation:		$375	$105	28%	$480	2.3%	$384	$107	$491	$0	2025Q3	45.6%	$558	$156	$715
0.031	Project Management		$968	$271	28%	$1,239	2.3%	$990	$277	$1,268	$0	2025Q3	45.6%	$1,442	$404	$1,845
0.09	NON-FED Construction Management (Relocations)		$1,900	$532	28%	$2,432	2.3%	$1,944	$544	$2,488	$0	2025Q3	45.6%	$2,830	$792	$3,622
	CONTRACT COST TOTALS:		$71,230	$19,856		**$91,085**		$71,790	$20,012	$91,802	$0			$88,471	$24,670	**$113,141**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach G, Erosion Protection															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$18,457	$5,168	28%	$23,625	1.8%	$18,782	$5,259	$24,042	$0	2026Q3	22.6%	$23,034	$6,449	$29,483
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$18,457	$5,168	28%	**$23,625**		$18,782	$5,259	$24,042	$0			$23,034	$6,449	$29,483
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$151	$41	27%	$192	-1.0%	$150	$40	$190	$0	2025Q3	20.2%	$180	$49	$229
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$295	$83	28%	$378	2.3%	$302	$85	$386	$0	2025Q3	45.6%	$439	$123	$562
0.006	Planning & Environmental Compliance		$111	$31	28%	$142	2.3%	$114	$32	$145	$0	2025Q3	45.6%	$165	$46	$212
0.082	Engineering & Design		$1,514	$424	28%	$1,938	2.3%	$1,549	$434	$1,983	$0	2025Q3	45.6%	$2,255	$631	$2,886
0.003	Reviews, ATRs, IEPRs, VE		$55	$15	28%	$70	2.3%	$56	$16	$72	$0	2025Q3	45.6%	$82	$23	$105
0.007	Life Cycle Updates (cost, schedule, risks)		$129	$36	28%	$165	2.3%	$132	$37	$169	$0	2025Q3	45.6%	$192	$54	$246
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$185	$52	28%	$237	2.3%	$189	$53	$242	$0	2025Q3	45.6%	$276	$77	$353
0.01	Contracting & Reprographics		$185	$52	28%	$237	2.3%	$189	$53	$242	$0	2025Q3	45.6%	$276	$77	$353
0.02	Engineering During Construction		$369	$103	28%	$472	2.3%	$377	$106	$483	$0	2026Q3	52.0%	$574	$161	$734
0.003	Planning During Construction		$55	$15	28%	$70	2.3%	$56	$16	$72	$0	2026Q3	52.0%	$86	$24	$109
0.013	Project Operations		$240	$67	28%	$307	2.3%	$246	$69	$314	$0	2025Q3	45.6%	$357	$100	$458
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$867	$243	28%	$1,110	2.3%	$887	$248	$1,135	$0	2026Q3	52.0%	$1,348	$377	$1,726
0.012	Project Operation:		$221	$62	28%	$283	2.3%	$226	$63	$289	$0	2026Q3	52.0%	$344	$96	$440
0.031	Project Management		$572	$160	28%	$732	2.3%	$585	$164	$749	$0	2026Q3	52.0%	$889	$249	$1,138
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$23,406	$6,552		**$29,959**		$23,841	$6,674	$30,514	$0			$30,496	$8,537	**$39,033**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J		P	L	M	N	O
	ARS, Reach G, Erosion Protection, Planting & Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$2,211	$619	28%	$2,830	0.4%	$2,221	$622	$2,843	$0	2028Q3	27.6%	$2,833	$793	$3,627
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,211	$619	28%	**$2,830**		$2,221	$622	$2,843	$0			$2,833	$793	$3,627
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$18	$5	27%	$23	-1.0%	$18	$5	$23	$0	2025Q3	20.2%	$22	$6	$27
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$35	$10	28%	$45	2.3%	$36	$10	$46	$0	2025Q3	45.6%	$52	$15	$67
0.006	Planning & Environmental Compliance		$13	$4	28%	$17	2.3%	$13	$4	$17	$0	2025Q3	45.6%	$19	$5	$25
0.082	Engineering & Design		$181	$51	28%	$232	2.3%	$185	$52	$237	$0	2025Q3	45.6%	$270	$75	$345
0.003	Reviews, ATRs, IEPRs, VE		$7	$2	28%	$9	2.3%	$7	$2	$9	$0	2025Q3	45.6%	$10	$3	$13
0.007	Life Cycle Updates (cost, schedule, risks)		$15	$4	28%	$19	2.3%	$15	$4	$20	$0	2025Q3	45.6%	$22	$6	$29
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$22	$6	28%	$28	2.3%	$23	$6	$29	$0	2025Q3	45.6%	$33	$9	$42
0.01	Contracting & Reprographics		$22	$6	28%	$28	2.3%	$23	$6	$29	$0	2025Q3	45.6%	$33	$9	$42
0.02	Engineering During Construction		$44	$12	28%	$56	2.3%	$45	$13	$58	$0	2028Q3	65.9%	$75	$21	$96
0.003	Planning During Construction		$7	$2	28%	$9	2.3%	$7	$2	$9	$0	2028Q3	65.9%	$12	$3	$15
0.013	Project Operations		$29	$8	28%	$37	2.3%	$30	$8	$38	$0	2025Q3	45.6%	$43	$12	$55
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$104	$29	28%	$133	2.3%	$106	$30	$136	$0	2028Q3	65.9%	$177	$49	$226
0.012	Project Operation:		$27	$8	28%	$35	2.3%	$28	$8	$35	$0	2028Q3	65.9%	$46	$13	$59
0.031	Project Management		$69	$19	28%	$88	2.3%	$71	$20	$90	$0	2028Q3	65.9%	$117	$33	$150
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$2,804	$785		**$3,589**		$2,827	$791	$3,618	$0			$3,763	$1,054	**$4,817**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:		TOTAL					
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J						M	N	O
	ARN, Reach A																	
02	RELOCATIONS *		$1,972	$552	28%	$2,524	0.8%	$1,987	$556	$2,544		0		$2,544	19.7%	$2,379	$666	$3,045
06	FISH & WILDLIFE FACILITIES	Construction	$2,521	$706	28%	$3,226	0.4%	$2,531	$709	$3,240		0		$3,240	19.0%	$3,013	$844	$3,857
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$4,602	$1,289	28%	$5,891	0.4%	$4,622	$1,294	$5,916		0		$5,916	16.7%	$5,394	$1,510	$6,904
16	BANK STABILIZATION		$70,051	$19,614	28%	$89,666	1.8%	$71,285	$19,960	$91,245		0		$91,245	16.7%	$83,187	$23,292	$106,480
	CONSTRUCTION ESTIMATE TOTALS:		$79,146	$22,161		$101,306	1.6%	$80,426	$22,519	$102,945		0		$102,945	16.8%	$93,974	$26,313	$120,286
01	LANDS AND DAMAGES		$1,646	$518	31%	$2,164	0.6%	$1,656	$520	$2,176		0		$2,176	13.3%	$1,876	$590	$2,465
30	PLANNING, ENGINEERING & DESIGN *		$14,093	$3,946	28%	$18,039	2.3%	$14,417	$4,037	$18,454		0		$18,454	29.7%	$18,706	$5,238	$23,944
31	CONSTRUCTION MANAGEMENT *		$6,945	$1,945	28%	$8,890	2.3%	$7,105	$1,989	$9,094		0		$9,094	37.0%	$9,733	$2,725	$12,458
18	CULTURAL RESOURCE PRESERVATION		$659	$178	27%	$837	0.8%	$653	$176	$829		0		$829	13.4%	$740	$200	$940
	PROJECT COST TOTALS:		$102,489	$28,747	28%	$131,236		$104,257	$29,242	**$133,499**		0		**$133,499**	19.9%	$125,028	$35,065	$160,093

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED TOTAL PROJECT COST: **$160,093**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach A, Erosion Protection															
02	RELOCATIONS		$1,578	$442	28%	$2,019	0.4%	$1,584	$444	$2,028	$0	2024Q1	16.7%	$1,849	$518	$2,366
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$4,602	$1,289	28%	$5,891	0.4%	$4,622	$1,294	$5,916	$0	2024Q1	16.7%	$5,394	$1,510	$6,904
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$70,051	$19,614	28%	$89,666	1.8%	$71,285	$19,960	$91,245	$0	2024Q1	16.7%	$83,187	$23,292	$106,480
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$76,231	$21,345	28%	**$97,576**		$77,492	$21,698	$99,189	$0			$90,430	$25,320	$115,750
01	LANDS AND DAMAGES	Fed	$190	$10	5%	$200	0.6%	$191	$10	$201	$0	2022Q3	13.3%	$216	$11	$228
01	LANDS AND DAMAGES	Non-Fed	$1,456	$508	35%	$1,964	0.6%	$1,465	$510	$1,975	$0	2022Q3	13.3%	$1,659	$578	$2,237
18	CULTURAL RESOURCE PRESERVATION		$639	$172	27%	$811	-1.0%	$632	$171	$803	$0	2022Q3	13.3%	$717	$193	$910
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$1,194	$334	28%	$1,528	2.3%	$1,221	$342	$1,563	$0	2022Q3	28.7%	$1,572	$440	$2,012
0.006	Planning & Environmental Compliance		$1,420	$398	28%	$1,818	2.3%	$1,453	$407	$1,859	$0	2022Q3	28.7%	$1,870	$524	$2,393
0.082	Engineering & Design		$6,122	$1,714	28%	$7,836	2.3%	$6,263	$1,754	$8,017	$0	2022Q3	28.7%	$8,061	$2,257	$10,318
0.003	Reviews, ATRs, IEPRs, VE		$224	$63	28%	$287	2.3%	$229	$64	$293	$0	2022Q3	28.7%	$295	$83	$378
0.007	Life Cycle Updates (cost, schedule, risks)		$523	$146	28%	$669	2.3%	$535	$150	$685	$0	2022Q3	28.7%	$689	$193	$881
0.01	Contracting & Reprographics		$747	$209	28%	$956	2.3%	$764	$214	$978	$0	2022Q3	28.7%	$984	$275	$1,259
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$747	$209	28%	$956	2.3%	$764	$214	$978	$0	2022Q3	28.7%	$984	$275	$1,259
0.02	Engineering During Construction		$1,493	$418	28%	$1,911	2.3%	$1,527	$428	$1,955	$0	2024Q1	36.8%	$2,089	$585	$2,674
0.003	Planning During Construction		$224	$63	28%	$287	2.3%	$229	$64	$293	$0	2024Q1	36.8%	$313	$88	$401
0.013	Project Operations		$970	$272	28%	$1,242	2.3%	$992	$278	$1,270	$0	2022Q3	28.7%	$1,277	$358	$1,635
0.16	NON-FED Planning, Engineering & Design (Relocations)		$252	$71	28%	$323	2.3%	$258	$72	$330	$0	2022Q3	28.7%	$332	$93	$425
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$3,509	$983	28%	$4,492	2.3%	$3,590	$1,005	$4,595	$0	2024Q1	36.8%	$4,911	$1,375	$6,286
0.012	Project Operation:		$896	$251	28%	$1,147	2.3%	$917	$257	$1,173	$0	2024Q1	36.8%	$1,254	$351	$1,605
0.031	Project Management		$2,314	$648	28%	$2,962	2.3%	$2,367	$663	$3,030	$0	2024Q1	36.8%	$3,238	$907	$4,145
0.09	NON-FED Construction Management (Relocations)		$142	$40	28%	$182	2.3%	$145	$41	$186	$0	2024Q1	36.8%	$199	$56	$254
	CONTRACT COST TOTALS:		$99,293	$27,852		**$127,145**		$101,035	$28,340	$129,375	$0			$121,089	$33,962	**$155,051**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach A, Erosion Protection, Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$2,521	$706	28%	$3,226	0.4%	$2,531	$709	$3,240	$0	2025Q1	19.0%	$3,013	$844	$3,857
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,521	$706	28%	**$3,226**		$2,531	$709	$3,240	$0			$3,013	$844	$3,857
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$21	$6	27%	$26	-1.0%	$20	$6	$26	$0	2023Q3	15.6%	$24	$6	$30
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$40	$11	28%	$51	2.3%	$41	$11	$52	$0	2022Q3	28.7%	$53	$15	$67
0.006	Planning & Environmental Compliance		$15	$4	28%	$19	2.3%	$15	$4	$20	$0	2022Q3	28.7%	$20	$6	$25
0.082	Engineering & Design		$207	$58	28%	$265	2.3%	$212	$59	$271	$0	2022Q3	28.7%	$273	$76	$349
0.003	Reviews, ATRs, IEPRs, VE		$8	$2	28%	$10	2.3%	$8	$2	$10	$0	2022Q3	28.7%	$11	$3	$13
0.007	Life Cycle Updates (cost, schedule, risks)		$18	$5	28%	$23	2.3%	$18	$5	$24	$0	2022Q3	28.7%	$24	$7	$30
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$25	$7	28%	$32	2.3%	$26	$7	$33	$0	2022Q3	28.7%	$33	$9	$42
0.01	Contracting & Reprographics		$25	$7	28%	$32	2.3%	$26	$7	$33	$0	2022Q3	28.7%	$33	$9	$42
0.02	Engineering During Construction		$50	$14	28%	$64	2.3%	$51	$14	$65	$0	2025Q1	42.5%	$73	$20	$93
0.003	Planning During Construction		$8	$2	28%	$10	2.3%	$8	$2	$10	$0	2025Q1	42.5%	$12	$3	$15
0.013	Project Operations		$33	$9	28%	$42	2.3%	$34	$9	$43	$0	2022Q3	28.7%	$43	$12	$56
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$118	$33	28%	$151	2.3%	$121	$34	$155	$0	2025Q1	42.5%	$172	$48	$220
0.012	Project Operation:		$30	$8	28%	$38	2.3%	$31	$9	$39	$0	2025Q1	42.5%	$44	$12	$56
0.031	Project Management		$78	$22	28%	$100	2.3%	$80	$22	$102	$0	2025Q1	42.5%	$114	$32	$146
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$3,196	$895		**$4,091**		$3,222	$902	$4,124	$0			$3,939	$1,103	**$5,042**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARN, Reach B																
02	RELOCATIONS *		$81	$23	28%	$104	0.8%	$82	$23	$105		0	$105	27.7%	$105	$29	$134
06	FISH & WILDLIFE FACILITIES	Construction	$383	$107	28%	$491	0.4%	$385	$108	$493		0	$493	27.6%	$491	$138	$629
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$408	$114	28%	$522	0.4%	$410	$115	$525		0	$525	22.6%	$503	$141	$643
16	BANK STABILIZATION		$3,538	$991	28%	$4,528	1.8%	$3,600	$1,008	$4,608		0	$4,608	22.6%	$4,415	$1,236	$5,651
	CONSTRUCTION ESTIMATE TOTALS:		$4,410	$1,235		$5,645	1.5%	$4,477	$1,253	$5,730		0	$5,730	23.2%	$5,513	$1,544	$7,057
01	LANDS AND DAMAGES		$235	$41	18%	$276	0.6%	$236	$41	$278		0	$278	20.2%	$284	$50	$334
30	PLANNING, ENGINEERING & DESIGN *		$736	$206	28%	$942	2.3%	$753	$211	$964		0	$964	46.6%	$1,104	$309	$1,413
31	CONSTRUCTION MANAGEMENT *		$389	$109	28%	$498	2.3%	$398	$111	$509		0	$509	53.2%	$610	$171	$781
18	CULTURAL RESOURCE PRESERVATION		$37	$10	27%	$48	0.8%	$37	$10	$47		0	$47	20.4%	$45	$12	$57
	PROJECT COST TOTALS:		$5,808	$1,601	28%	$7,409		$5,901	$1,627	**$7,528**		0	**$7,528**	28.1%	$7,556	$2,085	$9,641

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

ESTIMATED TOTAL PROJECT COST: **$9,641**

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach B, Erosion Protection															
02	RELOCATIONS		$65	$18	28%	$84	0.4%	$66	$18	$84	$0	2026Q3	22.6%	$80	$23	$103
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$408	$114	28%	$522	0.4%	$410	$115	$525	$0	2026Q3	22.6%	$503	$141	$643
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$3,538	$991	28%	$4,528	1.8%	$3,600	$1,008	$4,608	$0	2026Q3	22.6%	$4,415	$1,236	$5,651
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$4,011	$1,123	28%	**$5,134**		$4,075	$1,141	$5,216	$0			$4,998	$1,399	$6,397
01	LANDS AND DAMAGES	Fed	$48	$2	5%	$50	0.6%	$48	$3	$50	$0	2025Q3	20.2%	$57	$3	$60
01	LANDS AND DAMAGES	Non-Fed	$187	$39	21%	$226	0.6%	$188	$39	$227	$0	2025Q3	20.2%	$227	$47	$273
18	CULTURAL RESOURCE PRESERVATION		$34	$9	27%	$44	-1.0%	$34	$9	$43	$0	2025Q3	20.2%	$41	$11	$52
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$63	$18	28%	$81	2.3%	$64	$18	$82	$0	2025Q3	45.6%	$94	$26	$120
0.006	Planning & Environmental Compliance		$24	$7	28%	$31	2.3%	$25	$7	$31	$0	2025Q3	45.6%	$36	$10	$46
0.082	Engineering & Design		$324	$91	28%	$415	2.3%	$331	$93	$424	$0	2025Q3	45.6%	$483	$135	$618
0.003	Reviews, ATRs, IEPRs, VE		$12	$3	28%	$15	2.3%	$12	$3	$16	$0	2025Q3	45.6%	$18	$5	$23
0.007	Life Cycle Updates (cost, schedule, risks)		$28	$8	28%	$36	2.3%	$29	$8	$37	$0	2025Q3	45.6%	$42	$12	$53
0.01	Contracting & Reprographics		$39	$11	28%	$50	2.3%	$40	$11	$51	$0	2025Q3	45.6%	$58	$16	$74
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$39	$11	28%	$50	2.3%	$40	$11	$51	$0	2025Q3	45.6%	$58	$16	$74
0.02	Engineering During Construction		$79	$22	28%	$101	2.3%	$81	$23	$103	$0	2026Q3	52.0%	$123	$34	$157
0.003	Planning During Construction		$12	$3	28%	$15	2.3%	$12	$3	$16	$0	2026Q3	52.0%	$19	$5	$24
0.013	Project Operations		$51	$14	28%	$65	2.3%	$52	$15	$67	$0	2025Q3	45.6%	$76	$21	$97
0.16	NON-FED Planning, Engineering & Design (Relocations)		$10	$3	28%	$13	2.3%	$10	$3	$13	$0	2025Q3	45.6%	$15	$4	$19
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$185	$52	28%	$237	2.3%	$189	$53	$242	$0	2026Q3	52.0%	$288	$81	$368
0.012	Project Operation:		$47	$13	28%	$60	2.3%	$48	$13	$62	$0	2026Q3	52.0%	$73	$20	$94
0.031	Project Management		$122	$34	28%	$156	2.3%	$125	$35	$160	$0	2026Q3	52.0%	$190	$53	$243
0.09	NON-FED Construction Management (Relocations)		$6	$2	28%	$8	2.3%	$6	$2	$8	$0	2026Q3	52.0%	$9	$3	$12
	CONTRACT COST TOTALS:		$5,321	$1,465		**$6,786**		$5,410	$1,490	$6,900	$0			$6,902	$1,902	**$8,805**

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach B, Erosion Protection, Plant Establishment															
02	RELOCATIONS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Construction	$383	$107	28%	$491	0.4%	$385	$108	$493	$0	2028Q3	27.6%	$491	$138	$629
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$383	$107	28%	**$491**		$385	$108	$493	$0			$491	$138	$629
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$3	$1	27%	$4	-1.0%	$3	$1	$4	$0	2026Q3	22.6%	$4	$1	$5
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$6	$2	28%	$8	2.3%	$6	$2	$8	$0	2025Q3	45.6%	$9	$3	$11
0.006	Planning & Environmental Compliance		$2	$1	28%	$3	2.3%	$2	$1	$3	$0	2025Q3	45.6%	$3	$1	$4
0.082	Engineering & Design		$31	$9	28%	$40	2.3%	$32	$9	$41	$0	2025Q3	45.6%	$46	$13	$59
0.003	Reviews, ATRs, IEPRs, VE		$1	$0	28%	$1	2.3%	$1	$0	$1	$0	2025Q3	45.6%	$1	$0	$2
0.007	Life Cycle Updates (cost, schedule, risks)		$3	$1	28%	$4	2.3%	$3	$1	$4	$0	2025Q3	45.6%	$4	$1	$6
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$4	$1	28%	$5	2.3%	$4	$1	$5	$0	2025Q3	45.6%	$6	$2	$8
0.01	Contracting & Reprographics		$4	$1	28%	$5	2.3%	$4	$1	$5	$0	2025Q3	45.6%	$6	$2	$8
0.02	Engineering During Construction		$8	$2	28%	$10	2.3%	$8	$2	$10	$0	2028Q3	65.9%	$14	$4	$17
0.003	Planning During Construction		$1	$0	28%	$1	2.3%	$1	$0	$1	$0	2028Q3	65.9%	$2	$0	$2
0.013	Project Operations		$5	$1	28%	$6	2.3%	$5	$1	$7	$0	2025Q3	45.6%	$7	$2	$10
0.16	NON-FED Planning, Engineering & Design (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$18	$5	28%	$23	2.3%	$18	$5	$24	$0	2028Q3	65.9%	$31	$9	$39
0.012	Project Operation:		$5	$1	28%	$6	2.3%	$5	$1	$7	$0	2028Q3	65.9%	$8	$2	$11
0.031	Project Management		$12	$3	28%	$15	2.3%	$12	$3	$16	$0	2028Q3	65.9%	$20	$6	$26
0.09	NON-FED Construction Management (Relocations)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:		$487	$136		**$623**		$490	$137	$628	$0			$653	$183	**$836**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NO(P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARN, Reach C																
02	RELOCATIONS *		$1,180	$331	28%	$1,511	0.8%	$1,190	$333	$1,523		0	$1,523	30.0%	$1,546	$433	$1,980
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$100	$28	28%	$128	0.4%	$100	$28	$129		0	$129	24.5%	$125	$35	$160
11	LEVEES & FLOODWALLS	Levees	$5,025	$1,407	28%	$6,431	0.4%	$5,045	$1,412	$6,457		0	$6,457	24.5%	$6,279	$1,758	$8,037
	CONSTRUCTION ESTIMATE TOTALS:		$6,305	$1,765		$8,070	0.5%	$6,335	$1,774	$8,108		0	$8,108	25.5%	$7,950	$2,226	$10,176
01	LANDS AND DAMAGES		$191	$15	8%	$206	0.6%	$192	$15	$207		0	$207	21.4%	$233	$18	$251
30	PLANNING, ENGINEERING & DESIGN *		$870	$244	28%	$1,114	2.3%	$890	$249	$1,139		0	$1,139	49.9%	$1,334	$373	$1,707
31	CONSTRUCTION MANAGEMENT *		$461	$129	28%	$590	2.3%	$472	$132	$604		0	$604	56.9%	$740	$207	$947
18	CULTURAL RESOURCE PRESERVATION		$49	$13	27%	$63	0.8%	$49	$13	$62		0	$62	21.4%	$59	$16	$75
	PROJECT COST TOTALS:		$7,876	$2,166	28%	$10,043		$7,937	$2,183	**$10,120**		0	**$10,120**	30.0%	$10,316	$2,841	$13,157

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: $13,157

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach C, Levee Improvements															
02	RELOCATIONS		$944	$264	28%	$1,209	0.4%	$948	$266	$1,214	$0	2027Q2	24.5%	$1,180	$330	$1,511
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$100	$28	28%	$128	0.4%	$100	$28	$129	$0	2027Q2	24.5%	$125	$35	$160
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$5,025	$1,407	28%	$6,431	0.4%	$5,045	$1,412	$6,457	$0	2027Q2	24.5%	$6,279	$1,758	$8,037
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$6,069	$1,699	28%	**$7,768**		$6,093	$1,706	$7,799	$0			$7,584	$2,123	$9,707
01	LANDS AND DAMAGES	Fed	$48	$2	5%	$50	0.6%	$48	$3	$50	$0	2026Q1	21.4%	$58	$3	$61
01	LANDS AND DAMAGES	Non-Fed	$143	$13	9%	$156	0.6%	$144	$13	$157	$0	2026Q1	21.4%	$175	$15	$190
18	CULTURAL RESOURCE PRESERVATION		$49	$13	27%	$63	-1.0%	$49	$13	$62	$0	2026Q1	21.4%	$59	$16	$75
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$82	$23	28%	$105	2.3%	$84	$23	$107	$0	2026Q1	48.7%	$125	$35	$160
0.006	Planning & Environmental Compliance		$31	$9	28%	$40	2.3%	$32	$9	$41	$0	2026Q1	48.7%	$47	$13	$60
0.082	Engineering & Design		$420	$118	28%	$538	2.3%	$430	$120	$550	$0	2026Q1	48.7%	$639	$179	$818
0.003	Reviews, ATRs, IEPRs, VE		$15	$4	28%	$19	2.3%	$15	$4	$20	$0	2026Q1	48.7%	$23	$6	$29
0.007	Life Cycle Updates (cost, schedule, risks)		$36	$10	28%	$46	2.3%	$37	$10	$47	$0	2026Q1	48.7%	$55	$15	$70
0.01	Contracting & Reprographics		$51	$14	28%	$65	2.3%	$52	$15	$67	$0	2026Q1	48.7%	$78	$22	$99
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$51	$14	28%	$65	2.3%	$52	$15	$67	$0	2026Q1	48.7%	$78	$22	$99
0.02	Engineering During Construction		$102	$29	28%	$131	2.3%	$104	$29	$134	$0	2027Q2	56.9%	$164	$46	$210
0.003	Planning During Construction		$15	$4	28%	$19	2.3%	$15	$4	$20	$0	2027Q2	56.9%	$24	$7	$31
0.013	Project Operations		$67	$19	28%	$86	2.3%	$69	$19	$88	$0	2026Q1	48.7%	$102	$29	$131
0.16	NON-FED Planning, Engineering & Design (Relocations)		$151	$42	28%	$193	2.3%	$154	$43	$198	$0	2026Q1	48.7%	$230	$64	$294
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$241	$67	28%	$308	2.3%	$247	$69	$316	$0	2027Q2	56.9%	$387	$108	$495
0.012	Project Operation:		$61	$17	28%	$78	2.3%	$62	$17	$80	$0	2027Q2	56.9%	$98	$27	$125
0.031	Project Management		$159	$45	28%	$204	2.3%	$163	$46	$208	$0	2027Q2	56.9%	$255	$71	$327
0.09	NON-FED Construction Management (Relocations)		$85	$24	28%	$109	2.3%	$87	$24	$111	$0	2027Q2	56.9%	$136	$38	$175
	CONTRACT COST TOTALS:		$7,876	$2,166		**$10,043**		$7,937	$2,183	$10,120	$0			$10,316	$2,841	**$13,157**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NO(P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:		TOTAL					
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)	FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARN, Reach D																
02	RELOCATIONS *		$8,344	$2,336	28%	$10,680	0.8%	$8,409	$2,355	$10,764		0	$10,764	23.5%	$10,387	$2,908	$13,296
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$660	$185	28%	$845	0.4%	$663	$186	$848		0	$848	20.2%	$797	$223	$1,020
11	LEVEES & FLOODWALLS	Levees	$27,062	$7,577	28%	$34,639	0.4%	$27,170	$7,607	$34,777		0	$34,777	20.2%	$32,666	$9,146	$41,812
	CONSTRUCTION ESTIMATE TOTALS:		$36,065	$10,098		$46,164	0.5%	$36,242	$10,148	$46,389		0	$46,389	21.0%	$43,850	$12,278	$56,128
01	LANDS AND DAMAGES		$2,950	$405	14%	$3,355	0.6%	$2,967	$407	$3,374		0	$3,374	14.4%	$3,394	$465	$3,860
30	PLANNING, ENGINEERING & DESIGN *		$4,711	$1,319	28%	$6,030	2.3%	$4,819	$1,349	$6,169		0	$6,169	33.2%	$6,422	$1,798	$8,220
31	CONSTRUCTION MANAGEMENT *		$2,495	$699	28%	$3,194	2.3%	$2,552	$715	$3,267		0	$3,267	45.6%	$3,716	$1,040	$4,756
18	CULTURAL RESOURCE PRESERVATION		$290	$78	27%	$368	0.8%	$287	$77	$364		0	$364	14.4%	$328	$89	$417
	PROJECT COST TOTALS:		$46,511	$12,599	27%	$59,110		$46,867	$12,696	**$59,563**		0	**$59,563**	23.2%	$57,710	$15,671	$73,380

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: $73,380

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach D, Levee Improvements															
02	RELOCATIONS		$6,675	$1,869	28%	$8,544	0.4%	$6,702	$1,877	$8,578	$0	2025Q3	20.2%	$8,057	$2,256	$10,314
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$660	$185	28%	$845	0.4%	$663	$186	$848	$0	2025Q3	20.2%	$797	$223	$1,020
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$27,062	$7,577	28%	$34,639	0.4%	$27,170	$7,607	$34,777	$0	2025Q3	20.2%	$32,666	$9,146	$41,812
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$34,396	$9,631	28%	**$44,027**		$34,534	$9,670	$44,204	$0			$41,520	$11,626	$53,146
01	LANDS AND DAMAGES	Fed	$665	$35	5%	$700	0.6%	$669	$35	$704	$0	2023Q1	14.4%	$765	$40	$805
01	LANDS AND DAMAGES	Non-Fed	$2,285	$370	16%	$2,655	0.6%	$2,298	$372	$2,670	$0	2023Q1	14.4%	$2,629	$425	$3,054
18	CULTURAL RESOURCE PRESERVATION		$290	$78	27%	$368	-1.0%	$287	$77	$364	$0	2023Q1	14.4%	$328	$89	$417
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$444	$124	28%	$568	2.3%	$454	$127	$581	$0	2023Q1	31.3%	$596	$167	$763
0.006	Planning & Environmental Compliance		$166	$46	28%	$212	2.3%	$170	$48	$217	$0	2023Q1	31.3%	$223	$62	$285
0.082	Engineering & Design		$2,273	$636	28%	$2,909	2.3%	$2,325	$651	$2,976	$0	2023Q1	31.3%	$3,054	$855	$3,909
0.003	Reviews, ATRs, IEPRs, VE		$83	$23	28%	$106	2.3%	$85	$24	$109	$0	2023Q1	31.3%	$112	$31	$143
0.007	Life Cycle Updates (cost, schedule, risks)		$194	$54	28%	$248	2.3%	$198	$56	$254	$0	2023Q1	31.3%	$261	$73	$334
0.01	Contracting & Reprographics		$277	$78	28%	$355	2.3%	$283	$79	$363	$0	2023Q1	31.3%	$372	$104	$476
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$277	$78	28%	$355	2.3%	$283	$79	$363	$0	2023Q1	31.3%	$372	$104	$476
0.02	Engineering During Construction		$554	$155	28%	$709	2.3%	$567	$159	$725	$0	2025Q3	45.6%	$825	$231	$1,056
0.003	Planning During Construction		$83	$23	28%	$106	2.3%	$85	$24	$109	$0	2025Q3	45.6%	$124	$35	$158
0.013	Project Operations		$360	$101	28%	$461	2.3%	$368	$103	$471	$0	2023Q1	31.3%	$484	$135	$619
0.16	NON-FED Planning, Engineering & Design (Relocations)		$1,068	$299	28%	$1,367	2.3%	$1,093	$306	$1,399	$0	2023Q1	31.3%	$1,435	$402	$1,836
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,303	$365	28%	$1,668	2.3%	$1,333	$373	$1,706	$0	2025Q3	45.6%	$1,941	$543	$2,484
0.012	Project Operation:		$333	$93	28%	$426	2.3%	$341	$95	$436	$0	2025Q3	45.6%	$496	$139	$635
0.031	Project Management		$859	$241	28%	$1,100	2.3%	$879	$246	$1,125	$0	2025Q3	45.6%	$1,279	$358	$1,638
0.09	NON-FED Construction Management (Relocations)		$601	$168	28%	$769	2.3%	$615	$172	$787	$0	2025Q3	45.6%	$895	$251	$1,146
	CONTRACT COST TOTALS:		$46,511	$12,599		**$59,110**		$46,867	$12,696	$59,563	$0			$57,710	$15,671	**$73,380**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NO(P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)		TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J					M	N	O
	ARN, Reach E																
02	RELOCATIONS *		$10,565	$2,958	28%	$13,523	0.8%	$10,648	$2,981	$13,630		0	$13,630	26.6%	$13,483	$3,775	$17,258
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$495	$139	28%	$634	0.4%	$497	$139	$636		0	$636	22.6%	$610	$171	$780
11	LEVEES & FLOODWALLS	Levees	$25,431	$7,121	28%	$32,551	0.4%	$25,532	$7,149	$32,681		0	$32,681	22.6%	$31,311	$8,767	$40,078
	CONSTRUCTION ESTIMATE TOTALS:		$36,491	$10,217		$46,708	0.5%	$36,678	$10,270	$46,947		0	$46,947	23.8%	$45,403	$12,713	$58,116
01	LANDS AND DAMAGES		$4,325	$594	14%	$4,919	0.6%	$4,348	$597	$4,946		0	$4,946	16.7%	$5,074	$697	$5,771
30	PLANNING, ENGINEERING & DESIGN *		$4,408	$1,234	28%	$5,642	2.3%	$4,509	$1,263	$5,772		0	$5,772	38.9%	$6,262	$1,753	$8,015
31	CONSTRUCTION MANAGEMENT *		$2,334	$654	28%	$2,988	2.3%	$2,388	$669	$3,056		0	$3,056	52.0%	$3,629	$1,016	$4,645
18	CULTURAL RESOURCE PRESERVATION		$295	$80	27%	$375	0.8%	$292	$79	$371		0	$371	16.7%	$341	$92	$433
	PROJECT COST TOTALS:		$47,853	$12,779	27%	$60,632		$48,216	$12,877	**$61,093**		0	**$61,093**	26.0%	$60,710	$16,272	$76,981

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: $76,981

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach E, Levee Improvements															
02	RELOCATIONS		$8,452	$2,367	28%	$10,819	0.4%	$8,486	$2,376	$10,863	$0	2026Q3	22.6%	$10,407	$2,914	$13,321
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$495	$139	28%	$634	0.4%	$497	$139	$636	$0	2026Q3	22.6%	$610	$171	$780
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$25,431	$7,121	28%	$32,551	0.4%	$25,532	$7,149	$32,681	$0	2026Q3	22.6%	$31,311	$8,767	$40,078
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$34,378	$9,626	28%	**$44,004**		$34,516	$9,664	$44,180	$0			$42,328	$11,852	$54,180
01	LANDS AND DAMAGES	Fed	$974	$51	5%	$1,025	0.6%	$979	$52	$1,031	$0	2024Q1	16.7%	$1,143	$60	$1,203
01	LANDS AND DAMAGES	Non-Fed	$3,351	$543	16%	$3,894	0.6%	$3,369	$546	$3,915	$0	2024Q1	16.7%	$3,932	$637	$4,569
18	CULTURAL RESOURCE PRESERVATION		$295	$80	27%	$375	-1.0%	$292	$79	$371	$0	2024Q1	16.7%	$341	$92	$433
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$415	$116	28%	$531	2.3%	$425	$119	$543	$0	2024Q1	36.8%	$581	$163	$743
0.006	Planning & Environmental Compliance		$156	$44	28%	$200	2.3%	$160	$45	$204	$0	2024Q1	36.8%	$218	$61	$279
0.082	Engineering & Design		$2,126	$595	28%	$2,721	2.3%	$2,175	$609	$2,784	$0	2024Q1	36.8%	$2,975	$833	$3,808
0.003	Reviews, ATRs, IEPRs, VE		$78	$22	28%	$100	2.3%	$80	$22	$102	$0	2024Q1	36.8%	$109	$31	$140
0.007	Life Cycle Updates (cost, schedule, risks)		$181	$51	28%	$232	2.3%	$185	$52	$237	$0	2024Q1	36.8%	$253	$71	$324
0.01	Contracting & Reprographics		$259	$73	28%	$332	2.3%	$265	$74	$339	$0	2024Q1	36.8%	$362	$101	$464
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$259	$73	28%	$332	2.3%	$265	$74	$339	$0	2024Q1	36.8%	$362	$101	$464
0.02	Engineering During Construction		$519	$145	28%	$664	2.3%	$531	$149	$680	$0	2026Q3	52.0%	$807	$226	$1,033
0.003	Planning During Construction		$78	$22	28%	$100	2.3%	$80	$22	$102	$0	2026Q3	52.0%	$121	$34	$155
0.013	Project Operations		$337	$94	28%	$431	2.3%	$345	$97	$441	$0	2024Q1	36.8%	$472	$132	$604
0.16	NON-FED Planning, Engineering & Design		$1,352	$379	28%	$1,731	2.3%	$1,383	$387	$1,770	$0	2024Q1	36.8%	$1,892	$530	$2,422
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$1,219	$341	28%	$1,560	2.3%	$1,247	$349	$1,596	$0	2026Q3	52.0%	$1,895	$531	$2,426
0.012	Project Operation:		$311	$87	28%	$398	2.3%	$318	$89	$407	$0	2026Q3	52.0%	$484	$135	$619
0.031	Project Management		$804	$225	28%	$1,029	2.3%	$823	$230	$1,053	$0	2026Q3	52.0%	$1,250	$350	$1,600
0.09	NON-FED Construction Management		$761	$213	28%	$974	2.3%	$779	$218	$996	$0	2026Q3	52.0%	$1,183	$331	$1,515
	CONTRACT COST TOTALS:		$47,853	$12,779		**$60,632**		$48,216	$12,877	$61,093	$0			$60,710	$16,272	**$76,981**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NO(P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:							
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)		TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J						M	N	O
	ARN, Reach F																	
02	RELOCATIONS *		$4,237	$1,186	28%	$5,424	0.8%	$4,271	$1,196	$5,466			0	$5,466	27.4%	$5,439	$1,523	$6,962
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$100	$28	28%	$128	0.4%	$100	$28	$129			0	$129	22.6%	$123	$34	$158
11	LEVEES & FLOODWALLS	Levees	$16,597	$4,647	28%	$21,244	0.4%	$16,663	$4,666	$21,328			0	$21,328	22.6%	$20,434	$5,722	$26,156
	CONSTRUCTION ESTIMATE TOTALS:		$20,934	$5,861		$26,795	0.5%	$21,034	$5,889	$26,923			0	$26,923	23.6%	$25,996	$7,279	$33,275
01	LANDS AND DAMAGES		$466	$68	15%	$534	0.6%	$468	$68	$536			0	$536	19.0%	$557	$81	$639
30	PLANNING, ENGINEERING & DESIGN *		$2,838	$795	28%	$3,633	2.3%	$2,903	$813	$3,716			0	$3,716	43.8%	$4,176	$1,169	$5,345
31	CONSTRUCTION MANAGEMENT *		$1,503	$421	28%	$1,924	2.3%	$1,538	$431	$1,968			0	$1,968	52.0%	$2,337	$654	$2,991
18	CULTURAL RESOURCE PRESERVATION		$162	$44	27%	$205	0.8%	$160	$43	$203			0	$203	19.0%	$191	$51	$242
	PROJECT COST TOTALS:		$25,902	$7,188	28%	$33,091		$26,103	$7,244	**$33,348**			0	**$33,348**	27.4%	$33,257	$9,235	$42,492

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: $42,492

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach F, Levee Improvements															
02	RELOCATIONS		$3,390	$949	28%	$4,340	0.4%	$3,404	$953	$4,357	$0	2026Q3	22.6%	$4,175	$1,169	$5,343
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$100	$28	28%	$128	0.4%	$100	$28	$129	$0	2026Q3	22.6%	$123	$34	$158
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$16,597	$4,647	28%	$21,244	0.4%	$16,663	$4,666	$21,328	$0	2026Q3	22.6%	$20,434	$5,722	$26,156
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$20,087	$5,624	28%	**$25,711**		$20,167	$5,647	$25,814	$0			$24,732	$6,925	$31,657
01	LANDS AND DAMAGES	Fed	$71	$4	5%	$75	0.6%	$72	$4	$75	$0	2025Q1	19.0%	$85	$4	$90
01	LANDS AND DAMAGES	Non-Fed	$395	$64	16%	$459	0.6%	$397	$64	$461	$0	2025Q1	19.0%	$472	$77	$549
18	CULTURAL RESOURCE PRESERVATION		$162	$44	27%	$205	-1.0%	$160	$43	$203	$0	2025Q1	19.0%	$191	$51	$242
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$267	$75	28%	$342	2.3%	$273	$76	$350	$0	2025Q1	42.5%	$389	$109	$498
0.006	Planning & Environmental Compliance		$100	$28	28%	$128	2.3%	$102	$29	$131	$0	2025Q1	42.5%	$146	$41	$187
0.082	Engineering & Design		$1,369	$383	28%	$1,752	2.3%	$1,401	$392	$1,793	$0	2025Q1	42.5%	$1,996	$559	$2,555
0.003	Reviews, ATRs, IEPRs, VE		$50	$14	28%	$64	2.3%	$51	$14	$65	$0	2025Q1	42.5%	$73	$20	$93
0.007	Life Cycle Updates (cost, schedule, risks)		$117	$33	28%	$150	2.3%	$120	$34	$153	$0	2025Q1	42.5%	$171	$48	$218
0.01	Contracting & Reprographics		$167	$47	28%	$214	2.3%	$171	$48	$219	$0	2025Q1	42.5%	$244	$68	$312
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$167	$47	28%	$214	2.3%	$171	$48	$219	$0	2025Q1	42.5%	$244	$68	$312
0.02	Engineering During Construction		$334	$94	28%	$428	2.3%	$342	$96	$437	$0	2026Q3	52.0%	$519	$145	$665
0.003	Planning During Construction		$50	$14	28%	$64	2.3%	$51	$14	$65	$0	2026Q3	52.0%	$78	$22	$100
0.013	Project Operations		$217	$61	28%	$278	2.3%	$222	$62	$284	$0	2025Q1	42.5%	$316	$89	$405
0.16	NON-FED Planning, Engineering & Design (Relocations)		$542	$152	28%	$694	2.3%	$554	$155	$710	$0	2025Q1	42.5%	$790	$221	$1,012
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$785	$220	28%	$1,005	2.3%	$803	$225	$1,028	$0	2026Q3	52.0%	$1,221	$342	$1,562
0.012	Project Operation:		$200	$56	28%	$256	2.3%	$205	$57	$262	$0	2026Q3	52.0%	$311	$87	$398
0.031	Project Management		$518	$145	28%	$663	2.3%	$530	$148	$678	$0	2026Q3	52.0%	$805	$226	$1,031
0.09	NON-FED Construction Management (Relocations)		$305	$85	28%	$390	2.3%	$312	$87	$399	$0	2026Q3	52.0%	$474	$133	$607
	CONTRACT COST TOTALS:		$25,902	$7,188		**$33,091**		$26,103	$7,244	$33,348	$0			$33,257	$9,235	**$42,492**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NO: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)							TOTAL PROJECT COST (FULLY FUNDED)				
							Program Year (Budget EC):			2016								
							Effective Price Level Date:			1 OCT 15								
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)	TOTAL FIRST COST ($K)		ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)	
A	B		C	D	E	F	G	H	I	J					M	N	O	
	ARN, Reach I																	
02	RELOCATIONS *		$50	$14	28%	$64	0.8%	$50	$14	$65	0	$65		30.1%	$66	$18	$84	
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$275	$77	28%	$352	0.4%	$276	$77	$354	0	$354		24.5%	$344	$96	$440	
11	LEVEES & FLOODWALLS	Levees	$1,950	$546	28%	$2,497	0.4%	$1,958	$548	$2,507	0	$2,507		24.5%	$2,437	$682	$3,120	
	CONSTRUCTION ESTIMATE TOTALS:		$2,276	$637		$2,913	0.4%	$2,285	$640	$2,925	0	$2,925		24.6%	$2,847	$797	$3,644	
01	LANDS AND DAMAGES		$20,492	$11,788	58%	$32,280	0.6%	$20,606	$11,853	$32,459	0	$32,459		21.4%	$25,017	$14,391	$39,408	
30	PLANNING, ENGINEERING & DESIGN *		$379	$106	28%	$485	2.3%	$388	$109	$496	0	$496		49.9%	$581	$163	$744	
31	CONSTRUCTION MANAGEMENT *		$201	$56	28%	$257	2.3%	$206	$58	$263	0	$263		56.9%	$323	$90	$413	
18	CULTURAL RESOURCE PRESERVATION		$152	$41	27%	$193	0.8%	$150	$41	$191	0	$191		21.4%	$182	$49	$232	
	PROJECT COST TOTALS:		$23,499	$12,628	54%	$36,128		$23,634	$12,700	**$36,334**	0	**$36,334**		22.3%	$28,950	$15,490	$44,440	

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: $44,440

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	ARN, Reach I, Levee Improvements															
02	RELOCATIONS		$40	$11	28%	$51	0.4%	$40	$11	$51	$0	2027Q2	24.5%	$50	$14	$64
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$275	$77	28%	$352	0.4%	$276	$77	$354	$0	2027Q2	24.5%	$344	$96	$440
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$1,950	$546	28%	$2,497	0.4%	$1,958	$548	$2,507	$0	2027Q2	24.5%	$2,437	$682	$3,120
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$2,266	$634	28%	**$2,900**		$2,275	$637	$2,912	$0			$2,831	$793	$3,624
01	LANDS AND DAMAGES	Fed	$713	$38	5%	$750	0.6%	$716	$38	$754	$0	2026Q1	21.4%	$870	$46	$916
01	LANDS AND DAMAGES	Non-Fed	$19,780	$11,750	59%	$31,530	0.6%	$19,889	$11,816	$31,705	$0	2026Q1	21.4%	$24,147	$14,345	$38,493
18	CULTURAL RESOURCE PRESERVATION		$152	$41	27%	$193	-1.0%	$150	$41	$191	$0	2026Q1	21.4%	$182	$49	$232
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$36	$10	28%	$46	2.3%	$37	$10	$47	$0	2026Q1	48.7%	$55	$15	$70
0.006	Planning & Environmental Compliance		$13	$4	28%	$17	2.3%	$13	$4	$17	$0	2026Q1	48.7%	$20	$6	$25
0.082	Engineering & Design		$182	$51	28%	$233	2.3%	$186	$52	$238	$0	2026Q1	48.7%	$277	$78	$355
0.003	Reviews, ATRs, IEPRs, VE		$7	$2	28%	$9	2.3%	$7	$2	$9	$0	2026Q1	48.7%	$11	$3	$14
0.007	Life Cycle Updates (cost, schedule, risks)		$16	$4	28%	$20	2.3%	$16	$5	$21	$0	2026Q1	48.7%	$24	$7	$31
0.01	Contracting & Reprographics		$22	$6	28%	$28	2.3%	$23	$6	$29	$0	2026Q1	48.7%	$33	$9	$43
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$22	$6	28%	$28	2.3%	$23	$6	$29	$0	2026Q1	48.7%	$33	$9	$43
0.02	Engineering During Construction		$45	$13	28%	$58	2.3%	$46	$13	$59	$0	2027Q2	56.9%	$72	$20	$92
0.003	Planning During Construction		$7	$2	28%	$9	2.3%	$7	$2	$9	$0	2027Q2	56.9%	$11	$3	$14
0.013	Project Operations		$29	$8	28%	$37	2.3%	$30	$8	$38	$0	2026Q1	48.7%	$44	$12	$56
0.16	NON-FED Planning, Engineering & Design (Relocations)		$6	$2	28%	$8	2.3%	$6	$2	$8	$0	2026Q1	48.7%	$9	$3	$12
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$105	$29	28%	$134	2.3%	$107	$30	$137	$0	2027Q2	56.9%	$169	$47	$216
0.012	Project Operation:		$27	$8	28%	$35	2.3%	$28	$8	$35	$0	2027Q2	56.9%	$43	$12	$55
0.031	Project Management		$69	$19	28%	$88	2.3%	$71	$20	$90	$0	2027Q2	56.9%	$111	$31	$142
0.09	NON-FED Construction Management (Relocations)		$4	$1	28%	$5	2.3%	$4	$1	$5	$0	2027Q2	56.9%	$6	$2	$8
	CONTRACT COST TOTALS:		$23,499	$12,628		**$36,128**		$23,634	$12,700	$36,334	$0			$28,950	$15,490	**$44,440**

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NUMBER: P2 # 149827
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

NOTE - Sacramento Bypass Widening is an LPP feature, so the Cultural Resources Preservation cost is set to $0

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST							TOTAL PROJECT COST			
							Program Year (Budget EC):			2016							
							Effective Price Level Date:			1 OCT 15							
										Spent Thru:		TOTAL					
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)		10/1/2014 ($K)		FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B		C	D	E	F	G	H	I	J						M	N	O
	Sacramento Bypass Widening																	
02	RELOCATIONS *		$21,201	$5,936	28%	$27,137	0.8%	$21,368	$5,983	$27,350			0	$27,350	14.9%	$24,561	$6,877	$31,438
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$12,000	$3,360	28%	$15,360	0.4%	$12,052	$3,375	$15,427			0	$15,427	13.9%	$13,723	$3,842	$17,565
08	ROADS, RAILROADS & BRIDGES		$20,073	$5,620	28%	$25,693	0.4%	$20,155	$5,643	$25,798			0	$25,798	5.1%	$21,192	$5,934	$27,126
11	LEVEES & FLOODWALLS	Levees	$77,016	$21,564	28%	$98,580	0.4%	$77,323	$21,650	$98,974			0	$98,974	13.9%	$88,040	$24,651	$112,691
15	FLOODWAY CONTROL & DIVERSION STRUCTURE		$42,316	$11,849	28%	$54,165	0.4%	$42,501	$11,900	$54,401			0	$54,401	13.9%	$48,391	$13,549	$61,941
	CONSTRUCTION ESTIMATE TOTALS:		$172,606	$48,330		$220,936	0.5%	$173,398	$48,551	$221,950			0	$221,950	13.0%	$195,907	$54,854	$250,761
01	LANDS AND DAMAGES		$3,617	$1,383	38%	$5,000	0.6%	$3,637	$1,391	$5,028			0	$5,028	6.2%	$3,864	$1,478	$5,341
30	PLANNING, ENGINEERING & DESIGN *		$25,740	$7,207	28%	$32,947	2.3%	$26,332	$7,373	$33,705			0	$33,705	15.4%	$30,396	$8,511	$38,907
31	CONSTRUCTION MANAGEMENT *		$13,627	$3,816	28%	$17,443	2.3%	$13,941	$3,903	$17,844			0	$17,844	30.0%	$18,124	$5,075	$23,199
18	CULTURAL RESOURCE PRESERVATION		$0	$0	-	$0	0.8%	$0	$0	$0			0	$0		$0	$0	$0
	PROJECT COST TOTALS:		$215,590	$60,736	28%	$276,326		$217,308	$61,219	**$278,527**			0	**$278,527**	14.2%	$248,291	$69,917	$318,208

CHIEF, COST ENGINEERING, Jeremiah Frost

PROJECT MANAGER, Dan Tibbitts

CHIEF, REAL ESTATE, Diane Simpson

ESTIMATED TOTAL PROJECT COST: **$318,208**

CHIEF, PLANNING, Alicia Kirchner

CHIEF, ENGINEERING, Rick Poeppelman

CHIEF, OPERATIONS, Randy Olsen

CHIEF, CONSTRUCTION, Norbert Suter

CHIEF, CONTRACTING, Kim Ford

CHIEF, PM-PB, Mary Evans

CHIEF, DPM, Tambour Eller

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account. Associated 30 and 31 Account costs are itemized below.

****** CONTRACT COST SUMMARY ******

PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared:			9/21/2015	Program Year (Budget EC):			2016						
			Effective Price Level:			10/1/2014	Effective Price Level Date:			1 OCT 15						
					RISK BASED											
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	Sacramento Bypass Widening, New Weir															
02	RELOCATIONS		$2,757	$772	28%	$3,529	0.4%	$2,768	$775	$3,543	$0	2022Q4	13.9%	$3,152	$882	$4,034
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$12,000	$3,360	28%	$15,360	0.4%	$12,052	$3,375	$15,427	$0	2022Q4	13.9%	$13,723	$3,842	$17,565
08	ROADS, RAILROADS & BRIDGES		$20,073	$5,620	28%	$25,693	0.4%	$20,155	$5,643	$25,798	$0	2018Q4	5.1%	$21,192	$5,934	$27,126
11	LEVEES & FLOODWALLS	Levees	$737	$206	28%	$943	0.4%	$739	$207	$947	$0	2022Q4	13.9%	$842	$236	$1,078
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
15	FLOODWAY CONTROL & DIVERSION STRUCTURE		$42,316	$11,849	28%	$54,165	0.4%	$42,501	$11,900	$54,401	$0	2022Q4	13.9%	$48,391	$13,549	$61,941
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$77,883	$21,807	28%	**$99,690**		$78,215	$21,900	$100,115	$0			$87,300	$24,444	$111,744
01	LANDS AND DAMAGES	Fed	$238	$13	5%	$251	0.6%	$239	$13	$252	$0	2019Q2	6.2%	$254	$13	$268
01	LANDS AND DAMAGES	Non-Fed	$3,379	$1,371	41%	$4,750	0.6%	$3,398	$1,379	$4,776	$0	2019Q2	6.2%	$3,609	$1,464	$5,074
18	CULTURAL RESOURCE PRESERVATION		$0	$0	0%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$1,202	$337	28%	$1,539	2.3%	$1,230	$344	$1,574	$0	2019Q2	13.1%	$1,391	$390	$1,781
0.006	Planning & Environmental Compliance		$451	$126	28%	$577	2.3%	$461	$129	$591	$0	2019Q2	13.1%	$522	$146	$668
0.082	Engineering & Design		$6,160	$1,725	28%	$7,885	2.3%	$6,302	$1,764	$8,066	$0	2019Q2	13.1%	$7,130	$1,997	$9,127
0.003	Reviews, ATRs, IEPRs, VE		$225	$63	28%	$288	2.3%	$230	$64	$295	$0	2019Q2	13.1%	$260	$73	$333
0.007	Life Cycle Updates (cost, schedule, risks)		$526	$147	28%	$673	2.3%	$538	$151	$689	$0	2019Q2	13.1%	$609	$170	$779
0.01	Contracting & Reprographics		$751	$210	28%	$961	2.3%	$768	$215	$983	$0	2019Q2	13.1%	$869	$243	$1,113
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$751	$210	28%	$961	2.3%	$768	$215	$983	$0	2019Q2	13.1%	$869	$243	$1,113
0.02	Engineering During Construction		$1,503	$421	28%	$1,924	2.3%	$1,538	$431	$1,968	$0	2022Q4	30.0%	$1,999	$560	$2,559
0.003	Planning During Construction		$225	$63	28%	$288	2.3%	$230	$64	$295	$0	2022Q4	30.0%	$299	$84	$383
0.013	Project Operations		$977	$274	28%	$1,251	2.3%	$999	$280	$1,279	$0	2019Q2	13.1%	$1,131	$317	$1,448
0.16	NON-FED Planning, Engineering & Design (Relocations)		$441	$123	28%	$564	2.3%	$451	$126	$577	$0	2019Q2	13.1%	$510	$143	$653
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$3,531	$989	28%	$4,520	2.3%	$3,612	$1,011	$4,624	$0	2022Q4	30.0%	$4,696	$1,315	$6,011
0.012	Project Operation:		$902	$253	28%	$1,155	2.3%	$923	$258	$1,181	$0	2022Q4	30.0%	$1,200	$336	$1,536
0.031	Project Management		$2,329	$652	28%	$2,981	2.3%	$2,383	$667	$3,050	$0	2022Q4	30.0%	$3,098	$867	$3,965
0.09	NON-FED Construction Management (Relocations)		$248	$69	28%	$317	2.3%	$254	$71	$325	$0	2022Q4	30.0%	$330	$92	$422
	CONTRACT COST TOTALS:		$101,722	$28,853		**$130,574**		$102,540	$29,084	$131,623	$0			$116,078	$32,898	**$148,976**

****** CONTRACT COST SUMMARY ******

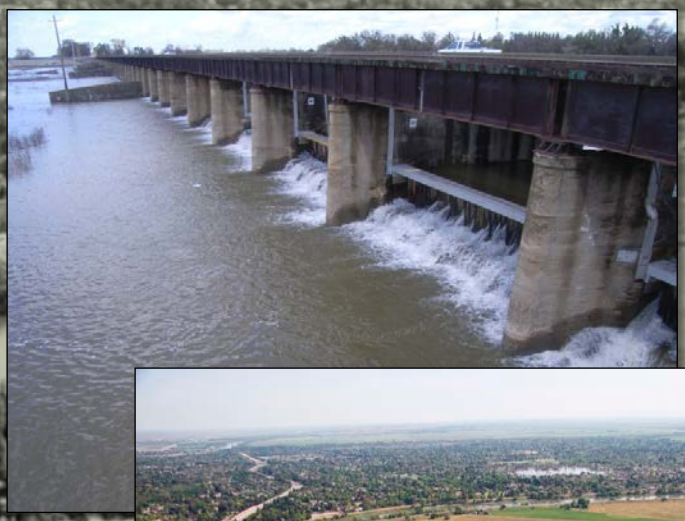
PROJECT: American River Common Features GRR - Alt 2 - LPP
LOCATION: Sacramento, CA
This Estimate reflects the scope and schedule in report; Feasibility Report

DISTRICT: SPK - Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 11/20/2015

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST					TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 9/21/2015				Program Year (Budget EC): 2016									
			Effective Price Level: 10/1/2014				Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*		*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*P*	*L*	*M*	*N*	*O*
	Sacramento Bypass Widening															
02	RELOCATIONS		$14,204	$3,977	28%	$18,181	0.4%	$14,262	$3,993	$18,255	$0	2022Q4	13.9%	$16,238	$4,547	$20,785
06	FISH & WILDLIFE FACILITIES	Construction	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
11	LEVEES & FLOODWALLS	Levees	$76,279	$21,358	28%	$97,638	0.4%	$76,584	$21,443	$98,027	$0	2022Q4	13.9%	$87,198	$24,415	$111,613
11	LEVEES & FLOODWALLS	Floodwalls	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
16	BANK STABILIZATION		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE)		$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:		$90,483	$25,335	28%	**$115,819**		$90,845	$25,437	$116,282	$0			$103,436	$28,962	$132,398
01	LANDS AND DAMAGES	Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	Non-Fed	$0	$0	28%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
18	CULTURAL RESOURCE PRESERVATION		$0	$0	0%	$0	0.0%	$0	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN															
0.016	Project Management		$1,220	$342	28%	$1,562	2.3%	$1,248	$349	$1,598	$0	2019Q2	13.1%	$1,412	$395	$1,808
0.006	Planning & Environmental Compliance		$458	$128	28%	$586	2.3%	$469	$131	$600	$0	2019Q2	13.1%	$530	$148	$679
0.082	Engineering & Design		$6,255	$1,751	28%	$8,006	2.3%	$6,399	$1,792	$8,191	$0	2019Q2	13.1%	$7,240	$2,027	$9,268
0.003	Reviews, ATRs, IEPRs, VE		$229	$64	28%	$293	2.3%	$234	$66	$300	$0	2019Q2	13.1%	$265	$74	$339
0.007	Life Cycle Updates (cost, schedule, risks)		$534	$150	28%	$684	2.3%	$546	$153	$699	$0	2019Q2	13.1%	$618	$173	$791
0.01	Cultural Investigations (Survey, test,& Evaluate archeological resources)		$763	$214	28%	$977	2.3%	$781	$219	$999	$0	2019Q2	13.1%	$883	$247	$1,130
0.01	Contracting & Reprographics		$763	$214	28%	$977	2.3%	$781	$219	$999	$0	2019Q2	13.1%	$883	$247	$1,130
0.02	Engineering During Construction		$1,526	$427	28%	$1,953	2.3%	$1,561	$437	$1,998	$0	2022Q4	30.0%	$2,030	$568	$2,598
0.003	Planning During Construction		$229	$64	28%	$293	2.3%	$234	$66	$300	$0	2022Q4	30.0%	$305	$85	$390
0.013	Project Operations		$992	$278	28%	$1,270	2.3%	$1,015	$284	$1,299	$0	2019Q2	13.1%	$1,148	$322	$1,470
0.16	NON-FED Planning, Engineering & Design (Relocations)		$2,273	$636	28%	$2,909	2.3%	$2,325	$651	$2,976	$0	2019Q2	13.1%	$2,631	$737	$3,368
31	CONSTRUCTION MANAGEMENT															
0.047	Construction Management		$3,585	$1,004	28%	$4,589	2.3%	$3,668	$1,027	$4,694	$0	2022Q4	30.0%	$4,768	$1,335	$6,103
0.012	Project Operation:		$915	$256	28%	$1,171	2.3%	$936	$262	$1,198	$0	2022Q4	30.0%	$1,217	$341	$1,558
0.031	Project Management		$2,365	$662	28%	$3,027	2.3%	$2,419	$677	$3,097	$0	2022Q4	30.0%	$3,146	$881	$4,026
0.09	NON-FED Construction Management (Relocations)		$1,278	$358	28%	$1,636	2.3%	$1,307	$366	$1,673	$0	2022Q4	30.0%	$1,700	$476	$2,176
	CONTRACT COST TOTALS:		$113,868	$31,883		**$145,751**		$114,769	$32,135	$146,904	$0			$132,212	$37,019	**$169,232**

American River Watershed

Common Features
General Reevaluation Report



Attachment E
Erosion Protection Report

December 2015

Sacramento Area Flood Control Agency

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:
Sacramento Weir during operation
Sacramento River facing south near the Pocket and Little Pocket neighborhoods
High flows on the American River at the Highway 160 overcrossing
Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Attachment E
Erosion Protection Report

U.S. Army Corps of Engineers
Sacramento District

December 2015

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American River Watershed Common Features
General Re-Evaluation Report

Erosion Protection Report

Post-ATR Version Dated 8 April 2014

April 2014

On the cover:
Erosion of the left bank and levee of the Lower American River between river miles 4 and 5 resulting from the February 1986 flood.

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ACRONYNMS and ABBREVIATIONS

ACN ..... Arcade Creek North
ACS ..... Arcade Creek South
ARCF ..... American River Common Features
ARCH ..... Air Rotary Casing Hammer
ARFCD ..... American River Flood Control District
ARFCP ..... American River Flood Control Project
ARN ..... American River North Basin
ARS ..... American River South Basin
ASTM ..... American Society of Testing and Materials
ARWI ..... American River Watershed Investigation
BGS ..... Below Ground Surface
BTA ..... Blanket Theory Analysis
CB ..... Cement-Bentonite
CFS ..... Cubic Feet Per Second
CHP ..... California Highway Patrol
COS ..... City of Sacramento
CPT ..... Cone Penetrometer Test
CW ..... Cutoff Wall
CVFPB ..... Central Valley Flood Protection Board
CVFPP ..... Central Valley Flood Protection Plan
CY ..... Cubic Yard(s)
DBH ..... Diameter at Breast Height
DCN ..... Dry Creek North
DCS ..... Dry Creek South
DMM ..... Deep Mix Method
DSM ..... Deep Soil Mixing
DWR ..... Department of Water Resources
DWSC ..... Deep Water Ship Channel
EFA ..... Erosion Function Apparatus
EIP ..... Early Implementation Project
EM ..... Engineering Manual
ERU ..... Erosionally Resistant Unit
ESP ..... Erosion Screening Process
ETL ..... Engineering Technical Letter
EVS ..... Environmental Visualization System
FEMA ..... Federal Emergency Management Agency
FOS ..... Factor(s) Of Safety
FOSM ..... First Order Second Moment
FT ..... Foot/Feet
FT/S ..... Feet Per Second
GER ..... Geotechnical Engineering Report
GIS ..... Geographical Information System
GMS ..... Groundwater Modeling Software
GRR ..... General Reevaluation Report
H:V ..... Horizontal To Vertical Ratio
HTRW ..... Hazardous, Toxic, and Radioactive Waste
HQUSACE ..... Headquarters U.S. Army Corps Of Engineers
IBC ..... International Building Code
IWM ..... In-Stream Woody Material
JET ..... Jet Erosion Test

K ..... Coefficient Of Permeability
KH ..... Horizontal Hydraulic Conductivity Under Fully Saturated Conditions
KH/KV ..... Ratio Between The Vertical And Horizontal Conductivities; Anisotropic Ratio
KV ..... Vertical Hydraulic Conductivity Under Fully Saturated Conditions
Ky ..... Yield Acceleration
LAR ..... Lower American River
LiDAR ..... Light Detection and Ranging
LM ..... Levee Mile
MA ..... Maintenance Area
MCDC ..... Magpie Creek Diversion Canal
MCY ..... Million Cubic Yards
MSWL ..... Mean Summer Water Level
MUSYM ..... Map Unit Symbol
Mw ..... Moment Magnitude
NAD83 ..... North American Datum of 1983
NAFCI ..... Natomas Area Flood Control Improvement
NALP ..... North Area Levee Project
NAT ..... Natomas Basin
NAVD88 ..... North American Vertical Datum of 1988
NCC ..... Natomas Cross Canal
NCEER ..... National Center for Earthquake Engineering Research
NCMWC ..... Natomas Central Mutual Water Company
NCSS ..... National Cooperative Soil Survey
NGA ..... Next Generation Attenuation
NGVD29 ..... National Geodetic Vertical Datum of 1929
NEMDC ..... Natomas East Main Drainage Canal
NLD ..... National Levee Database
NLIP ..... Natomas Levee Improvement Project
NPACR ..... Natomas Post Authorization Change Report
NRCS ..... National Resources Conservation Service
NSF ..... National Science Foundation
NULE ..... Nonurban Levee Evaluations
OCR ..... Over-Consolidation Ratio
PACR ..... Post Authorization Change Report
PDT ..... Project Delivery Team
PED ..... Pre-Construction Engineering and Design
PGA ..... Peak Ground Acceleration
PGCC ..... Pleasant Grove Creek Canal
PGL ..... Policy Guidance Letter
Pr(f) ..... Probability of Failure
PSHA ..... Probabilistic Seismic Hazard Analysis
P1GDR ..... Phase 1 Geotechnical Data Report
P1GER ..... Phase 1 Geotechnical Engineering Report
QA ..... Quality Assurance
QC ..... Quality Control
RD ..... Reclamation District
RM ..... River Mile
SAFCA ..... Sacramento Area Flood Control Agency
SB ..... Soil-Bentonite
SCB ..... Soil-Cement-Bentonite
SGDR ..... Supplemental Geotechnical Data Report
SOP ..... Standard Operating Procedure
SPT ..... Standard Penetration Test

SRBPP ..... Sacramento River Bank Protection Project
SRFCP ..... Sacramento River Flood Control Project
SRN ..... Sacramento River North
SRS ..... Sacramento River South
SSURGO ..... Soil Survey Geographic Database
SUALRP ..... Sacramento Urban Area Levee Reconstruction Project
SWIF ..... System-Wide Improvement Framework Policy
TEC ..... Topographic Engineering Center
TM ..... Technical Memorandum
TRM ..... Technical Review Memorandum
ULE ..... Urban Levee Evaluations
USACE ..... U.S. Army Corps Of Engineers
USDA ..... United States Department of Agriculture
USGS ..... United States Geological Society
V:H ..... Vertical To Horizontal Ratio
$\bar{V}$S30 ..... Velocity Of The Upper 30 Meters
VVR ..... Vegetation Variance Request
WRDA ..... Water Resources Development Act
WSAFCA ..... West Sacramento Area Flood Control Agency
WSE ..... water surface elevation

1 INTRODUCTION AND BACKGROUND

1.1 Introduction

The purpose of this attachment is to provide a concise summary of the work performed to date regarding understanding and predicting the stability of the Lower American and Sacramento Rivers with regards to erosion and the capability of the leveed reaches of the mainstem river channels to convey flood releases from Folsom Dam. Additionally, this attachment provides the rationale for the proposed erosion protection features presented in the Engineering Appendix of the American River Common Features GRR Study (ARCF).

This attachment provides further rationale for why the erosion protection features are needed. This is in addition to the American River Common Features General Re-Evaluation Report (ARCF GRR) study efforts to quantify the risk of erosion using levee performance curves (probability of failure) and floodplain delineation (consequence) from a levee break. The levee performance curves are summarized in section 5.4 and are fully described in the ARCF GRR Geotechnical Report (Attachment C). The floodplain delineation is described in the ARCF GRR Hydraulic Report (Attachment B).

1.2 Location

The overall study area for the ARCF GRR Study is illustrated on Figure 1-1 and includes the Sacramento River between Verona and the Freeport Bridge and the American River between Nimbus Dam and the Sacramento River confluence.

In the study area there are additional reaches depicted but not highlighted in Figure 1-1 where erosion concerns have been addressed in one of two ways:

1) The following reaches were analyzed for erosion protection as part of the Natomas Post Authorization Chief's Report of December 2010:

- Sacramento River: Left Bank, From the American Confluence up to the Confluence with the Natomas Cross Canal
- Natomas Cross Canal: Left Bank, Entire reach
- Pleasant Grove Creek Canal: Left Bank, Entire reach
- Natomas East Main Drain Canal: Right Bank, Entire reach,

2) The proposed design in the chief's report and subsequent site specific design refinements are assumed to adequately address erosion concerns on these reaches.

The remaining project reaches in the ARCF Study include:

- Natomas East Main Drain Canal: Left Bank, Entire reach
- Arcade Creek, Left and Right Banks, Entire reach
- Dry Creek, Right Bank, Entire reach
- Robla Creek, Left Bank, Entire reach
- Magpie Creek, Left Bank, Entire reach.

These tributary project reaches are significantly influenced by backwater and, therefore, the erosion concerns in these reaches are not considered as critical to address with a separate analysis given the

reduced velocities and erosive forces. In addition, the tributaries on the eastside of Natomas including Dry Creek, Arcade and others do not share the same high risk of erosion in terms of consequence, duration and velocity as on the American and Sacramento Rivers. As discussed in the ARCF Hydraulic Appendix, any features required to address erosion will be part of the site specific design. The cost of these features is likely minimal and will not affect selection of the tentatively selected plan (TSP) nor significantly impact the overall project costs.

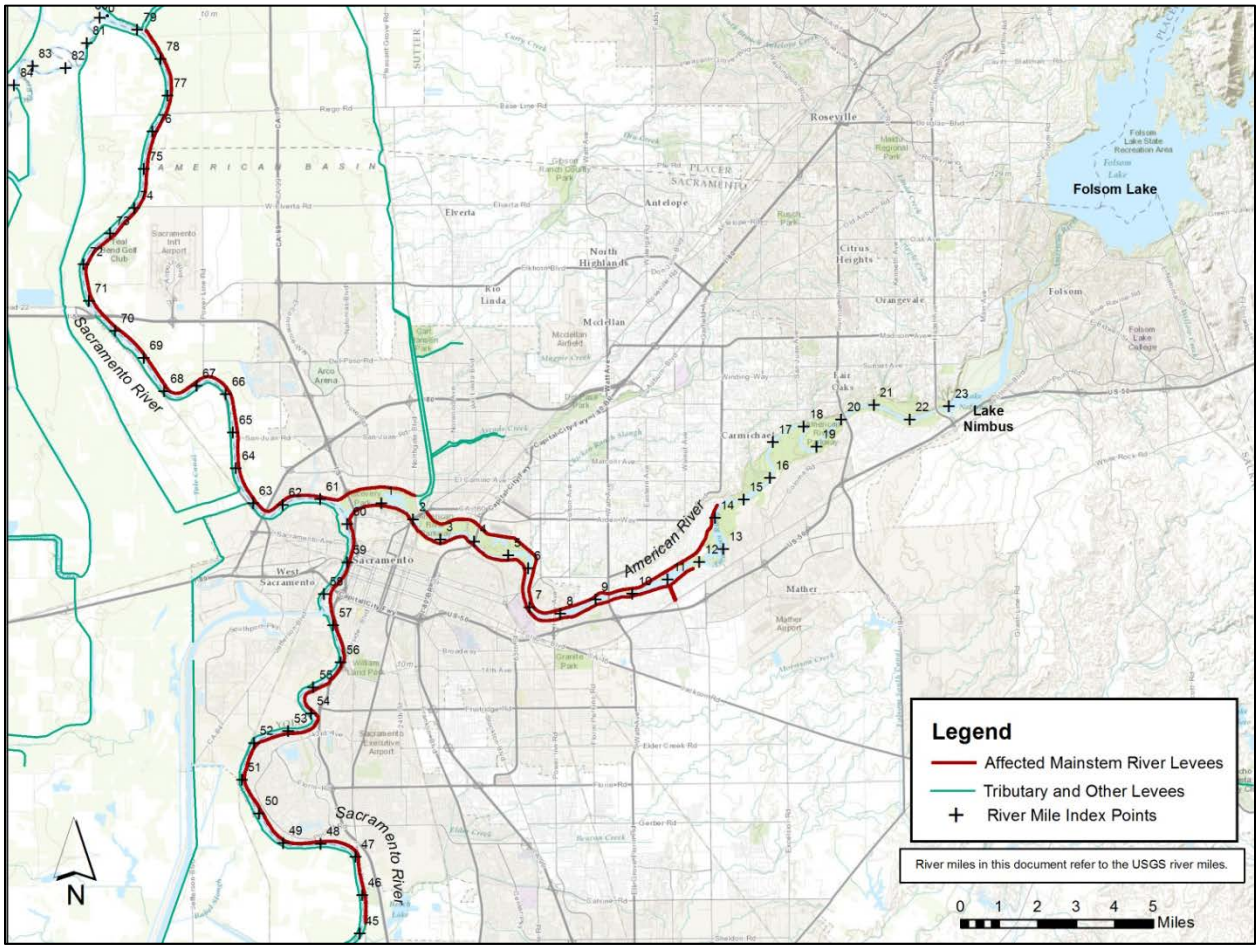

Figure 1-1. ARCF study area and affected mainstem channel levees

The focus areas for this attachment are the leveed reaches of mainstem channels shown in red on Figure 1-1 and specifically include the left levee (i.e. looking downstream) of the Sacramento River and both levees of the American River. The detailed focus area for many of the in depth investigations and analyses is the American River between RM 5 (Paradise Beach) and RM 11 (located above Watt Avenue). The focus areas for the with-project conditions and erosion mitigation features are the American River between RM 0 and 14 and the Sacramento River between the Freeport Bridge (RM 46) and the American River confluence (RM 60.5).

1.3 Background – Lower American River (LAR) Overview

The American River levees were originally intended to convey a release from Folsom Dam of 115,000 cubic feet per second (cfs). During several events since the construction of Folsom Dam, flows have equaled or exceeded the design capacity and caused significant erosion distress. All four significant

flood events since the completion of the Federal flood control system in the mid 1950s (1955, 1966, 1986, and 1997) caused considerable damage to the American River levee system due to erosion. The 1986 event had an imminent threat of levee failure. In addition, all four events required extensive repair after the event so the American River levee system could perform for the next major event. The objective release from Folsom Dam is currently under review as part of the Folsom Dam Reoperations Study and the Joint Federal Project is currently constructing improvements to the dam for a release of 160,000 cfs. Based on past performance and recent investigations, erosion is a serious threat to the American River levees that must be addressed.

Figure 1-2 is a typical view of the leveed reach of the Lower American River. This photo is looking upstream in the vicinity of the Guy West pedestrian bridge (RM 7). Figure 1-3 shows a view of an erosion site on the left bank near the lower end of the American River at RM 0.3 in 2008. This site is located just upstream from the Interstate 5 crossing (bridge seen in the background) and is affected by backwater from the Sacramento River.

A recent study (2010) was completed by Ayres Associates for the USACE that further assessed channel stability of the American River. The report included recommendations of short term and long term measures needed to safely convey a discharge (river flow) of 160,000 cfs from Folsom Dam through the Lower American River (LAR), including revetment and grade control.

Following the 2010 report a panel of experts in engineering fields associated with erosion was convened by West Consultants for the USACE due to questions and uncertainties regarding previous design recommendations and the environmental sensitivity of doing extensive erosion work on the American River including grade control. The panel was tasked to consider the adequacy of studies conducted to date, provide recommendations of additional study as appropriate, or recommend moving forward to basis of design and construction. Conclusions and recommendations from this panel led the USACE to pursue additional studies to address if the channel had reached equilibrium in terms of aggradation/degradation, additional refinements to the sediment transport model, further characterization of the geotechnical and geologic characteristics of the watershed, and refinement to the procedure for prioritization of repair sites and the development of erosion protection alternatives. There are a number of past studies that help with understanding erosion issues on the American River. These are summarized below in Section 1.7.

As part of the expanded erosion study, the USACE Project Delivery Team (PDT) found that insufficient geotechnical data were available to adequately support existing and proposed channel stability analysis and potential design recommendations. Specifically, the geotechnical and geologic study focused on characterization of soil properties through exploration and testing, geologic mapping, and 3-dimensional modeling of the subsurface stratigraphy. Additional geotechnical data were generated to characterize the material comprising the existing channel bed between the right and left bank levees of the LAR between River Miles (RM) 5.0 and 11.0. Emphasis was placed on the study reach between RM 5.0 and 11.0 due to substantial increases in velocities and applied shear stresses caused by changes in river geometry, including a narrowing of the channel and two sharp bends (downstream of Watt Avenue and near Paradise Beach, see Figure 1-1).

Figure 1-2. View of Lower American River (looking upstream) at Guy West pedestrian bridge

Figure 1-3. Erosion site on left bank near LAR RM 0.3 (2008)

1.4 Background - Sacramento River Overview

The portion of the Sacramento River in this study has two distinct reaches. The Sacramento River was split at the confluence with the American River for the purposes of this discussion because the conditions of the river change at this location.

Sacramento River – Verona to American River Confluence (RM 79 to RM 61). This reach of the Sacramento River has the levees close to the river and contains the Sacramento Weir which diverts flow into the bypass system. This reach was intentionally designed with the levees close to the banks to help move some of the bed load and debris that remained from the days of hydraulic mining. In addition, USACE was responsible for keeping the river navigable up to the city of Colusa. As a result of this design, much of the reach is protected with rock, especially the outsides of bends. The majority of the rock in this reach consists of cobbles placed prior to the 1960s and some areas with more recent quarry stone. The cobble sites are reaching the end of their design life. Many of the levees are constructed of dredged soils from the bottom of the channel. This reach is also notable because it contains numerous private residences and commercial structures including boat docks on the waterside of the levee. Figure 1-4 shows a section of this reach of the Sacramento River.

Figure 1-4. Typical View of the Sacramento River - Verona to American River Confluence (RM 79 to RM 61)

Sacramento River – Sacramento River South, American River Confluence to Freeport (RM 61 to RM 45). This section of the Sacramento River has tight levees and is tidally influenced. The location of the channel has been relatively stable for the past 150 years (although local scour and erosion can still be an issue). A large percentage of this reach has already been armored with riprap. This area has heavy wave action from recreational boats and wind, and the banks are heavily used by the general public in contrast to the reach discussed above where the banks are heavily occupied by private residences and commercial structures that limits public access along the levees. The general public use in this reach often creates local erosion by walking directly on the levee and banks. Many of the levees are constructed of dredged soils from the bottom of the channel. This reach does not have significant waterside structures such as private and commercial buildings, but has some sections of heavy vegetation and boat docks. Figure 1-5 shows a section of the Sacramento River South study area. The causes of erosion in this reach are boat wake, wind-wave, mass failure, fluvial processes, and public use.

Figure 1-5. Typical View of the Sacramento River Sacramento River South, American River Confluence to Freeport (RM 61 to RM 45)

1.5 Historical Performance

1.5.1 American River

The history of the American River has been significantly impacted by human activity. During the California Gold Rush of 1849 to 1864, the foothills upstream of the river were mined hydraulically, resulting in millions of cubic yards of mining debris being sent down the American River. The hydraulic mining caused approximately 15 to 20 ft of aggradation in the project reach. Dredge mining for gold caused alignment changes to the floodplain and in-channel bars, and significantly altered the

topography. Subsequent sand and gravel mining in the river and floodplain resulted in the development of split flow reaches. In 1864, a rechanneling project moved the downstream end of the American River to its present location from an alignment which ran roughly through the Union Pacific rail yard. In the 1950's, the construction of Folsom Dam (RM 30) and Nimbus Dam (RM 23) essentially eliminated the sediment supply from the upper watershed, resulting in the lower reaches of the LAR to become sediment starved causing a lowering of the river channel invert.

Construction of the south levee of the American River started around 1850 and was completed in the 1910's. Construction of the north levee of the American River, located between the Sacramento River and about RM 5 (near Cal Expo), occurred in the 1910's. Construction of the remainder of the north levee, upstream of Cal Expo extending to RM 14, occurred between 1955 and 1957.

In 1955, the American River experienced the flood of record. This is an important flood event in that of the 1 million acre-feet reservoir at Folsom Dam(only 400,000 acre feet is allocated to flood control) was filled in a single event. The peak release from this flood event was 115,000 cfs. Soon after this flood event, the flood magnitude was factored into the hydrology for Folsom Dam operations, which led to the level of protection provided by Folsom Dam being considerably lowered.

Sacramento experienced significant flood events again in 1964, 1986, and 1997. The 1964 flood event was the first time the complete American River levee system was tested with a flow of 115,000 cfs. The 1964 flood event showed considerable stress on the levee system for a flow of 115,000 cfs. An emergency flood-fight along the left bank of the American River near H Street was required to pass the flood event.

The 1986 flood event is significant in that it required a peak release from Folsom Dam of 130,000 cfs in order to avoid a dam failure. The peak flow was passed without a levee failure, but two locations were in the process of failing as flows were receding. Figure 1-6 shows one of the erosion sites located just upstream of the Capital City Freeway. Had the discharge been sustained longer, the levee would have likely failed from erosion.

In 1997, the Sacramento and San Joaquin River systems experienced record flooding and a number of levee breaks. However, in the American River watershed, Folsom Lake experienced a peak inflow of 255,000 cfs and was able to control it to the objective release of 115,000 cfs down the American River, with 28 percent of the flood management storage available at the peak of the storm. Nonetheless, significant erosion occurred at five sites along the American River which required immediate repair following the flood event. These repairs were accomplished under the SRBPP.

All four significant flood events since completion of the federal flood control system in the mid 1950's (1955, 1964, 1986, and 1997) caused considerable damage to the levee system because of erosion. And, all four events required extensive repair after the event so the system was ready for the next major flood event. In addition, erosion also occurred during a flood event in 2006.

Outflow hydrographs (from Folsom Dam) for these flood events are depicted in Figure 1-7 and the approximate durations at various peak flows are listed in Table 1-1.

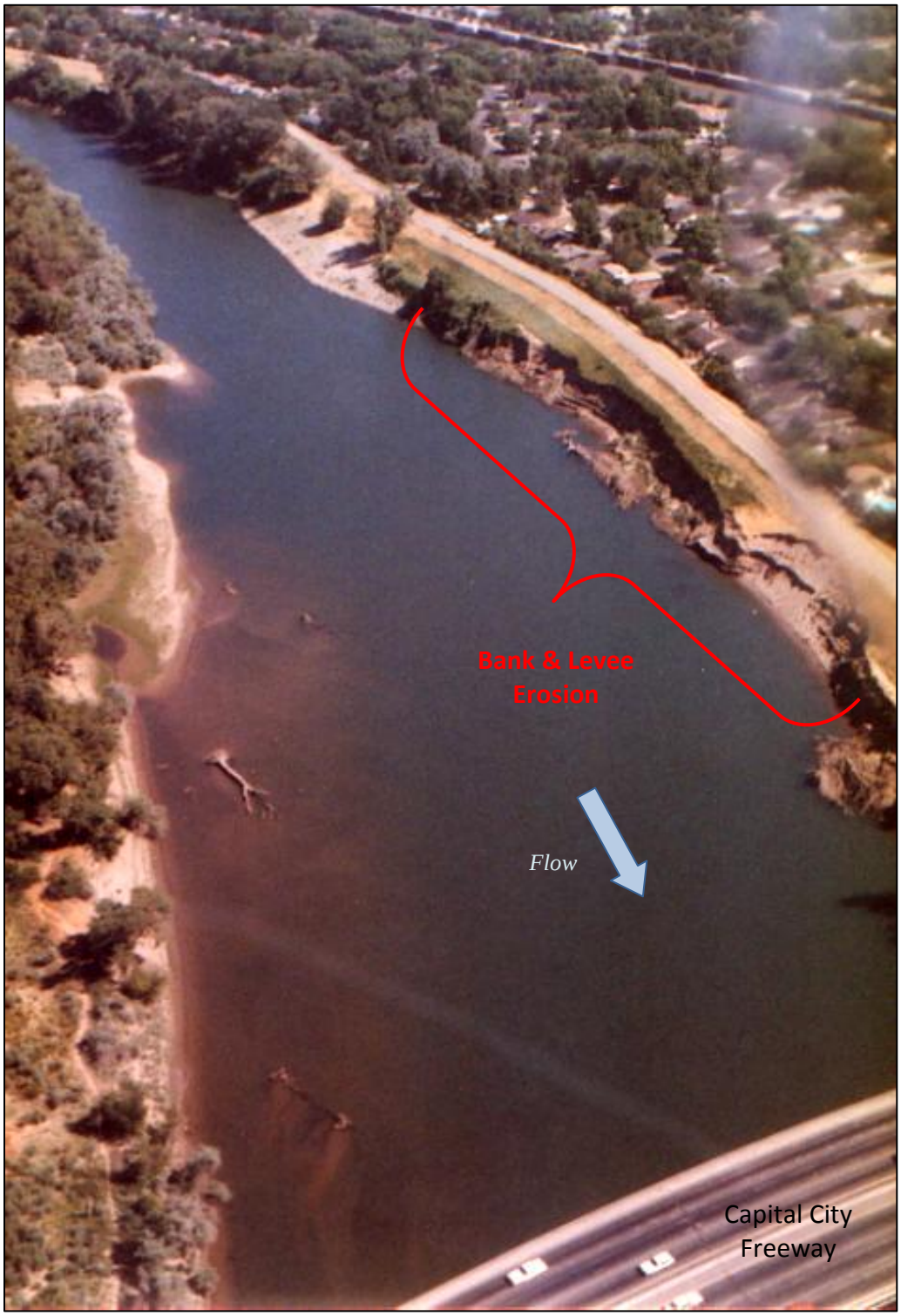

Figure 1-6. Levee erosion from the 1986 flood event (130,000 cfs) on the American River left bank just upstream of the Capital City Freeway (Business 80)

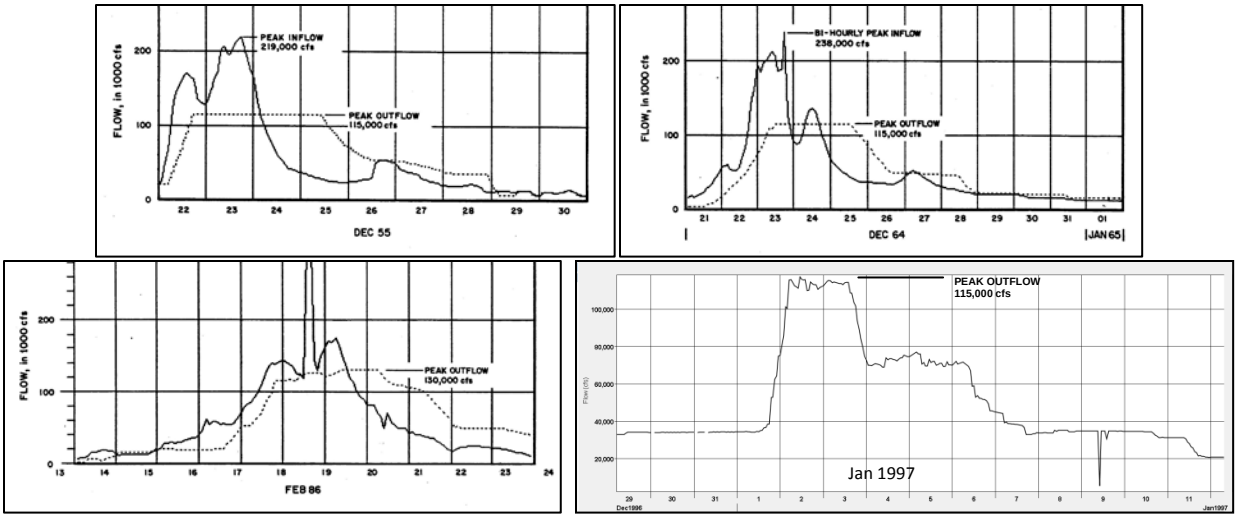

Figure 1-7. Historic outflow hydrographs from Folsom Dam[1]

Table 1-1. Duration of significant historic peak flood events

Flood Event	Approximate Duration (hrs)		
	90,000 cfs	115,000 cfs	> 115,000 cfs
1955	74	64	---
1964	68	48	---
1986	94	64	52
1997	42	33	---

1.5.2 Sacramento River

The history of the Sacramento River has been greatly impacted by the influx of people into the Central Valley. Prior to 1800's the Sacramento River had insufficient capacity to carry the large winter and spring flows, resulting in floodplains that extended for miles beyond the channel banks. The overbank velocities were low and much of the sediment eroded from the mountain and foothill areas would drop out, resulting in floodplain deposition (vertical accretion) and the development of natural levees through the rapid deposition of coarse particles as flow velocities decreased. Hydraulic mining, particularly in the Yuba and Bear Rivers resulted in an excess of sediment load being washed into the Sacramento River and resulted in reduced channel flow and increased flooding in the low elevation areas.

In addition to the hydraulic mining, increased agriculture in the area resulted in land owners building low levees along the river to protect their cultivated fields. The levees were a piecemeal fashion, without coordination between landowners, and led to competition between landowners to continually raise and strengthen their section of the levee to induce flooding on someone else's land.

[1] 1955, 1964, & 1986 events from USACE 1987; the hydrograph for the 1997 event is from CDEC (FOL - Reservoir Outflow)

During the time of hydraulic mining and agricultural development (1850 to 1900), the Sacramento River saw 13 large flood events. The flood of 1862 flooded the city of Sacramento and resulted in loss of life and destruction of property. The levees protecting the city of Sacramento were subsequently raised following this flood. The floods of 1881 resulted in numerous levee breaks on both sides of the Sacramento River, downstream of the city of Sacramento. After the 1800's, significant floods occurred in 1904, 1907, 1909, and 1928 on the Sacramento River.

Following the floods of the 1800's and early 1900's, early planning for the modern Sacramento River flood protection system started and consisted of dams, bypasses, channel widening and deepening, and levee enlargement. Construction of the Sacramento River Flood Control Project began in 1918 and was completed in 1953. The major features that were constructed included levees along the Sacramento River channel, leveed bypasses, and weirs.

The levees along the Sacramento River south of the confluence with the American River were constructed by a private mining and dredging company with the purpose of reclaiming and selling thousands of acres of farmland. The levees were constructed using large "clam shell" dredging machines. The work began in 1912 and was completed by the end of 1915. Based on typical construction schematics shown on basin-wide maps and historical literature, the levees along the Sacramento River were constructed in the following manner:

- A dragline was used to excavate a trench about 6 to 12 feet deep along the centerline of the levee alignment. The trench bottom width ranged from about 12 to 28 feet. The excavated material was deposited along both sides of the trench forming two small containment dikes.

- Hydraulic dredging operations placed material from the adjacent Sacramento River bottom into the excavation area between the dikes. This material consisted predominately of sands.

- The final levee configuration was achieved by covering the dredged sand with the adjacent dike materials. These materials consisted predominately of silt, clay, and fine sand.

It should be noted that because of the construction history outlined above, the upper portion of the semi-pervious blanket beneath the center of the levee has been removed and commonly replaced with sand. Typically, the sand core extends to a greater depth beneath the center of the levee than beneath either of the flanks or the surrounding ground. Most of the levee material was hydraulically dredged from the Sacramento River and piled or pushed into place with no mechanical compaction. Some mechanical shaping of the upper and outer portions of the sand core likely occurred during establishment of the general levee geometry.

The levees along the Sacramento River south of the confluence with the American River were constructed by local interests using clamshell dredges excavating material from the Sacramento River in the early 1900's. This method of construction usually resulted in a levee constructed on the channel banks with loose, sandy fill material that is deepest below the center of the levee. The materials within the levee embankment are predominantly sands, silty sands, and cohesionless materials. Since the construction of the original levee embankment in the early 1900's the levee has been remediated and improved several times. Levee remediation and improvements have consisted of embankment reconstruction and or enlargement, floodwalls, waterside rock slope protection, shallow through seepage cutoff wall, deep underseepage cutoff walls, seepage berms, and relief wells.

The 1955 flood was the first test of the new Sacramento River Flood Protection system. At the Sacramento Weir, 30 gates were opened with the peak flow reaching 48,000 cfs sent into the bypass. The peak flow in the Sacramento River at I Street was about 95,000 cfs. During the 1964 flood, the peak flow on the Sacramento River at I Street was about 100,000 cfs, just below the channel capacity of the reach. The flood of 1969 was largely controlled by the reservoirs, flood channels, and bypasses. The flood of 1974 saw a peak of 95,000 cfs at the I Street gage; the Sacramento Weir gates were not opened.

In 1960, Congress authorized the Sacramento River Bank Protection Project for the construction of bank erosion control works and setback levees within the limits of the existing levee system. This project is intended to maintain the integrity of the levee system to continue the degree of protection for which it was designed.

The flood of 1986 had a peak flow of 117,000 cfs at the Freeport gage, just south of the city of Sacramento. The levees on the Sacramento River were severely stressed from high water and seepage. The levees near the Garden Highway required extensive repairs during the flood and nearly failed. The north bank along Arcade Creek was overtopped and 500 homes were inundated.

Since the completion of the Sacramento River Flood Control Project, significant floods have caused considerable erosion related damage to the levee system. Erosion in the Sacramento River has even occurred during lower flow events, as documented by the Sacramento River Bank Protection Project. Numerous emergency bank repairs and repairs done by SRBPP (over 800,000 linear feet) have been constructed in the last 50 years. Erosion continues along the Sacramento River banks and levees and there are currently numerous sites that are in need of repair.

1.6 Monitoring by Corps and CVFPB

USACE and the Central Valley Flood Protection Board (CVFPB) have an ongoing program that identifies critical erosion sites and monitors erosion sites that may become critical. No critical erosion sites were identified during the 2012 reconnaissance by USACE; however, multiple erosion sites were identified on the left bank of the Sacramento River between RM 50.3 to 58.5 (corresponding to approximately MA9 LM 6.0 to COS LM 1.4). Based on the report, some of these sites currently have scattered rock, cobbles or quarry stone at the levee toe and have exhibited no change relative to previous erosion surveys, other than minor new slumping. The erosion mechanisms identified at these sites include wavewash, eddy scour, tree pop-outs, fluvial and whole bank failure.

Two erosion sites were also identified at RM 56.6 and RM 58.5 (corresponding to approximately COS LM 3.5 to LM 1.4), with the erosion mechanisms including fluvial and whole bank failure. These sites reportedly have concrete rubble (does not meet USCAC standards) on the bank and at the toe that is in poor condition; no significant changes in condition have been observed between annual inspections. One erosion site at RM 46.7 (corresponding to MA9 LM 10.0) was recently repaired by the State.

1.7 Stability Investigations

There are a number of studies, investigations, research efforts, and assemblages of expert panels which were focused on quantifying erosion on the Lower American River. These efforts are summarized below. Additional in-depth documentation of these studies is presented in Section 2.3 of the report titled "American River Common Features Project, American River Erosion Advisory Panel Workshop, November 29, 2011 – December 2, 2011, DRAFT Summary of Presentation and Conclusions" by the Sacramento District, U.S. Army Corps of Engineers, dated September 2012.

1.7.1 Prior Studies, Investigations, & Research Efforts

1.7.1.1 Geomorphic Analysis and Bank Protection Alternatives (Water Engineering and Technology, Inc., June 1991)

This study looked at the Sacramento and American Rivers as well as a number of other reaches. The report presents the results of a geomorphic study that was conducted "to determine the dynamics of the studied rivers and sloughs with the objective of developing a geomorphically-based framework upon which bank protection methods could be evaluated and overall protection strategies formulated." The study discussed Lower American River channel aggradation that occurred as a result of hydraulic mining, then degradation that occurred after mining ceased and then much more degradation that has occurred since completion of Folsom Dam in the mid 1950s. The channel incision has slowed down and even stopped in some locations as it reached Pleistocene-age rock outcrops. The study states the river is "sediment hungry" as flow leaves Folsom Dam. The channel degradation creates concerns for both levees and bridges. The levees are at a higher risk of toe scour and the several bridge footings have been exposed as a result of the channel incision.

It is important to note that at the time this report was written, many of the seepage and stability mitigation features had not been constructed along the LAR. In addition, the thinking at that time was that an Auburn Dam would eventually be constructed and that Folsom Dam would limit outflows to 115,000 cfs for events up to the 0.25% (1/400) ACE event.

1.7.1.2 American and Sacramento River, California Project- Geomorphic, Sediment Engineering, and Channel Stability Analyses (Ayres Associates, December 1997)

The purpose of this study was to examine the effects of a potential dry dam (Auburn Dam) including potential modifications to the existing flood control levees along the Lower American River. This included HEC-2 (hydraulic model) and HEC-6 (sediment model) modeling. Output from the HEC-2 model was used to evaluate channel capacity, bed shear stress, work done on the channel banks, and local scour at bridge crossings. Sediment routing was performed for five different scenarios, all using the 100-year flood event. Predicted bed elevation changes within the lower 13 miles of the LAR were all less than 1 foot (either aggradation or degradation). The report concluded that vertical stability along the LAR is not a significant issue. An incipient motion analysis indicated that the bed material is generally immobile at discharges less than 50,000 cfs. A quantitative analysis of the relative effects of the various design scenarios on lateral stability of the channel was conducted using the results from the HEC-2 model and a "weighted average work index" (velocity * bank shear stress * time for various frequency events multiplied by the probability of that event in a year and summed over all events). Rock-based revetments and dikes were recommended as the only forms of bank protection that will insure the integrity of the levees at the majority of the erosion locations.

1.7.1.3 Two-Dimensional Modeling and Analysis of Spawning Bed Mobilization Lower American River (Ayres Associates, October 2001)

The purpose of this report was to examine the possibility of spawning bed mobilization at different flow values on the LAR. A two dimensional model was developed to examine the velocities of different potential flow scenarios. The largest tested flow for the study was 115,000 cfs. The study confirmed the 50,000 cfs as the break point for incipient motion as determined in the previous report. The results indicate that there will be some movement of the spawning material especially above Goethe Park in the upper part of the study reach. The movement of the material largely depends on how long the high flows last. The model is a good indicator of whether movement will occur, but it does not show how far the motion will carry the material or where it is likely to end up.

1.7.1.4 Lower American River, Erosion Susceptibility Analysis For infrequent Flood Events (Ayres Associates, July 2004)

The purpose of this report was to determine the potential for erosion of grass-lined levees and overbanks when flows reached the design flow of 145,000 cfs. This study concluded that the river is degradational under present operating conditions as confirmed by geomorphic principles, by the thalweg profile, and by the field review.

It also concluded that since the channel bed is comprised of erosion resistant material in many locations, the river will tend to erode laterally to satisfy the need for sediment. A field review verified riverbank erosion is occurring even at flows of only 7,000 cfs. The bare soil on these eroded channel banks is increasingly susceptible to future erosion even at lower velocities. The report states a levee failure is possible for at least one location for 145,000 cfs. Additionally, other discharges ranging from 115,000 to 160,000 cfs were investigated and documented in this report.

1.7.1.5 Channel Stability Analysis of the Lower American River, Folsom Dam to the Confluence Sacramento, California (Ayres Associates, January 2010)

The purpose of this study was to assess the long term stability of the LAR for flows up to 160,000 cfs and to identify short and long term measures required to ensure safe and reliable conveyance of these flood flows. This study included a bathymetric survey of the LAR from Nimbus Dam to the confluence with the Sacramento River. The data collection for this survey was completed in August 2006. Ayres performed a field review of the reach (RM 0 to RM 23) of the LAR below Nimbus Dam. Riverbed and riverbank sampling was done for the entire reach and erosion and armored sites were inventoried through the project levee reach (RM 0 to RM 14). The current methods of bank protection include revetments, river cobble revetments, concrete walls, gabions, stone dikes, and concrete rubble. The four primary modes of channel response to the current conditions are channel degradation, increased sinuosity, channel widening, and bed material coarsening. Potential solutions include: revetment, vegetation, grade control, and introducing sediment supply. The only place the HEC-6T model (MBH, 2002) predicted degradation was at Guy West Bridge. In the other reaches, the lateral movement or widening of the channel is expected to occur as the river looks to fill its sediment capacity.

Although each expert provided recommendations that were summarized in the previous chapter of this report, several of the common or related recommendations have been summarized in this section. The consensus was that the current levee system most likely requires repairs to pass the 160,000 cfs release.

The majority of the experts agreed that the location and prioritization of the repairs have not been adequately defined, leading to some of the following observations and recommendations. The status of actions taken or not taken on the recommendations are noted in parentheses below each recommendation:

- Field observations show the bed material is coarsening in the upstream reaches. The coarsening of bed material is not obvious downstream of RM 10, but the pattern of propagation downstream is a logical conclusion.

- The right overbank area between RM 8 and RM 9.5 is also composed of mostly sand and will erode in areas were no armor is available and also where armor is in poor condition. The levee is much closer to the existing riverbank and could be threatened in a single high flow event.

- The river bottom at Guy West Bridge is scoured clean of alluvium. The exposed material in the riverbed consists of clay and has been found to be erodible.

- Based on a discharge of 160,000 cfs and corresponding erosion rates, there is approximately 10 feet of vertical erosion potential into the clay material at Guy West Bridge. The degradation is likely to propagate upstream through the abandoned sewer line and past the Fairbairn water intake structure.

- The river invert immediately upstream of Watt Avenue is also composed of clay. However, river thalweg plots show no change in elevation at that location since 1955.

- The two highest priorities for preventative maintenance at this point in time are to armor the bed at Guy West Bridge and provide bank protection at select locations on the right bank between Howe and Watt.

1.7.2 Expert Panel Consultations and Recent Activities

A series of expert panels were convened on three occasions: 1) October 6-8 & November 16, 2010, 2) November 29 – December 2, 2011, and 3) October 16-17, 2012. Key recommendations and concerns from these panels led to additional investigations and analyses which complimented the studies which were already in progress.

1.7.2.1 Lower American River, Panel of Experts Findings Report (West Consultants, December 2010). [Panel meeting from October 6-8 & November 16, 2010]

A panel of experts was convened to consider the adequacy of what has been done to date and to provide recommendations of additional study as appropriate or to recommend studies completed to date are adequate and can be used as a basis for design and construction. The main conclusions and recommendations include:

- With relatively little effort the existing HEC-6T sediment transport model can be modified to better reflect bed sediment conditions. Results of the model may shed light on vertical stability of the system and could also be used to examine “what-if” scenarios (e.g., stable points such as the gravel plug or clay outcrops are removed). (Status: HEC-6T was modified to reflect improved

information on bed sediment conditions. However, what-if scenarios have not been conducted to date.)

- The horizontal and vertical location of the scour resistant clay should be clearly identified and mapped as these materials can impact both vertical and lateral erosion potential of the river. Existing geophysical studies may help with this task and should be identified (see recommendation on consolidating data below). (Status: An initial phase of geologic mapping and 3-dimensional stratigraphic modeling has been completed using existing data as well as data generated for the ARCF GRR study. The level of detail included in the current mapping and modeling is sufficient to support planning level recommendations and conclusions but further refinement could be of benefit depending on the level of certainty required in understanding the locations of this geologic unit).

- Many of the experts viewed the results of the EFA erosion testing program with some doubt or skepticism which points to the need for better characterization of the erodibility of the resistant materials. (Status: Additional EFA as well as JET testing was completed on many samples collected on the channel banks and riverbed. There is a need to study those results, place them in a geologic context, calibrate them based on judgment and any potential scaling effects, and provide guidance on incorporating them into the hydraulic models. This has not been completed).

- Levee slopes previously treated with mixtures of soil and rock be assessed to determine if they meet USACE levee criteria for erosion. Non-standard designs need to be backed up with research or defendable scientific analysis. (Status: The tentatively selected plan assumes that recently constructed bank protection (e.g. “modern” bank protection) is adequately designed for 160,000 cfs. However, this will need to be confirmed in the future, such as during selecting and prioritizing sites).

- Many of the experts agreed that existing data is scattered may not be readily available to professionals studying this reach of river. A centralized database should be created to make past studies accessible. (Status: Much of the data has been centralized on the network).

- Monitoring should continue and possibly be enhanced or extended by various methods. (This has not been completed for this project during the feasibility phase of the study, but should be a component of future efforts).

- Systematic and justifiable criteria for site stabilization will be useful not only for prioritizing work but also to rationalize projects to the public and decision makers. (Status: Criteria for site stabilization and prioritization will need to be completed in the future).

- Written opinions and discussion touched upon the confusing nature and different methodologies employed in gathering bed profiles. Past profiles should be verified and future profiles collected in a consistent and systematic manner. (Status: No plan in place for collecting regular profiles in a consistent manner. This should be addressed as part of future systematic monitoring plan).

1.7.2.2 American River Common Features Project, American River Erosion Advisory Panel Workshop (report dated September 2012). [Panel meeting from November 29 – December 2, 2011]

A new panel of advisors was compiled to evaluate the then current course of study. Some of the recommendations from this panel include:

- The upstream extent of the study area currently is about one mile above Watt Avenue. This boundary should be extended upstream. The purpose of this is that from a sediment transport standpoint, there is still significant quantities of material above the leveed reach of the American River that can be transported through the leveed reach, and this needs to be understand because it will influence how rapidly erosion will occur in the leveed reach. (Status: The study was extended upstream but with lower level of detail. Further investigation would be needed to bring this section of the study up to the same level of detail.)

- The downstream extent of the study area currently is just downstream of H Street/Fair Oaks Boulevard. This boundary should be extended downstream. The purpose of this is that significant erosion has not only occurred in the current study reach but also downstream of here, most notably near the Capital City Freeway. (Status: The study was extended downstream but with lower level of detail. Further investigation would be needed to bring this section of the study up to the same level of detail.)

- There is a considerable amount of data available with regards to historic borings and characterizations of materials. A few examples of this include drilling logs for water wells and groundwater models. Research should occur to identify this data and it should be incorporated into the modeling efforts. (Status: This comment was in regard to including the regional geologic model into a more detailed site specific study and to make sure the study is not isolated from the larger regional context. This was addressed through an expansion to the high and low resolution study areas.)

- The extent of the geophysical investigation should be expanded. This expansion should include extending the overall study area in the upstream and downstream direction but also should include collecting cross sections at various locations; all of the geophysical lines collected at the time of the panel have been profiles (running parallel with the river) as opposed to cross sections (running perpendicular to the river). Additionally, geophysics should be validated by comparison to bore hole data. (Status: This has not been completed to date. However, it is not needed for a feasibility decision at this time. However, additional geophysics to refine the estimate of where highly erodible materials are located in profile and cross-section could be helpful information in the future if more refined modeling is desired such as to inform phasing construction using relative risk.)

- Modeling, most specifically the HEC-6T model is not calibrated. To the extent that any modeling can be calibrated, it should be. (Status: Model was verified using available gage data.)

- Soil filled rock mixtures used for bank protection should be closely monitored during and after flood events to assure that their performance meets USACE standards. (Status: At this time, the

use of soil filled rock is not specified as part of the tentatively selected plan. Monitored should be considered moving forward.)

- Existing modern bank protection sites need to be analyzed to assure they can withstand a flow of 160,000 cfs. (Note: This recommendation has not been followed to date. The feasibility study assumes that recent erosion protection was designed and constructed adequately to withstand this discharge without the need for additional analysis beyond what was conducted for the design. It has not been verified that each site was designed for 160,000 cfs.)

- Based on input presented to the panel, there is a high degree of variability in the bed materials. Interpretations made of connecting the dots between borings could be erroneous. More borings should be collected to assure continuity of various layers. Additionally, this refinement in detail needs to be accounted for in the stratigraphic model. (Status: This is true of any such geotechnical model. Additional investigation is deferred to future analysis and design efforts).

- Characterization of materials is primarily being completed by the EFA and JET testing. Other methods to characterize engineering properties of geologic materials should be utilized. An example of one would be the NRCS soil/rock erosion model. Additionally, lab test results needs to be correlated to behavior in the field. (Status: The method was not considered practical for use in the feasibility study and therefore was not conducted).

- Because of the large extent of bankline/levee requiring armoring, a site prioritization method needs to be developed so that the sites being the most urgent will be addressed first when construction begins. (Note: This recommendation to develop this site prioritization method has not been completed at this time and will need to be developed in the future.)

1.7.2.3 American River Common Features Project, American River Erosion Analysis, Technical Working Group Meeting (Final Meeting Minutes dated December 2012). [Panel meeting from October 16-17, 2012]

The previous advisory panel reconvened as a follow-on working group meeting to the November-December 2011 workshop. The following recommendations were given as a summary of the findings of the expert panel:

- Need to combine the results of the geophysical data into the stratigraphic mapping to develop a more complete picture. (Status: This was performed to the extent possible given the restrictions of the data and various software programs currently available.)

- Collect additional borings downstream of Paradise Beach down to the Business 80 crossing. Additionally, there is concern regarding erosion and scour in the downstream end of the river for releases made at Folsom for times when the Sacramento River is at a low stage. (This is anticipated to occur during the design and construction phase of the project).

- Conduct an analysis of how the dredge tailings located near RM's 16 – 19.2 act as a sediment supply to the river. (Status: This has been completed and is discussed later in this report).

- Results of the geophysical data need to be combined into the stratigraphic mapping to develop a more complete picture. (Status: This was performed to the extent possible given the restrictions of the data and various software programs currently available.)

- Collect additional borings downstream of Paradise Beach down to the Business 80 crossing. Additionally, there is concern regarding erosion and scour in the downstream end of the river for releases made at Folsom for times when the Sacramento River is at a low stage. (Status: Additional borings are deferred to future analysis and design efforts. No specific action taken to address erosion and scour in the Lower American River when the Sacramento is at a relatively low stage).

- Conduct an analysis of how the dredge tailings located near RM's 16 – 19.2 act as a sediment supply to the river. (Status: This is complete).

Many of the expert and/or advisory panel recommendations were addressed by work performed by the Sacramento District and/or by the District's contractors, or anticipated to be performed as part of the design and construction phases of the project. Most of these recommendations related to geotechnical, geologic, and/or geophysical investigations (refer to Section 1.8). Some of the recommendations were not addressed due to budget and schedule considerations. Some of these recommendations that were not completed are noted above in parentheses. The District envisions that, as appropriate, the remaining work efforts will be addressed in future studies. For example, there is currently an ongoing channel widening threshold analysis to support changing operations at Folsom Dam.

1.8 Geologic and Geotechnical Investigations and Analyses – Lower American River

1.8.1 Soil Boring and Cone Penetration Test Investigations

Subsurface exploration, soil borings and Cone Penetration Tests (CPT), and subsequent laboratory testing were performed in support of the various geologic, geophysical, and geotechnical investigations, mapping, modeling, and analyses associated with studying erosion on the LAR. The subsurface exploration was led by two teams, one using Sacramento District In-House resources and one led by URS Corporation (URS).

The Sacramento District In-House subsurface investigation included drilling a total of 11 vertical soil borings within the American River channel, 29 vertical soil borings on the levee crest and waterside channel bench, and 15 cone penetrometer tests (CPTs) on the waterside channel bench. The URS subsurface investigation included a total of 44 borings, with 24 primary sonic borings and 20 companion air rotary casing hammer (ARCH) borings along the levee crest and waterside bench.

1.8.2 Erosion Rate Testing

The Engineer Research and Development Center (ERDC), Geotechnical Structures Lab (GSL) and Texas A&M University (TAMU) Department of Civil Engineering further assed the erosion resistance of the LAR by performing Jet Erosion Tests (JET) and Erosion Function Apparatus (EFA) testing on undisturbed samples of cohesive materials located near the bed elevation of the LAR (URS, January 2012; USACE-ERDC, May 2013; USACE, February 2012; USACE, June 2013). The tests resulted in determining values of Erodibility Coefficient, K_d, and Critical Stress, τ_C, of the samples. A total of 81 JET tests were performed on 38 samples and 46 EFA tests on 46 samples.

1.8.3 Geophysical Investigations

To characterize the extent and thickness of lithologic units that may have differing scour potential, the United States Geological Survey (USGS) has performed several geoelectrical surveys of the LAR channel and floodplain between RM 5.5 and RM 11.0. Preceding reports document the methods and results of each survey (Asch et al, 2007; Ball and Teeple, 2012; Powers and Burton, 2012). The combined results of these surveys are released in the subject report as digital data in a three-dimensional (3-D) framework that allows geospatial comparison between the geophysical results and available geotechnical and lithologic data. The data resulting from these surveys have been compiled into similar database formats and converted to uniform geospatial datums and projections. These data have been visualized in a digital three-dimensional framework project that can be viewed using freely available software, allowing a comprehensive analysis of the resistivity structure underlying the LAR corridor and assisting in levee system management.

Traditionally, exploration of lithologic and geotechnical properties is accomplished through borehole drilling, where subsurface materials can be directly observed, described, and tested. Extensive drilling has been conducted on the LAR corridor, resulting in high vertical resolution datasets describing the lithology and stiffness of the sediments. While these types of data are invaluable, their inherently one-dimensional nature makes upscaling to a more manageable regional interpretation difficult. Surface geophysical data can provide supporting information about the variability of subsurface physical properties that may be correlated to changes in lithology or scour potential. While borings provide high-resolution data about the vertical distribution of properties, surface geophysical data can provide high-resolution supplemental data about the lateral variations in physical earth properties. Geoelectrical data, in particular, measure the electrical resistivity of the subsurface. The electrical resistivity of a given material is controlled primarily by the water content and quality, and also by the presence of clays or other conductive minerals. Changes in resistivity structure therefore reflect changes in porosity/compaction, lithologic texture, degree of saturation, and groundwater salinity. Geoelectrical methods also facilitate wide-spread data collection while minimizing potential noise presented by the urban environment, something that typically more strongly affects seismic and electromagnetic methods.

1.8.4 Stratigraphic and Geomorphic Mapping

Fugro Consultants developed reconnaissance and detailed surficial geologic maps of the LAR study area and developed conceptual geomorphic and stratigraphic model with the primary purpose of better understanding the stratigraphy exposed in the channel banks and bed of the LAR. The stratigraphic and geomorphic mapping effort was undertaken in direct response to concerns raised in the Lower American River, Panel of Experts Findings Report (West Consultants, December 2010) in regards to location and extents of the erosion resistant unit and better organizing existing geotechnical and geologic data.

Two levels of investigation were performed: (1) detailed mapping (1:2,400 scale [1 inch = 200 feet]) and analysis of the geologic deposits between the levees from RM 5.0 to 11.0, and (2) development of 1:12,000 [1 inch = 1,000 feet] reconnaissance mapping along the channel corridor between RM 0.0 to 5.5 and RM 11.0 to 22.4. The mapping synthesized existing surface and subsurface data including geomorphic/geologic maps, geophysical data, aerial photographs (both historic and recent), and boring logs, to augment the new field mapping and to aid in the interpretation of deposits and the development of the map.

Fieldwork included reconnaissance of the levees, banks, and river channel to map the riverbed and bank materials, surveying the elevation of relevant stratigraphic contacts, and documenting relevant exposures. Stratigraphic analysis of the apparently hard/dense unit specimens included section description, specimen petrography and microscopy, and pedogenic evaluation of the units. Geomorphic analysis included development of three-dimensional surface contour maps of erosion resistant units, and geologic cross sections and longitudinal profiles. The results of this study were used to identify locations requiring further study and investigation, validate the results of the laboratory testing, and were incorporated into the 3-dimensional stratigraphic model of the LAR.

1.8.5 Upstream Sediment Source Reconnaissance

Fugro Consultants conducted geologic field reconnaissance in areas of gold dredge tailings and aggregate quarries along the LAR in the approximate area between Nimbus Dam (RM ~22.4) and the Watt Avenue Bridge (RM ~9.1). This study was designed to directly address the recommendations of an LAR advisory panel convened by the USACE in October 2012. The primary goal of this reconnaissance level study was to estimate, at order-of-magnitude levels, the potential volume of sediment that could be available for river transport to the LAR from gold dredge tailings and former aggregate quarries along the river's floodplain, principally at flood discharge levels (115,000 cfs and above). A secondary goal was to characterize dredge tailings stratigraphy and visually estimate distributions of tailings' grain size distributions. The results of this study provided the initial field-based context for evaluating the significance of gold dredge tailings and former aggregate quarries as input sources to river sediment transport models. It is anticipated that the results of this reconnaissance effort will be incorporated into future hydraulic models and analyses.

1.8.6 3-Dimensional Stratigraphic Model

URS developed a three-dimensional (3D) stratigraphic model of the LAR to describe the stratigraphy and subsurface conditions of the study reach and help evaluate the stratigraphic susceptibility of this reach to erosion. The model encompassed the levees, banks, and channel of the LAR from RM 5.25 to RM 10.2. In late 2011, an initial model was created and served as a precursor and guide for producing the revised and final 3D model. The initial model included stratigraphic interpretation from numerous borings drilled through the levees along the north and south banks of the river. Except at the bridges, the initial model did not include information from borings drilled within the channel or along the inner banks. The final version of the 3D stratigraphic model represented an increase in detail and complexity over the initial version, presented data included from additional borings that were drilled between the levees and incorporated more geologic, geotechnical, and geophysical data than the earlier models. These data were constrained using an understanding of depositional and erosional processes to fit the model to its geologic environment. As a result, the final 3D model contains enhanced information, especially within the area between the levees where young alluvial sediments related to hydraulic mining have been deposited. In addition to showing subsurface alluvial stratigraphy, the final model shows the top of erosionally resistant sediments that are exposed and identified in the channel at several locations.

1.9 Geologic and Geotechnical Investigations and Analyses – Sacramento River

1.9.1 DWR Urban Levee Evaluations

The California Department of Water Resources' (DWR) Department of Flood Management is managing a levee evaluation program to assess the existing conditions of urban levees in California's Central Valley. The Urban Levee Geotechnical Evaluations (ULE) Program evaluates levee systems that are expected to protect communities of more than 10,000 people and includes a study area referred to as the Sacramento River South Study Area. This study area comprises the levees on the east (left) bank of the Sacramento River from the American River to Freeport, and is comparable to the ARCF GRR Sacramento River study area outside of Natomas. The DWR ULE Project consists of a multiphase investigation and evaluation of levee study area. This multiphase approach consists of a Technical Review Memorandum (TRM), Phase I Geotechnical Data Report (GDR), Phase I Geotechnical Evaluation Report (GER), Supplemental GDR, and GER. These phases of the ULE Project collect existing data, generate new geotechnical data, evaluate the levees based on these data, and form recommendations for improvement measures. While the DWR ULE program and ARCF GRR are independent and separate studies, both studies share relatively common approaches and desired outcomes. The data, results, and recommendations generated by each study are reviewed by both DWR and USACE for consistency and share much of the same supporting information without relying on each other as a basis of conclusions or recommendations. In that form, the Erosion Screening Process (ESP) developed by DWR and discussed in summary in this Section was used by the USACE ARCF GRR PDT not as a basis of decision making but as an independent check.

Part of the ULE Project is a three-tiered ESP that was developed to qualitatively analyze the potential for erosion-induced levee breach during a 200-year flood event. Tier 1 analyses included the following tests: historical performance, levee prism geometry, wind fetch length, and soil erodibility. Tier 2 analyses involved evaluating: flow velocity and testing erosion surface adequacy, wind-wave shear and testing erosion surface adequacy, and field reconnaissance. During Tier 3 analysis, a representative cross section was selected for each levee segment based on existing levee geometry and soil erodibility conditions, given that the other properties (i.e., velocity and wind) were generally constant within a segment. Levee segments are assigned one of three erosion risk levels (low erosion risk, medium erosion risk, or high erosion risk) based on Tier 3 erosion analyses results.

During the Tier 1 evaluation the Sacramento River Study Area was subdivided into 22 levee segments, all of which did not meet one or more of the four Tier 1 test criteria and were advanced to Tier 2 for analysis. Of those 22 segments, 20 did not meet Tier 2 analysis criteria and were advanced to Tier 3 for analysis. The 2 segments not advanced to Tier 3 analysis were classified as low erosion risk. Of the segments advanced to Tier 3 analysis, 2 were classified as low, 14 were classified as a medium, and 4 were classified as high erosion risk primarily due to channel velocity, erodible soil, and levee geometry. This report showed that the Sacramento River levees have a medium to high risk of breach due to erosion.

1.9.2 Fugro WLA Surficial Geologic Mapping and Geomorphic Assessment

William Lettis and Associates developed a technical memorandum to present the results of surficial geologic mapping and geomorphic assessment along the Sacramento River (East Side) from the confluence with the American River south to the town of Freeport. The goal was to provide information on the type and distribution of surface and shallow subsurface deposits that underlie the levee for

assessing potential levee underseepage, and to develop a conceptual model that allows reasonable stratigraphic interpretations between widely-spaced subsurface explorations. Data on potential geologic and geomorphic controls on levee underseepage were developed primarily to help guide geotechnical explorations, and secondarily to provide a geologic basis for characterization of levee foundation materials. This study involved integration and analysis of aerial photography, topographic, geologic, and soil maps, other historical documents, and review of available geotechnical exploration data and helicopter-based geophysical imaging data. Synthesis of these data allows for assessing the primary geomorphic processes responsible for the distribution of surficial deposits within the project area, and constructing a preliminary conceptual geomorphic model with shallow stratigraphic interpretations.

1.10 Hydraulic and Sedimentation Studies

Based on the expert panel recommendations above in paragraph 1.7.2.1 "Lower American River, Panel of Experts Findings Report (West Consultants, December 2010), new studies were started. These studies include characterizing and mapping the geology and erosion resistance properties as described below in Section 1.8 "Background of Geotechnical Studies Completed to Date." A bank migration analysis was also completed and is discussed below. In addition, the HEC-6T model of the American River was converted from NGVD 29 vertical datum to NAVD 88 vertical datum and updated to include new geologic and sediment data. This effort is ongoing but draft results and report are available. However, this effort has not been reviewed by USACE for quality and therefore the results should be used with caution. These draft results are further discussed below. In addition, the Sacramento River Bank Protection project included a larger scale sediment study of the Sacramento, Feather, and American Rivers along with relevant weirs and inflows/outflows. These studies are also discussed below.

1.10.1 Sacramento River Sediment Study Phase II – Sediment Transport Modeling and Channel Shift Analysis Lower American River. Common Features - Completed tasks.

This task updated previous bank migration analysis by Ayres with current information, reviewed the approach used by Ayres, and summarized findings and implications. This new approach used new LiDAR information to assist with defining the top of bank in GIS, an issue identified during the expert panel review. Previously, Ayres concluded that the Lower American River had not exhibited significant lateral shifting due to natural river processes from 1957 to 1998, and that significant changes in bankline location were the result of sand and gravel mining operations. NHC confirmed Ayres findings of no significant recent bankline migration by using aerial photos combined with survey data from 1998 to 2010 to develop more accurate banklines. NHC noted that significant differences shown in the previous Ayres analysis were the result of Ayres incorrectly identifying the top of bank from aerial images without the aid of relatively accurate topographic data. NHC concludes that there are no actively migrating meander bends on the Lower American River, although large floods have caused significant instream changes between the channel banklines in the past. Annual river surveys show that lateral erosion and bankline shift is occurring on the Lower American River, but on a scale too small to be accurately identified by air photo interpretation. NHC also collected bed material samples along the Lower American River and compared the data with past measurements. While the report notes there is a lot of variability in the data, the range of the data is typical for natural gravel-bed rivers and does not appear to show any obvious trends (coarsening or fining) since 1993.

1.10.2 Sacramento River Sediment Study Phase II – Sediment Transport Modeling and Channel Shift Analysis Lower American River. Common Features Tasks in-progress (June 2013 draft information report).

This information is based on draft results that have not been fully reviewed by USACE and should be viewed with caution as they are subject to change. However, the information is included here as the results seem reasonable and can be informative. NHC updated the Ayres HEC-6T model by converting it NAVD88 vertical datum, by adding more recent surface and sub-surface bed material gradations and gage data, and by incorporating results from geotechnical investigations of erosion resistant material in the bed and banks (see section 1.9.2). The model was calibrated to the 1997 high water marks and to observed vertical channel changes between 1997 and 2006. The calibrated model was run for multiple synthetic hydrologic scenarios designed to mimic short-term and long-term morphological conditions. This does not include a full set of hydrographs over decades of future conditions but uses a series of individual events to approximate short-term and long-term conditions. This hydrologic approach to the sediment modeling is useful for relative comparison purposes and should not be used to estimate actual future conditions. Other studies have found that trends from a single flood event may be opposite of the long-term trend and therefore these results should not be used for estimating long-term aggradation/degradation trends.

NHC conducted HEC-6T sediment modeling for the Sacramento and Lower American rivers (NHC 2012) that included long-term hydrology (1997 - 2008) from actual gage data as well as n-year specific events (e.g. 1/50 ACE, 1/100 ACE). A comparison of the results for the same reach (Sacramento River between the Lower American River confluence and Freeport) shows that the reach is degradational during a specific n-year flood event but aggradational over the long-term. The implication is that using single event hydrology (e.g. the 1/100 ACE event) or hydrology composed of a series of single n-year events (e.g. 1/100 ACE event followed by a 1/200 ACE event) may provide evidence for the opposite trend (degradation) than if a wider range of flows (e.g. 1997 - 2008 "continuous" hydrology) is used for the same reach. So while specific event modeling is likely more conservative for design and cost of erosion counter-measures for this reach, it may not be helpful if long-term trends are needed for other purposes, such as for determining if future sedimentation will bury spawning gravel.

Despite this limitation, the results enhance the understanding of sedimentation trends in the Sacramento River and may still be informative and perhaps conservative relative to feasibility level designs and costs. There is a lot of uncertainty associated with all sediment models as noted in the comment. However, the Sac Bank Sediment Study shows that using event specific hydrology vs. long-term hydrology for the exact same model can lead the model to show opposite trends. Therefore the relative differences may lead to incorrect conclusions even though both models are subject to considerable inaccuracies.

The results from this study (NHC 2013) include:

- Most of the Lower American River is actively degrading and the degradation increases with increasing flood magnitude and is greater in the upstream reaches (particularly above about RM 14).

- Computed maximum channel degradation is 8-10 ft upstream of RM 19, 2-7 ft between RM's 5-19, and less than 1 ft downstream of RM 5. The results from the updated model of the lower American River are generally consistent with the original Ayres (2010) model. However, there is

limited geologic information below river mile 5 and above river mile 11.5 and results in these reaches may include some uncertainty.

- Modeling results indicate that for all the flows simulated the shear stress in the reach with locally exposed hard material (between RM 7 and RM 11) is below the critical stress for erosion of moderately resistant materials (clay and cemented sand with silt). Therefore, significant scour below this erosion resistant material/surface is not anticipated. However, this is for general reach wide trends and local erosion such as at bridge piers may occur. Local scour should be further evaluated during future studies.

- The simulations generally indicate a coarsening of the surface bed material due to flood events.

1.11 Levee Screening Tool

As part of the USACE Risk Assessment Framework, the levee segments along the American and Sacramento Rivers were assessed using the Levee Screening Tool, a part of the USACE Levee Safety Program. Through this approach a Levee Safety Action Classification (LSAC) was assigned to the American River North (American River North Bank, NEMDC East Bank, Arcade Creek North and South Bank, and Dry Creek North and South Bank levees) and South (American River South Bank and Sacramento River East Bank levees) Basins by the Levee Senior Oversight Group (LSOG). The USACE Risk Assessment Framework process for assigning LSAC ratings entailed a series of presentations and reviews at the District level (relative risk assessment), consistency level (National QA Cadre), and senior-level (LSOG) for each levee segment. Each segment was evaluated on up to six performance modes depending on the features that were present in the segment. The performance modes were: Embankment and foundation seepage and piping, embankment stability, embankment erosion, closure systems, floodwall stability, and floodwall underseepage and piping. Following the presentation and input from the National QA Cadre and LSOG panels, a final LSAC classification was assigned for each segment. The presentation process encompasses segments within the same levee system and following all presentation and assignment of ratings per segment, an overall LSAC rating was given to the system. The final recommendation was then forwarded to the USACE levee safety officer for approval, action, and dissemination.

The USACE Levee Screening Tool Application Guide and User's Manual: Levee Safety Action Classification (LSAC) provides reference documentation and further details the rating process. The system rating is consistent with the highest risk segment within the levee system. Levee systems were assigned one of five classes which are described below:

- Class I – Very high risk warranting "urgent and compelling" actions to reduce risk,
- Class II – High risk warranting "urgent" actions to reduce risk,
- Class III – Moderate risk warranting "high priority" actions to reduce risk,
- Class IV – Low risk warranting "priority" actions to reduce risk,
- Class V – Normal risk considered tolerable, requiring only that "normal" levee safety activities continue.

The overall system rating assigned to the American River North Basin was an LSAC I. The main contributing factor is embankment erosion on the American River North Levee. This performance mode

coupled with the high population at risk, critical infrastructure within the basin, and expected loss of life during a breach contributes heavily to the overall rating.

The overall system rating assigned to the American River South Basin was an LSAC I. The main contributing factors included embankment seepage and stability on the Sacramento River South Levees, and embankment erosion on both the American River South Levee and Sacramento River South Levees. These performance modes, in conjunction with the high population at risk, residential and critical infrastructure, and expected loss of life during a breach contributes to the overall rating.

2 Completed Bank Protection Work

As discussed in Section 1.5, erosion has continued on both the Sacramento and Lower American Rivers and ongoing repairs have been performed to maintain channel integrity (i.e., the ability of the channel to convey the design discharge). Figure 2-1 depicts the modern revetment repair sites (shown in green) and a series of historic revetment sites (shown in orange), many of which consist of cobbles. In the Lower American River, these cobble sites are considered ineffective as erosion protection for large discharges which approach 160,000 cfs. For completeness, revetment segments for both left and right levees on the Sacramento River are included on Figure 2-1 to illustrate the magnitudes of the erosion problem on these mainstem channels and levees. As will be shown in Figure 6-3, the tentatively selected plan is to replace the historic revetment (e.g. cobble) with modern revetment to protect the banks from anticipated future flows.

In general, the repair sites provide insight into the bank protection features proposed for the subject ARCF GRR study. Specifically, as will be presented below in Section 6, the proposed bank protection features use design concepts adopted from several of the existing repair sites along the Lower American and Sacramento Rivers.

Sample repair sites along the Lower American River are illustrated on Figure 2-2 and Figure 2-3. Figure 2-2 shows the left bankline, looking downstream, at the repair site near RM 0.3 in 2010. This is the same erosion site shown in Figure 1-3 located on the left bank of the LAR upstream of the Interstate 5 crossing. Figure 2-3 (2010) is looking downstream at the repair site near RM 4.3 which is the bank and levee erosion site shown in Figure 1-6 located on the left bank upstream of the Capitol City Freeway. Erosion during the 1986 flood event nearly failed the levee at this site. In some cases, the bank repair consists of re-grading the slope and placing riprap with an emphasis on ensuring that the toe rock meets design criteria. In other cases, woody material is placed with the toe rock for fish habitat.

On the Sacramento River located at RM 62.5 (just downstream of the Interstate 80 crossing), Figure 2-4 shows bank erosion on the right bank on the Sacramento River in 2009. The repair for this site is shown in Figure 2-5 which was completed under the SRBPP.

Another Sacramento River erosion site is illustrated in Figure 2-6. Specifically, this photo shows the erosion and slope stability problems along the left bank at RM 53.2 in 2005. The repair for this site is shown in Figure 2-7 which was completed under the SRBPP.

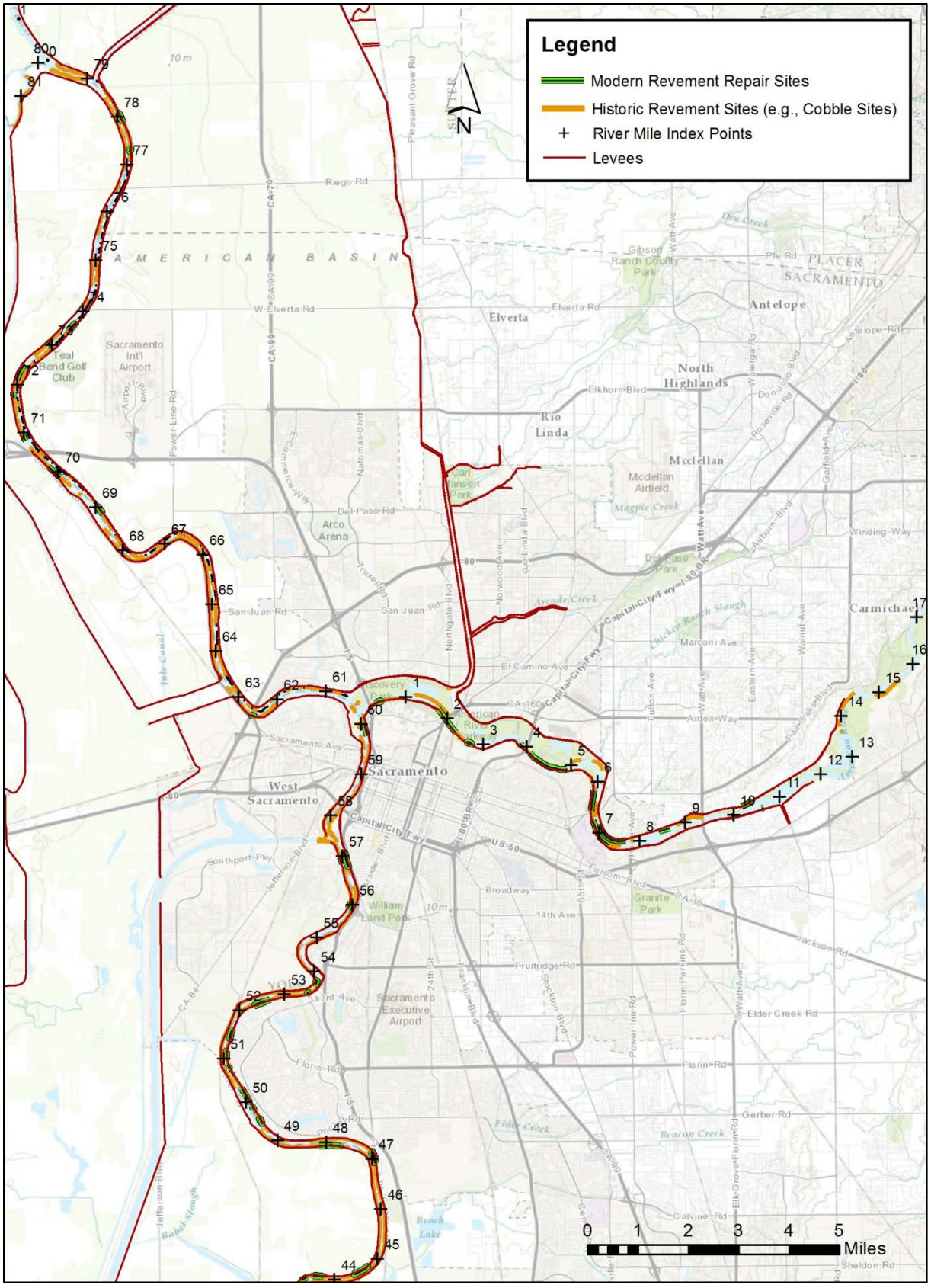

Figure 2-1. Historic and modern revetment sites along the Sacramento and American Rivers

Figure 2-2. View of repair site on the left bankline near LAR RM 0.3 (2009)

Figure 2-3. View of repair site on left bankline near LAR RM 4.3 (2010)

Figure 2-4. Erosion site of the right bank of the Sacramento River at RM 62.5 (2005)

Figure 2-5. Repaired site at Sacramento River right bank RM 62.5 (2009)

Figure 2-6. Erosion site of the left bank of the Sacramento River at RM 53.2 (2005)

Figure 2-7. Repaired site at Sacramento River left bank RM 53.2 (2009)

3 Geologic and Geotechnical Characterization

3.1 Geologic and Geomorphic Mapping and Analyses of the Lower American River

Regional geologic and geomorphic mapping show that the floodplain of the LAR is inset into (topographically lower than) older late Tertiary to Quaternary age alluvial deposits that form steep bluffs along the north (i.e. right) bank of the river from about Folsom Dam downstream to about Watt Avenue. Within the LAR study area, the middle Pliocene to Pleistocene (< 5.3 million to pre-Riverbank age) Fair Oaks, and the Pleistocene (1.8 million to 11,000 years old) Riverbank, and Modesto Formations underlie or are directly adjacent to the LAR. The Fair Oaks formation forms the steep bluffs along the north side of the American River with its contact dipping into the subsurface west of Watt Avenue while the Riverbank and Modesto Formations are expressed as a series of progressively younger and topographically lower alluvial fan deposits that make up most of the surficial geology of the LAR study area. The Riverbank Formation forms several broad, gently sloping alluvial fan surfaces south of the river, and the Modesto Formation forms the terraces closest to the river. To a large extent, the present-day levees along the American River have been constructed on the top of the river's banks, and overlie geologically young (i.e., late Pleistocene to Holocene), unconsolidated sand and silt-rich floodplain sediments, including post 1850 mining spoils.

Detailed geologic mapping, as well as petrographic and pedogenic analyses, completed during this study demonstrated the presence of two potentially erosion-resistant units within the stratigraphy of the LAR. These were: (1) a moderately cohesive silty and sandy interbed of relatively limited lateral and longitudinal extent within a thicker package of loose Holocene sediments (the "upper" unit); and (2) much thicker, more widespread relatively erosion-resistant deposits associated with the Pleistocene-aged Fair Oaks formation of Shlemon (1967) (the "lower unit"). Figure 3-3 presents a generalized stratigraphic section.

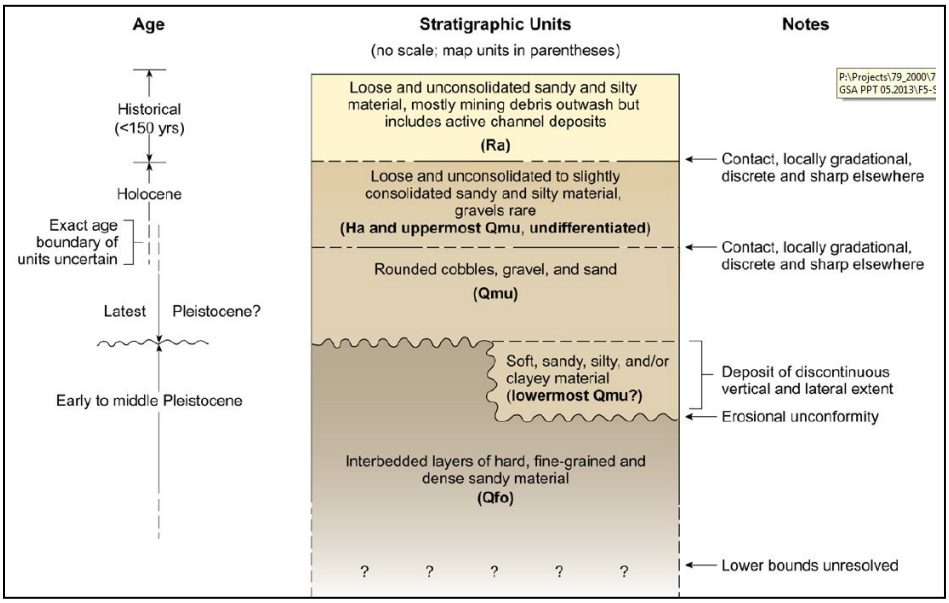

Figure 3-1. Generalized, composite stratigraphic section of the Lower American River

The upper unit was mapped in the banks of the LAR from RM 5.2 to 5.7 and may also exist near the Fairbairn water intake structure near RM 7.2 to 7.3. The upper unit was interpreted to be a geologically young deposit that is only slightly more cohesive than the surrounding early Holocene or the latest Pleistocene upper Modesto Formation sandy and gravelly sediments, and may be only weakly resistant to erosion.

Surficial geologic mapping and synthesis of geotechnical data show that the Plio-Pleistocene age Fair Oaks formation is exposed in the channel bed and banks locally upstream of Watt Avenue (RM 9.0 to 11.0) and intermittently exposed in the channel bed downstream of Watt Avenue to near RM 6.7 (slightly downstream of the Guy West pedestrian bridge). Prominent outcrops upstream of Watt Avenue occur at RM 10.1 and from RM 9.4 to 9.7. Downstream of Watt Avenue, the formation lies mostly below the modern bed elevation of the river and is not readily visible. Generally, a variable thickness of modern and/or upper Modesto Formation-age gravels and cobbles overlie the Fair Oaks formation in this reach. In some locations, the bathymetric data suggest that localized scour has removed most of the overlying gravels and cobbles and the Fair Oaks formation may be present in the channel bed (e.g., RM 8.2–8.3). Downstream of the Howe Avenue Bridge, between approximately RM 6.6– 7.5, bathymetry data show broader areas of scour where the formation is likely more widely exposed in the channel bed or lies concealed beneath a thin cover of active channel gravel only a few feet thick. The unit likely is continuous in the north-south directions beneath the levees, but at elevations below the present day thalweg, and thus the unit provides no bank resistance to lateral erosion and will not contribute to levee stability.

No paleosols containing well-developed, laterally continuous pedogenically-derived, clay-rich hardpans or silica-cemented duripans were observed in the detailed study area. Based on a review of the geotechnical data, inspection of a limited number of boxed core samples collected via sonic drilling in late 2011, examination of in-stream outcrops, and petrographic analysis, the erosionally resistant materials in the detailed study area have undergone only limited pedogenesis. Petrographic study supports field observations that there is little precipitated chemical cement in these sediments and shows the coarser grains to be held together at least partly by minor amounts of clay and fine silt, which occurs as secondary pedogenic coatings on grains and pores in some samples.

Multiple geologic processes likely are responsible for the relatively indurated nature and apparent erosion resistance of the sediments composing the lower unit (i.e., the Fair Oaks formation). The results of this study suggest that silica cementation is not responsible for the relatively high apparent density / hardness of the sediments. Rather, it is more likely that multiple lithification processes, including (but not limited to) partial cementation, compaction, desiccation, and authigenesis (i.e., recrystallization), occurring over geologic time (i.e., 10^5 to 10^6 years) in aggregate, contribute to the induration presently observed. An additional factor contributing to the high apparent density / hardness of these sediments may be the natural angularity of the glacially-derived silt and fine sand component. In our opinion, the relatively old age of the Fair Oaks formation is likely the greatest single factor contributing to the high apparent density / hardness of the sediments that make up the formation. The process of consolidation, acting over hundreds of thousands of years, may result in materials that are sufficiently dense and compact as those observed in the detailed study area.

Although the terminology “erosion resistant” is used to refer to the outcrops of the relatively indurated material in the river channel, the outcrops do erode. Field observations suggest several mechanisms of erosion are currently occurring at both the granular- and outcrop-scale, including tension cracking and

block-topple, scour resulting in potholes and development of flutes or grooves, and potentially wet-dry and freeze-thaw cycles.

3.2 3-Dimensional Stratigraphic Model of the Lower American River

The general goal was to develop a 3-dimensional (3D) stratigraphic model of the LAR study reach by incorporating both existing and newly collected geotechnical and geologic data, and utilizing geologic principles to place the stratigraphy into a depositionally based framework. The model was intended to describe the stratigraphy and subsurface conditions of the study reach and help evaluate the stratigraphic susceptibility of this reach to erosion near the levee banks.

URS created a 3D stratigraphic model of the LAR study reach using Environmental Visualization System (EVS) software (version 9.6, developed by C Tech Development Corporation). For the geographic information systems (GIS) component of the task, URS used ESRI's ArcGIS (version 10) to produce ESRI file geodatabases, shapefiles, and GRID geospatial data formats in ArcGIS (version 9.3.1) format, per USACE's specifications. URS used Microsoft Excel and EVS utilities to translate tabular data, comprising the interpretation of the stratigraphic units into EVS input file formats.

Stratigraphy was interpreted through review of the boring logs and surficial outcrops. To create the 3D model, the stratigraphic contacts were manually drawn on 24 hardcopy cross sections approximately perpendicular to the American River channel axis and 12 profiles. The sections and profiles included surface topography and exploratory boring stick logs. The stick logs contain abbreviated boring information, including; USCS soil classification, hammer blowcounts, laboratory fines content, collar elevation, bottom elevation, and offset distance from section or profile line. The sections and profiles were converted to x, y, z tables in Microsoft Excel and imported into the EVS data format.

Seven general stratigraphic units are described below, based upon consolidation of numerous sample descriptions within each layer. The descriptions are necessarily broad because they describe alluvial deposits that have some degree of variability with depth and lateral extent, both parallel and perpendicular to the channel.

- **Fill:** This unit is primarily levee construction soils excavated from nearby channel, composed of mixtures of sand, silt, and clay. Locally, this includes fill placed for roads or other purposes.
- **Post-1850 Alluvium:** This uppermost stratigraphic unit is sandy and crops out mainly between the current channel banks except downstream of the Howe Avenue bridge where it extends to the right edge of the model, beyond the land side toe of the right bank levee. This unit is primarily composed of silty fine sand, fine sandy silt, silt, and clean fine to medium grained micaceous sand. This unit is not defined by exploratory soil boring data primarily because it is located where it was difficult to drill soil borings: on mid-channel bars and along the inner edges of the high-flow channel margins.
- **Silty sand, sandy silt, silt, sand (three SS subunits):** This unit is primarily composed of sand and silty sand with SM and SP-SM classification with lesser amounts of poorly-graded sand (SP) and sandy silt (ML). This unit locally was described as containing thin lenses of clayey gravel (GC) and low-plasticity clay (CL).
- **Sand (three S subunits):** This unit is primarily composed of poorly-graded sand (SP) with slightly lesser amounts of silty sand (SM) and sand with silt (SP-SM). Thin, discontinuous lenses of low-plasticity sandy clay (CL), clayey sand (SC), and gravels (GM to GP) are occasionally present.

- **Silty clay, sandy clay, clay, and silt (five CS subunits):** This unit is primarily composed of low-plasticity clays and silts (CL) and (ML) with varying amounts of sand. Locally. this unit contains thin, discontinuous lenses of gravelly clay to clayey gravel (CL to GC), clayey sand (SC), and silty sand (SM).
- **Boulders, cobbles, gravel with sand (three BCG subunits):** This unit is primarily composed of well-rounded very coarse materials. These materials were difficult to sample, even with the sonic drill rigs because of the hardness of the cobbles and boulders. The boring logs classify these materials primarily as poorly- to well-graded gravels (GP to GW), and silty gravels (GM), with lesser amounts of poorly-graded gravels and silty gravels (GP-GM), and boulder/cobbles. Lenses of other finer grained materials were occasionally present within these coarse layers.
- **Clay (one C subunit):** This unit was only differentiated in two borings on the left bank near LM 9.6. It consists of a 3-to 4-foot-thick layer of fat clay.

The areal distribution and grain size of the alluvial deposits beneath the study reach reflect a complex history of erosion and deposition. There are clayey deposits, bouldery/cobbley deposits, and a variety of sedimentary layers with grain sizes in between. Relatively thin, discrete layers of alluvium can be identified in the boring logs. These layers are not always traceable between exploratory borings that are many hundreds of feet apart and are too thin for resolution of the model, but are important to identify as they relate to depositional and erosional processes. The larger-scale stratigraphic units composed of predominantly similar materials (but containing thin, heterogeneous lenses) can be projected from beneath one levee, across the river, and under the levee on the opposite bank. These larger packages of mostly similar deposits are what make up the units in the 3D model.

Each of the main stratigraphic units except the Post-1850 Alluvium appear to accrete in a downstream direction, where they are then overlain by the next younger unit. There is no unit younger than the Post-1850 Alluvium. This shows that at certain times, deposition of units of differing grain sizes was happening concurrently along the American River. However, the presence of the study area-wide lower clay and silt layer in the model appears to indicate that nearly this entire area was a distal fan environment for an extended period of time earlier in the Pleistocene epoch. The nearly continuous boulder/cobble/gravel layer reflects a period when discharge was sufficiently high that flow velocity and depth created shear stresses capable of transporting these large clasts. This may reflect the influence of climate change at the end of the last glacial period, about 10 to 15 thousand years ago.

The erosionally-resistant surface appears to be relatively continuous across the site and to have a downstream slope that is roughly parallel to but slightly steeper than the alluvial deposits and the modern active channel. The erosionally resistant materials observed exposed in the channel are relatively fine-grained silty sands and sandy silts that are predominantly uncemented. The top of the erosionally-resistant surface appears to have relief that may be the result of several factors. The most likely is the possible erosion that may have occurred in the past before this surface was buried or in modern time once the surface became exposed. This explanation fits areas where the erosionally-resistant boundary cuts sedimentary units (see Figure 3-4). The nearly ubiquitous presence of a coarse boulder/cobble/gravel layer on top of the erosionally-resistant surface would have required high discharge velocities and shear stresses to mobilize, and these forces could have eroded the top of the erosionally resistant surface. Another possible source of the relief visible on the top of the erosionally-resistant surface is due to the limitations of the input data, primarily the dependence on boring log information and the challenge of extrapolating a potential erosionally-resistant surface elevation where little information related to cementation or resistance to erosion is provided.

Figures 3-4 and 3-5 are examples of cross sections generated from the 3D stratigraphic model depicting the layer discussed above. Figure 3-6 provides a graphical legend for stratigraphic units displayed in the cross sections. Figures 3-4 and 3-5 are looking downstream.

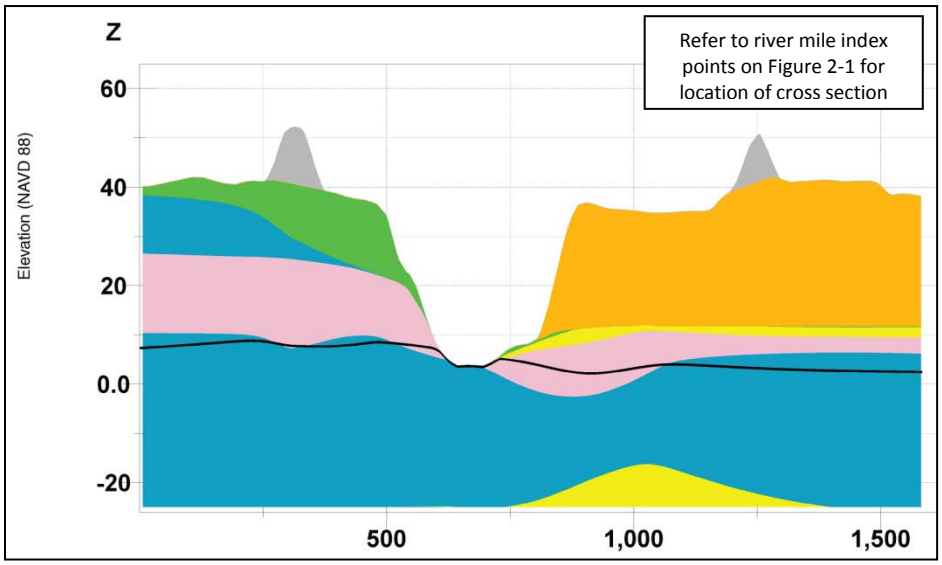

Figure 3-2. 3D Stratigraphic Model Section 11 Near RM 7.2

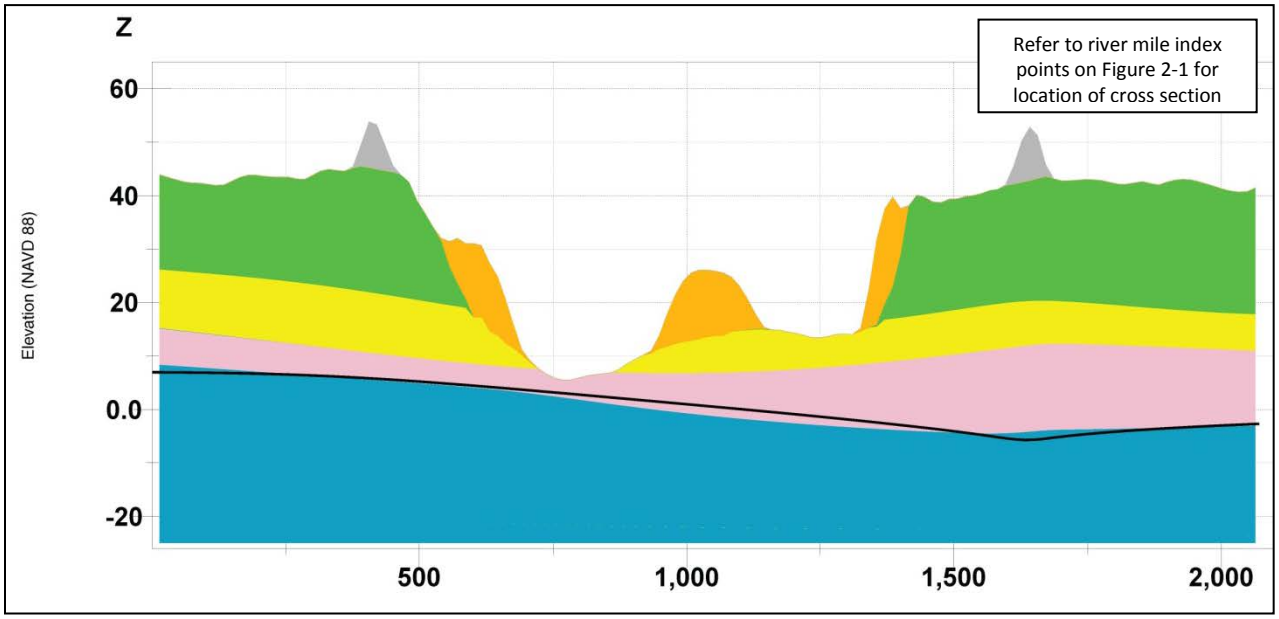

Figure 3-3. 3D Stratigraphic Model Section 15 Near RM 7.9

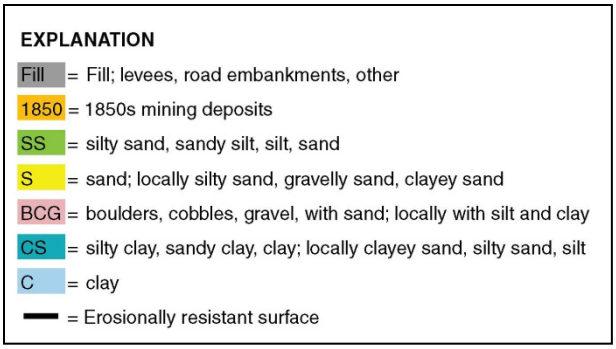

Figure 3-4. 3D Stratigraphic Model Unit Legend

3.3 Sacramento River South Geologic and Geotechnical Characterization

The Sacramento River has irregular sinuosity south of the confluence with the American River, with both large and small radius-of curvature meander bends. The river has, in places, laterally migrated over the past thousands of years, with erosion occurring on the outsides of bends, and deposition of younger sand-rich sediment occurring on the insides of the river bends. Geologically older and erosion-resistant Riverbank Formation is present at the ground surface south and east of the city of Sacramento, and younger alluvium is inset into this formation. Additionally, because of the low topographic position and proximity to the confluence of the two large rivers, the Sacramento area has been subjected to repeated inundation by floodwaters during the past several thousand years. The floodwaters deposit fine sand and silt-rich alluvium along the flanks of the river bank and finer-grained clay and silt are carried in suspension onto the distal floodplain. This hydraulic sorting process creates a 'natural levee' landform with a topographic gradient that slopes away from the river. Consequently, the levee is underlain by a variable, relative thick, and relatively young, sandy and silty, unconsolidated alluvial deposits.

South of the confluence of the American River, the Sacramento River demonstrates a complex relationship of fluvial deposits at the surface and beneath the eastern floodplain of the Sacramento River. The surface and subsurface distributions of sandy and clayey deposits are a function of former river positions on the landscape, and present-day geomorphic processes adjacent to the river channel. The levees are underlain entirely by geologically young, unconsolidated, silty and sandy fluvial deposits.

In general, the deposits beneath the eastern floodplain of the Sacramento River consist of three or four fluvial stratums in the following sequence, described from ground surface downward. The top-stratum, consists of very loose and very soft silt, sandy silt, with thin, laterally discontinuous clay and sand lenses. This stratum was laid down during the Holocene as overbank and flood basin deposits and represents vertical accretion of the natural levee and floodplain surface over the past several thousand years. Beneath the silty top-stratum is a stratum of coarser-grained sediment that ranges in consistency from medium dense fine-to-coarse grained clean sand, sandy silt, and localized occurrences of pebbles, gravels, and cobbles. This stratum is interpreted as latest Pleistocene Modesto Formation (upper member), which was deposited as meander scrolls and channels from lateral migration of river channel(s) across the former valley surface. Underlying this sandy unit is a stratum of gravel that may or may not be the lower member of the Modesto Formation. The gravel is laterally extensive near the American River confluence. In the south part of the study area (Pocket area), this gravel is not present or it exists only in local patches within older channels. Within the Pocket area, a medium stiff to stiff fine-grained (clayey silt, silty clay) stratum, with local gravel patches, discontinuously underlies the

more-permeable sands of the second stratum. This fine-grained stratum is distinctly denser than the top-stratum, and may represent lower Modesto Formation flood basin deposits on the earlier valley floor, in former low lying areas adjacent to the river channel. Underlying the upper three unconsolidated sequences is a hard, moderately-cemented silt to siltstone. This unit has been correlated to the upper member of the Riverbank Formation. Thus, the upper member is inset to the lower member of the Riverbank Formation. It is permissibly older, perhaps the latest Pliocene-early Pleistocene Laguna Formation.

4 Hydrology and Hydraulics

4.1 Flow Frequency and Duration

As discussed previously, the American River levee system was originally intended to convey a discharge of 115,000 cfs. When the Joint Federal Project (JFP) is completed at Folsom Dam, in combination with levee repairs currently being completed under the Common Features Project (and other authorities) and the dam 3.5 foot raise, the intent is for the river to be able to convey a discharge of 160,000 cfs, assuming that the levees do not fail from one or more of the potential failure modes (i.e., seepage, stability, insufficient height, or erosion). Please refer to Section 6.5 for a discussion on the feasibility design considerations.

In addition, modifications of Folsom Dam operations will shift the way floods are released into the lower river from Folsom Dam. Specifically, frequent flood events, that is, floods which occur say once in every ten to twenty-five years, will have a larger peak discharge compared to those under current dam operations. Table 4-1 lists a sample of the current and future peak discharges for a range of n-year flood events. This information is taken from the ARCF GRR study to remain consistent. The Folsom Water Control Manual Update will likely update these values as part of their evaluation.

In addition, modifications of Folsom Dam operations will shift the way floods are released into the lower river from Folsom Dam. Specifically, frequent flood events, that is, floods which occur say once in every ten to twenty-five years, will have a larger peak discharge compared to those under current dam operations. Table 4-1 lists a sample of the current and future peak discharges for a range of n-year flood events. These values are from the ARCF GRR study to maintain consistency and it is anticipated that the values will be updated as part of the Folsom Water Control Manual Update evaluation.

Table 4-1. Comparison of peak discharges between with- and without-project conditions

Flood Event	Peak Discharge (cfs)	
	Current Conditions[2]	Future Conditions[3]
50% (1/2) ACE (2-year)	30,200	25,200
10% (1/10) ACE (10-year)	43,100	71,700
4% (1/25) ACE (25-year)	99,700	115,000
2% (1/50) ACE (50-year)	115,000	115,000
1% (1/100) ACE (100-year)	145,000	115,000
0.5% (1/200) ACE (200-year)	320,000	160,000

The important point here is that under future operating conditions to meet the goal of increased flood damage reduction, larger flood flows will need to be conveyed through the American River with greater frequency compared to past operating conditions. These higher flood flows will exert additional pressure on the banklines and levees resulting in greater erosion, sediment transport, and potentially, modest changes to the planform of the low-flow channel.

[2]Draft values based on NA1 HEC-RAS modeling using the American River storm centering.
[3]Draft values based on the American River Common Features "With-Project Condition" HEC-RAS modeling using the American River storm centering and assuming that the dam 3.5' raise is in place.

In addition, durations of the larger peak flows have been tabulated for both the without-project condition (see Table 4-2) and for the with-project condition (see Table 4-3). The values for the without-project condition are of the same order magnitude as the durations listed in Table 1-1 for the significant historic flood events in which significant volumes of channel erosion occurred. However, the with-project durations (Table 4-3) are much greater for the 1 and 0.5% ACE events compared to the without-project values (Table 4-2). Duration of the flow is directly related to the volume of erosion which can occur. The flow durations are a source of uncertainty in the project performance since the channel will be expected to convey large peak flows (i.e., some in excess of historic floods) for durations substantially longer than the durations of historic peak flood flows.

Graphical comparisons of with- and without-project hydrographs are illustrated in Figures 4-1 through 4-3 for selected n-year events. The without-project hydrographs are depicted with blue lines and the with-project hydrographs with red lines.

Table 4-2. Durations of without-project peak discharges for n-year events

Synthetic Flood Event	Approximate Duration (hrs)[4]			
	90,000 cfs	115,000 cfs	>115,000 cfs	160,000 cfs
50% (1/2) ACE	---	---	---	---
10% (1/10) ACE	---	---	---	---
4% (1/25) ACE	23		---	---
2% (1/50) ACE	63	48	---	---
1% (1/100) ACE	120	91	43	---
0.5% (1/200) ACE	135	103	60	29

Table 4-3. Durations of with-project peak discharges for n-year events

Synthetic Flood Event	Approximate Duration (hrs)[5]			
	90,000 cfs	115,000 cfs	>115,000 cfs	160,000 cfs
50% (1/2) ACE	---	---	---	---
10% (1/10) ACE	---	---	---	---
4% (1/25) ACE	50	41	---	---
2% (1/50) ACE	88	74	---	---
1% (1/100) ACE	142	133	---	---
0.5% (1/200) ACE	171	163	55	31

[4] Draft values based on the American River Common Features "Without-Project Condition" HEC-RAS modeling using the American River storm centering.

[5] Draft values based on the American River Common Features "With-Project Condition" HEC-RAS modeling using the American River storm centering and assuming that the 3.5 ft dam raise is in place.

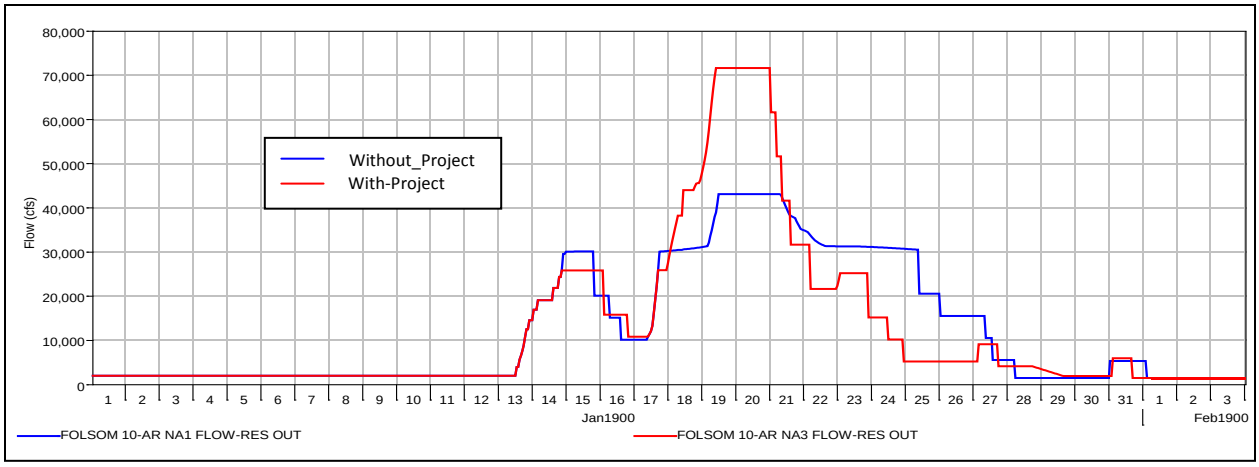

Figure 4-1. With- and without-project hydrographs for the 10% (1/10) ACE event on the LAR

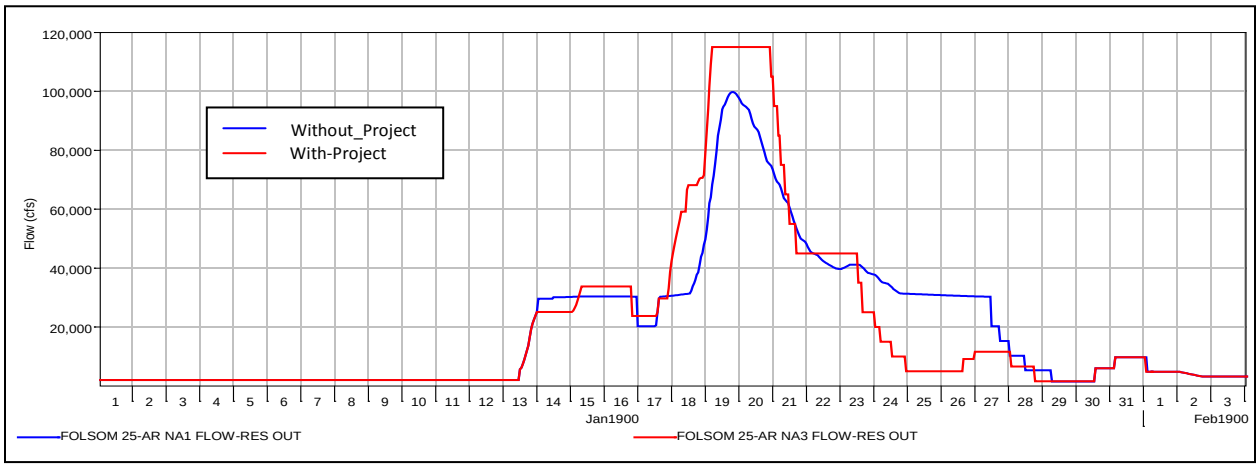

Figure 4-2. With- and without-project hydrographs for the 4% (1/25) ACE event on the LAR

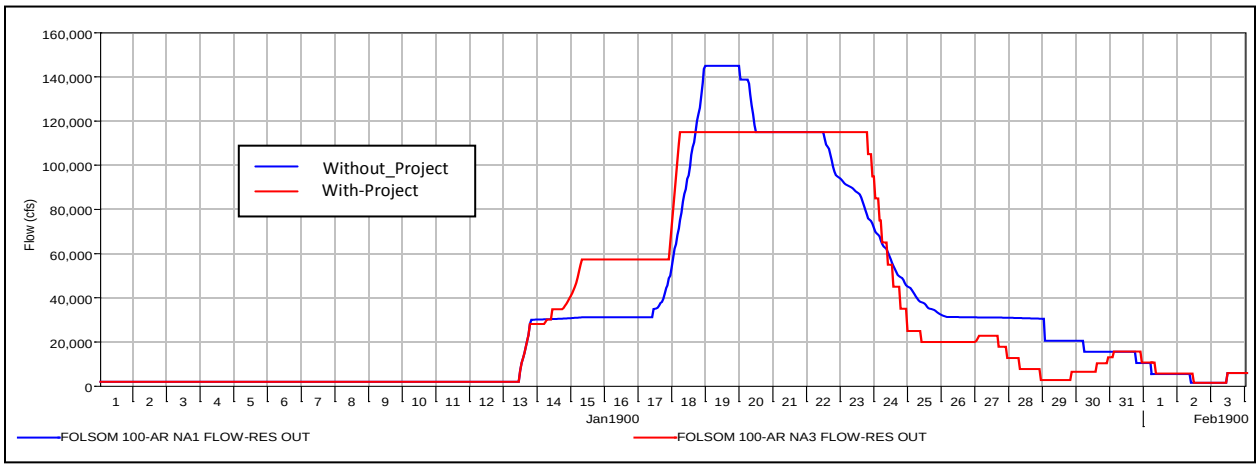

Figure 4-3. With- and without-project hydrographs for the 1% (1/100) ACE event on the LAR

4.2 Hydraulic Modeling Results

With- and without-project hydraulic analyses are presented in the Hydraulic Appendix Executive Report dated May 2013. Technical analyses therein consist of one-dimensional, unsteady HEC-RAS modeling for the channel hydraulics and quasi two-dimensional FLO-2D modeling for the overbank floodplains. Also included are analyses for quantifying uncertainties in the various hydraulic parameters and results. Please refer to that report for details and documentation of those efforts.

In order to get a more detailed estimate of the velocity and shear in the American River upon which the likelihood for erosion may be estimated, Ayres Associates performed two-dimensional modeling of the Lower American River using RMA-2 (Ayres 2004). This analysis was conducted for infrequent flood events specifically consisting of peak flows of 115,000, 130,000, 145,000, and 160,000 cfs. The areal extent of the modeling included the Lower American River between RM 0 and 14 and the Sacramento River approximately between RM 59.2 and 61.4.

Results of the two-dimensional modeling are presented in the report titled "Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events" dated July 2004 by Ayres Associates. Samples of the results from this analysis are shown in Figures 4-4 and 4-5. Specifically, Figure 4-4 shows the velocities for a discharge of 115,000 cfs which average about 6 to 8 ft/sec in the channel with maximum velocities ranging up to about 12 ft/sec. Figure 4-5 shows the velocities for a discharge of 160,000 cfs which average about 5 to 9 ft/sec in the channel with maximum velocities ranging up to about 13 ft/sec.

Of concern in both of these figures are the proximities of the relatively high velocities to the levees along the Lower American River. Additionally, the range of the computed velocities is of concern since the magnitude of the velocities is great enough to erode many of the relatively fine grained material present in the channel lining. Table 4-4 is an excerpt from Fischenich (2001) which lists the permissible shear and velocity for various materials. A review of this list coupled with the computed 2-D velocities and shears indicates that the large discharge events are capable of eroding the material typically found lining the Lower American River channel.

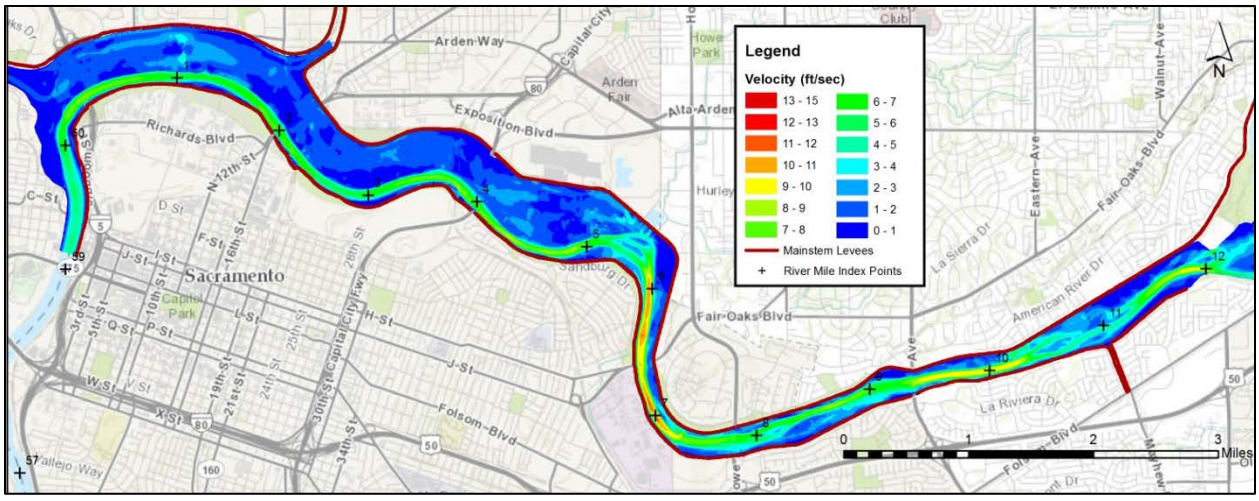

Figure 4-4. Two-dimensional velocities for a discharge of 115,000 cfs in the Lower American River

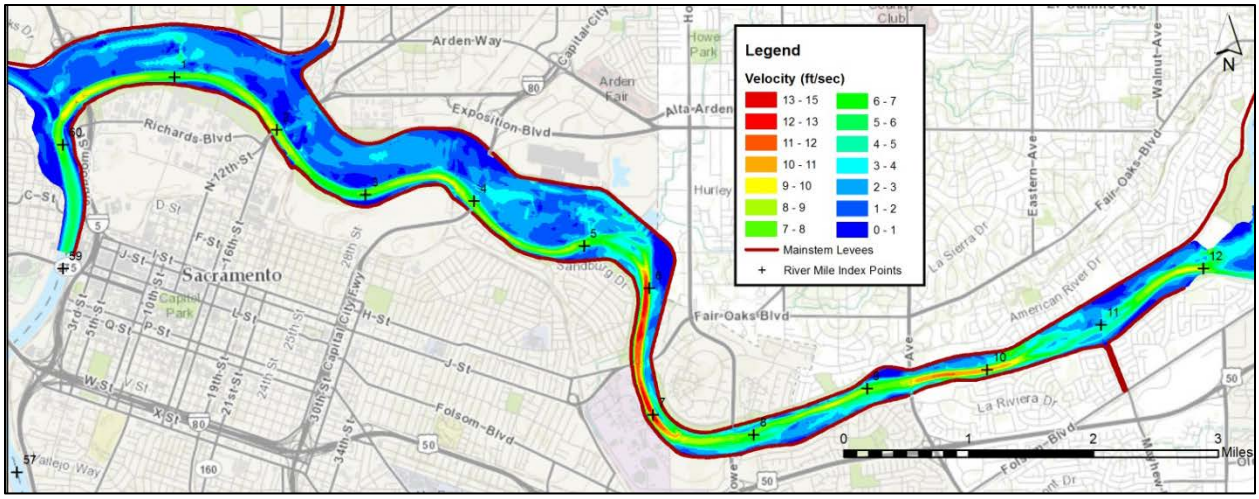

Figure 4-5. Two-dimensional velocities for a discharge of 160,000 cfs in the Lower American River

Table 4-4. Permissible shear and velocity for selected lining materials (Fischenich 2001)

Permissible Shear and Velocity for Selected Lining Materials[1]

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.38	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N
Temporary Degradable RECPs	Jute net	0.45	1 – 2.5	E, H, M
	Straw with net	1.5 – 1.65	1 – 3	E, H, M
	Coconut fiber with net	2.25	3 – 4	E, M
	Fiberglass roving	2.00	2.5 – 7	E, H, M
Non-Degradable RECPs	Unvegetated	3.00	5 – 7	E, G, M
	Partially established	4.0-6.0	7.5 – 15	E, G, M
	Fully vegetated	8.00	8 – 21	F, L, M
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E
Soil Bioengineering	Wattles	0.2 – 1.0	3	C, I, J, N
	Reed fascine	0.6-1.25	5	E
	Coir roll	3 - 5	8	E, M, N
	Vegetated coir mat	4 - 8	9.5	E, M, N
	Live brush mattress (initial)	0.4 – 4.1	4	B, E, I
	Live brush mattress (grown)	3.90-8.2	12	B, C, E, I, N
	Brush layering (initial/grown)	0.4 – 6.25	12	E, I, N
	Live fascine	1.25-3.10	6 – 8	C, E, I, J
	Live willow stakes	2.10-3.10	3 – 10	E, N, O
Hard Surfacing	Gabions	10	14 – 19	D
	Concrete	12.5	>18	H

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

A. Chang, H.H. (1988).
B. Florineth. (1982)
C. Gerstgraser, C. (1998).
D. Goff, K. (1999).
E. Gray, D.H., and Sotir, R.B. (1996).
F. Julien, P.Y. (1995).
G. Kouwen, N.; Li, R. M.; and Simons, D.B., (1980).
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K. Sprague, C.J. (1999).
L. Temple, D.M. (1980).
M. TXDOT (1999)
N. Data from Author (2001)
O. USACE (1997).

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5 Channel Stability and Erosion Assessment

Channel stability and erosion are interconnected but the terms “channel stability” and “erosion” need to be discussed for clarity. An unstable channel can be a channel with morphological changes that are so rapid that it generates public concern (ASCE 2008). A more scientific definition of an unstable channel is a channel that has abrupt, episodic, or progressive changes in location, geometry, slope, or planform pattern because of changes in water or sediment inputs or outputs (ASCE 2008). Channel erosion consists of erosion of the bed and banks by flowing water or collapse, slumping, or toppling of large masses of bed and bank material (ASCE 2008). While perhaps not typically considered erosion, slumping and toppling associated with river banks and sometimes in cohesive bed materials is an important consideration.

Channel stability depends on the time and space scale. The entire channel reach may be stable even though there are locations of instability, such as around bridges. Similarly, the channel may appear to be unstable over shorter periods of time but when viewed over a longer time frame the observed instabilities are oscillating around a long-term mean value. This last condition can be considered to be a state of dynamic equilibrium.

Channel stability and erosion of the Lower American River and Sacramento River in the Common Features GRR project area are discussed below in terms of vertical and lateral erosion, including some of the inter-connected nature of vertical and lateral erosion.

5.1 Vertical Erosion

Vertical erosion potential can be demonstrated for the American River by applying a qualitative general relationship originally proposed by Lane in 1955 (Lane 1955):

$$QS \approx Q_s d_s$$

Where:
Q = Water discharge
S = Slope of the channel
Q_s = Sediment discharge
d_s = Sediment diameter

Applying this to the Lower American River, the reduction of available sediment supply from construction of dams and erosion of the mining debris overtime (reduced Q_s), and increasing the magnitude of the lower discharge flood events that move the most sediment (i.e. cause the most erosion) over time corresponds to a coarsening of the river bed (increased sediment size), erosion of the channel (reduced slope), and increased flow depth with unpredictable shifts in channel width (ASCE 2008 page 476).

The evidence shows this expected vertical erosion occurred as anticipated from Lane’s relationship above. According to thalweg profiles compiled by various researchers, the channel of the lower American River degraded by up to 15-30 ft from the early 1900s to the late 1990s (NHC 2012). The reader is referred to NHC 2012 and NHC 2009 for other studies that corroborate this finding. See also Figure 5-1 and Figure 5-2 (Note elevations are in meters). The Sacramento River Bank Protection project’s sediment study indicates the Lower American River has degraded between 1997 and 2008 by

an average of 0.67 feet over the lower 3.7 miles. This degrading trend is shown in Figure 5-3 below (NHC 2012) (Note elevations are in meters). A similar degrading trend is also observed further upstream using a different approach. A plot of the changes in rating curve for the Fair Oaks gage on the American river indicates a general trend of erosion from 1986 to 2008 as shown in Figure 5-4 (NHC 2009). This general erosional trend is expected to occur in the future as indicated in Figure 5-5.

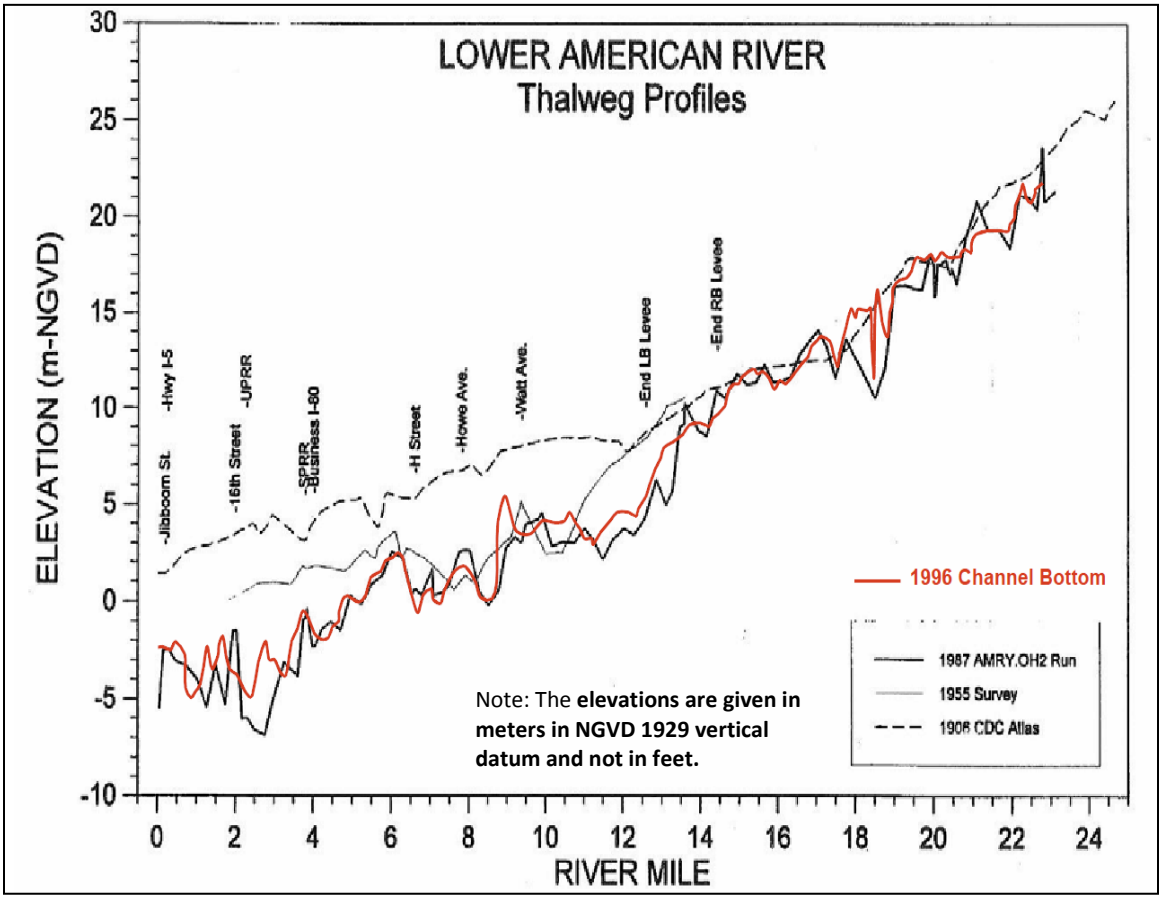

Figure 5-1. Historical profile of the Lower American River showing general degrading trend since 1906 (NHC 2009)

The Sacramento River discharge is also controlled by dams and should experience similar response to construction of dams as the American River. The same studies referenced above corroborate this trend for most of the Sacramento River. However, some reaches are aggrading and others degrading. The Sacramento River between Verona and the Sacramento Weir experienced a slight degradation trend between 1997 and 2008 while the portion from the Sacramento Weir to Freeport experienced aggradation as indicated in Figure 5-6. This may be due to the interaction of the Sacramento and American Rivers. During large flood events on the American River, water flows upstream in the Sacramento River and discharges over the Sacramento Weir. The sediment flowing from the American River and Sacramento River likely deposit in the reach between the Sacramento Weir and Freeport, contributing heavily to the aggradational trend noted between 1997 and 2008. This is a trend that seems likely to continue well into the future if no modifications are made to the system. Long term HEC-6T simulations show this same pattern after 50 and 100 years of simulation as shown in Figure 5-7.

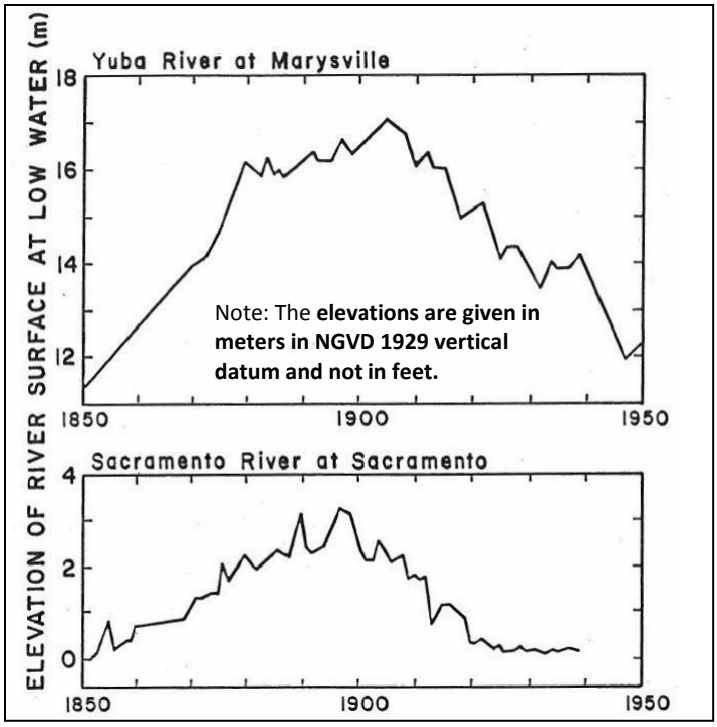

Figure 5-2. Historical water surface elevations on Yuba and Sacramento Rivers showing effects of deposition and erosion of hydraulic mining debris (developed by Meade 1982 from NHC 2009)

It is estimated that between 1 and 2.3 feet of aggradation will occur downstream of the Sacramento weir in the next 50 years. Implications for this aggradation are reduced capacity to pass flood flows. However, event specific simulations show this same reach degrades (0 – 1 ft of degradation estimated) following flood events (Figure 5-8). It is therefore possible that this long term aggradation does not significantly impact channel capacity during flood events as the floods may mobilize this sediment. This information together with estimated relative sea level rise and other pertinent information should be used to inform risk based decisions for both feasibility and design level study phases.

The future trend noted in Figure 5-5 does not include more recent data collected on the erosion resistant formation beneath the American River that could limit future vertical erosion. A more recent update of the model includes this new geotechnical information and draft results are shown below in Figure 5-9. The model used in Figure 5-9 includes the updated geotechnical information but has other differences with the model used in Figure 5-5. The significant differences between the models used for Figure 5-5 and Figure 5-9 are:

- Figure 5-9 model includes the updated geotechnical information while Figure 5-5 model does not

- Figure 5-9 model is based on synthetic event hydrology while Figure 5-5 model is based on actual historical hydrology

- Figure 5-9 model is "fixed" at the downstream boundary by a rating curve while the Figure 5-5 model is allowed to adjust dynamically based on changes to the Sacramento River (i.e. Figure 5-9 is not "linked" to the Sacramento River HEC-6T model while Figure 5-5 is).

Therefore the results depicted in Figure 5-9 cannot be compared directly with those shown in Figure 5-5. The amount of scour seems to be much less than previously predicted, which may be partially explained by model differences noted above. Despite these model differences, the average expected channel erosion for the Lower American River for 50 to 100 years of simulation is about 5 to 7 feet (see in Table 5-1). The results show it is possible the channel will degrade to the erosion resistant material between RM 6.5 and 10 (as shown in Figure 5-9). It is also possible that the bed will erode to the erosion resistant surface for portions of the reach above RM 15 (above where the current federal levees end); especially since the depth of active erosion likely exceeds that observed or predicted by the models. This makes protecting the levee toe critical for flood risk reduction and future degradation upstream of the levees may have detrimental impacts on environmental and recreational interests in that reach.

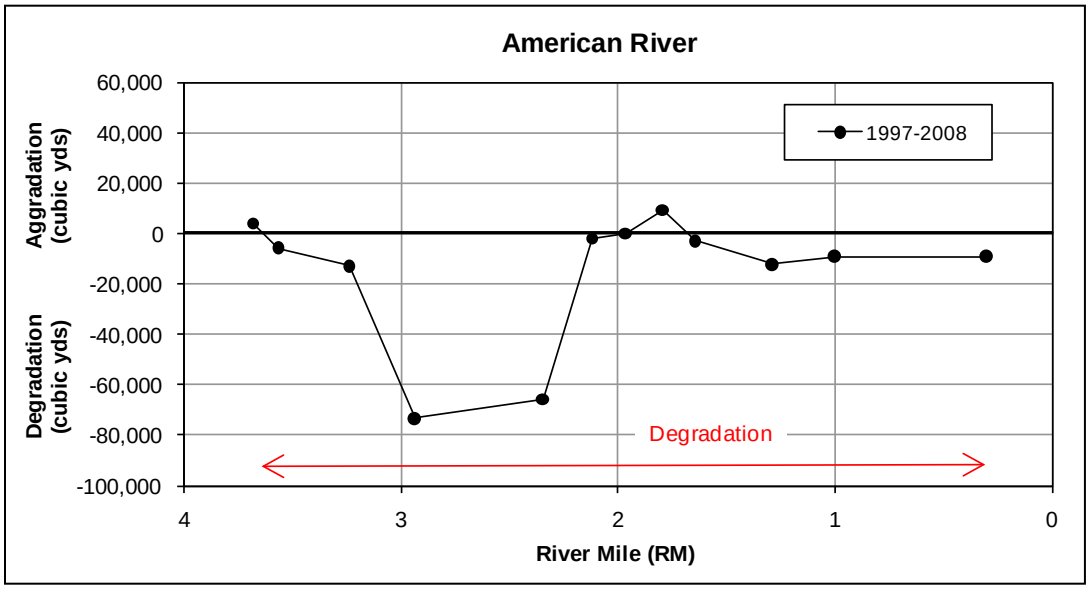

Figure 5-3. Aggradation/degradation trends for lower portion of the American River showing degradation between 1997 and 2008, supporting the trend noted in long-term HEC-6T simulations

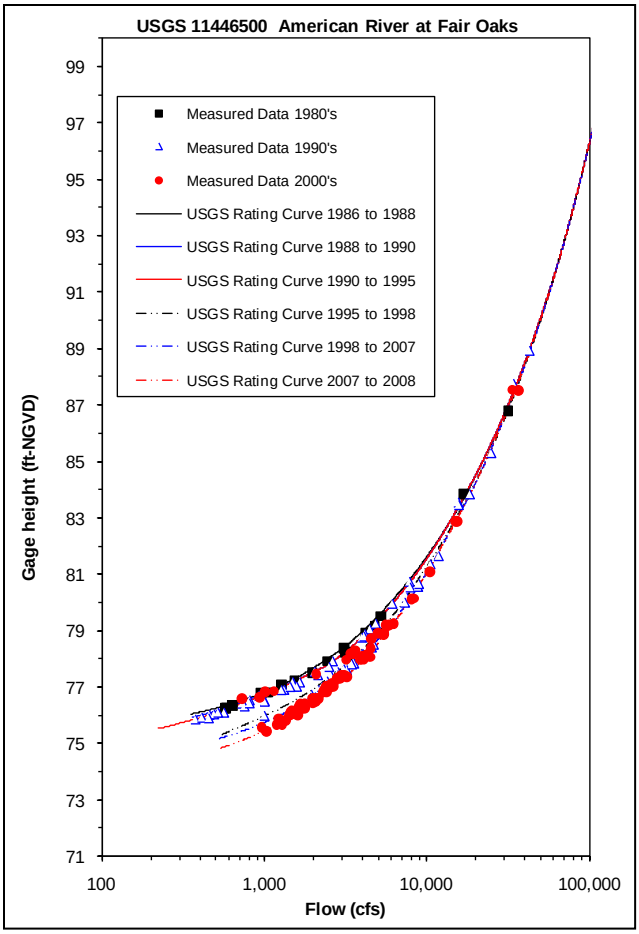

Figure 5-4. Stage versus flow plot of Fair Oaks gage on the American river indicating vertical erosion (reduction of water surface for the same discharge) from 1986 to 2008 (from NHC 2012)

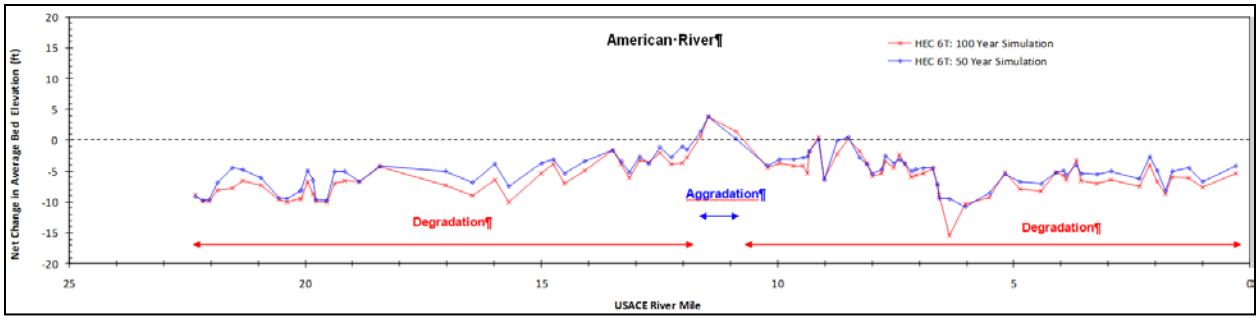

Figure 5-5. Net change in thalweg elevations and section-average bed elevations in American River (long-term simulations)

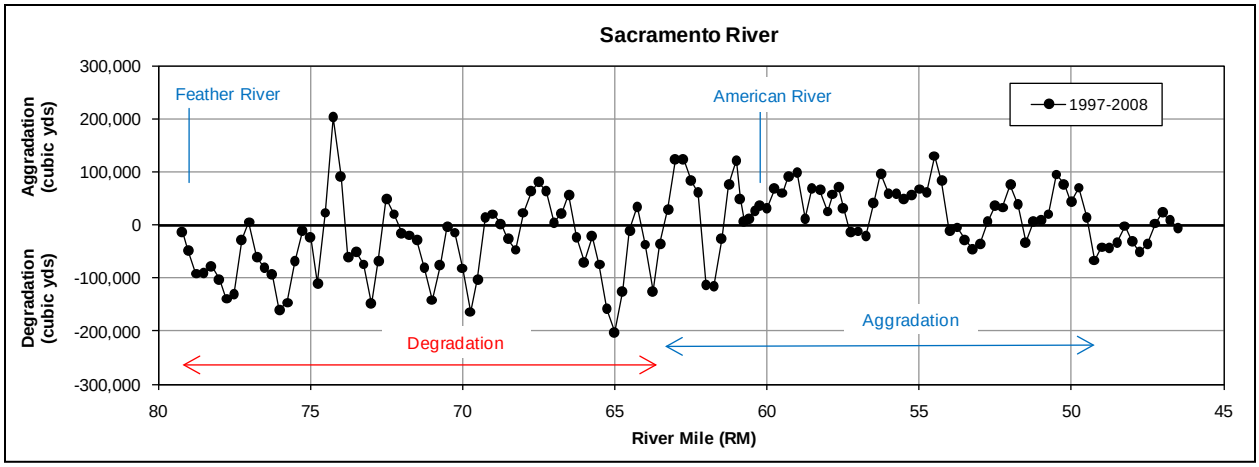

Figure 5-6. Aggradation/degradation trends of a portion of the Sacramento River showing aggradation between the Sacramento Weir and Freeport between 1997 and 2008, supporting the trend noted in long-term HEC-6T simulations

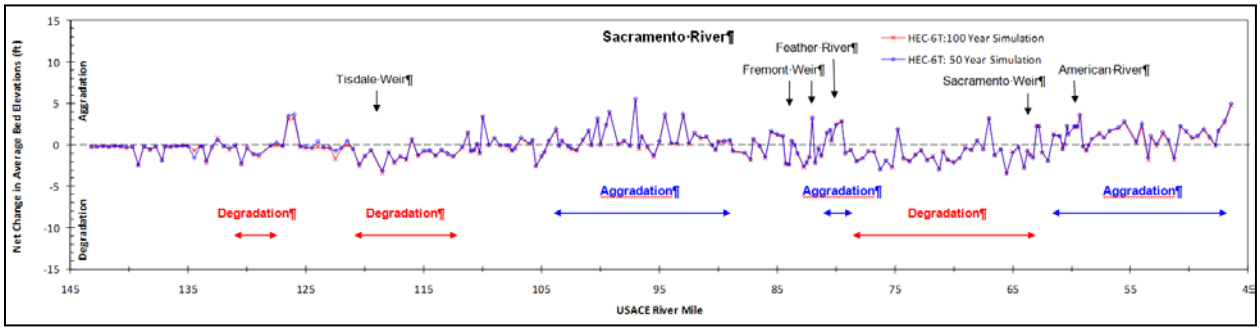

Figure 5-7. Net change in thalweg elevations and section-average bed elevations in Sacramento River (long-term simulations)

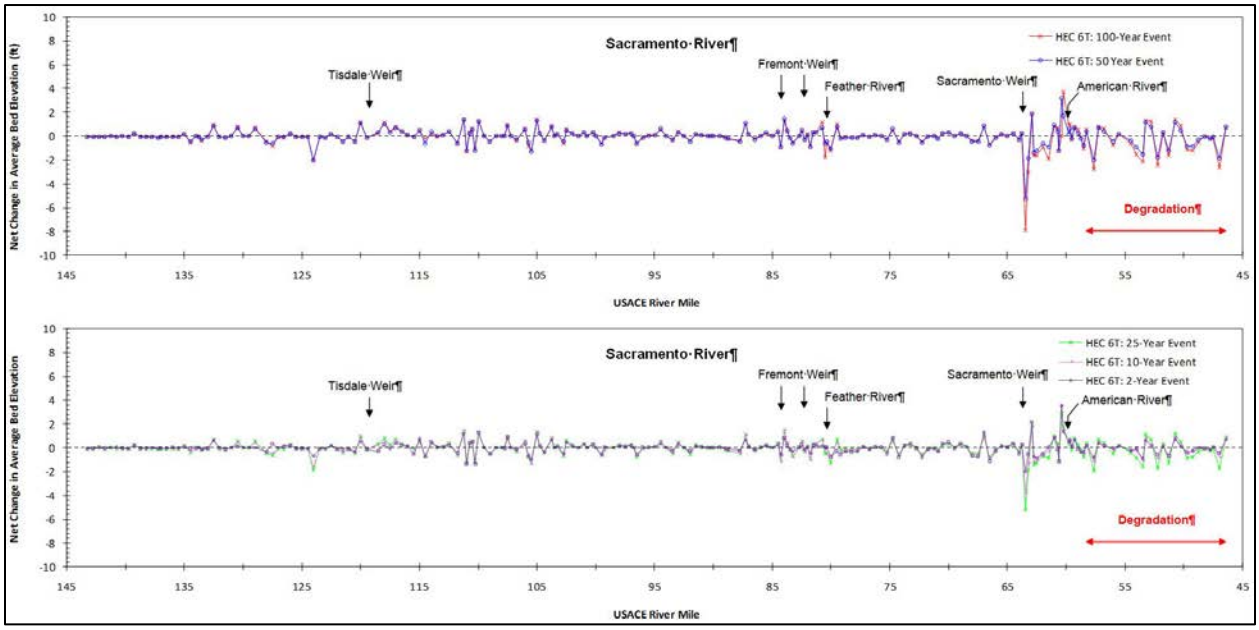

Figure 5-8. Results from single event HEC-6T simulations showing degradation between the Sacramento Weir and Freeport during individual flood events.

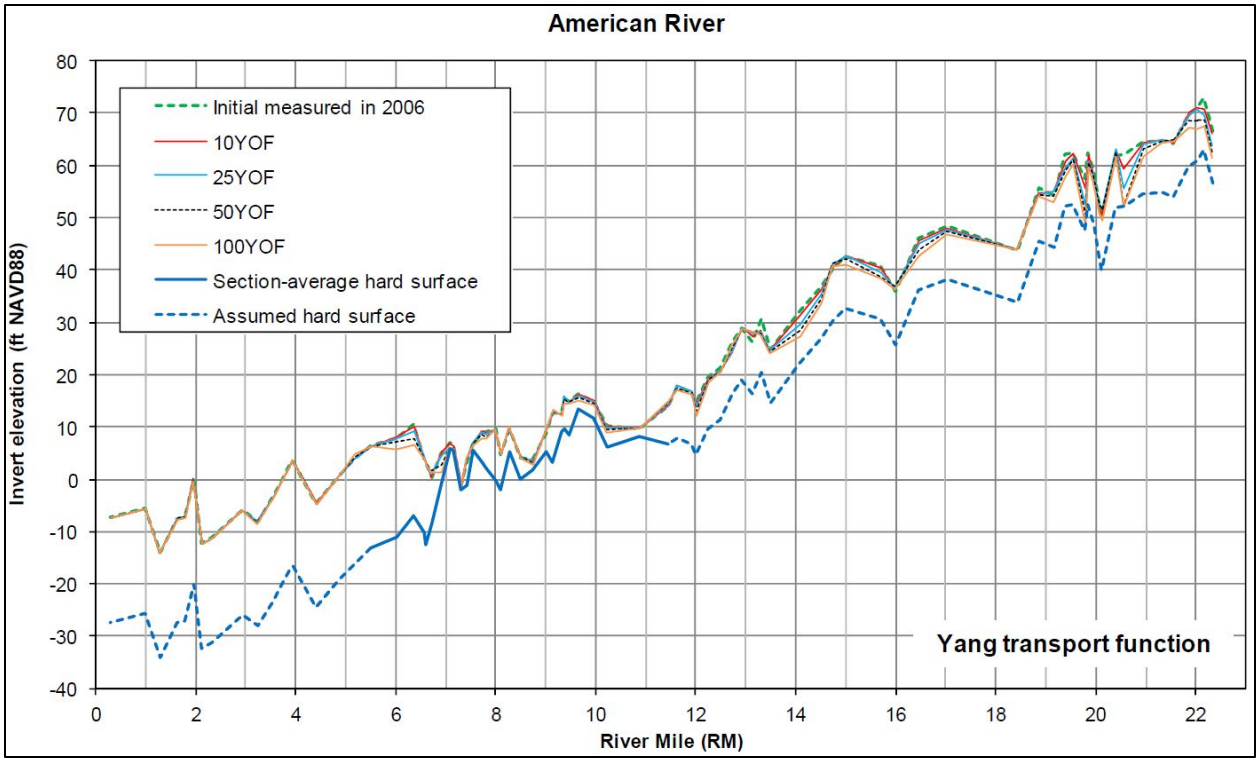

Figure 5-9. Draft results from simulation of a series of high flow flood events showing estimated erosion resistant material (e.g. Section-average hard surface).

Table 5-1. Simulated long-term bed aggradation and degradation for the American River by reach

American River				
River Mile	50-year simulation		100-year simulation	
22-20	-7.48	-7.30	-8.67	-8.48
20-15	-6.99	-5.70	-8.61	-7.21
15-10	-2.88	-2.08	-3.70	-2.72
10-5	-5.50	-4.88	-6.10	-5.57
5-0	-5.35	-5.67	-6.37	-6.79
Average	**-5.39**	**-4.83**	**-6.42**	**-5.84**

5.1.1 HEC-6T Model Sensitivity and Limitations

A series of sensitivity runs was performed for the 50-year period to evaluate effects of changing sediment supply on simulated bed profiles. Model sensitivity to changes in sediment supply was evaluated by increasing and decreasing upstream sediment inflows on the Sacramento, Feather, and American Rivers by 30%. The sensitivity test shows that the simulated hydrological changes generally tend to slightly increase the magnitude of long-term bed adjustments. The American River simulations are not sensitive to the upstream sediment supply because the supply is so small. For the Sacramento River, simulated degradation or aggradation generally increase from 1 to 5 ft, with a prevailing aggrading trend in the lower half of the study reach (less than 1 ft in the lower portion – which is the lower ½ of the reach from Colusa to Freeport).

A series of sensitivity runs was performed for the 50-year period to evaluate effects of climate changes on simulated bed profiles. Model sensitivity to climate changes was simulated by arbitrarily increasing the 30 highest flows in a given year by 1/3 and decreasing the other flows such that the total annual runoff did not change. The effect of future sea level rise on sediment transport conditions was assumed to be insignificant. This assumption is validated by a relative sea level rise analysis conducted for the Sacramento River Bank Protection project. The sensitivity test shows that the simulated hydrological changes generally tend to slightly increase the magnitude of long-term bed adjustments. The overall pattern in long-term evolution of the bed profile, however, does not change significantly. For the Sacramento River, simulated degradation or aggradation generally increase from 1 to 5 ft, with a prevailing aggrading trend in the lower half of the study reach. In general the simulated changes in hydrological conditions appear to have less significant effect on channel evolution trends compared to the simulated changes in sediment inflow. For the American River, bed degradation for the climate change scenario increases by up to 1-4 ft, particularly for the lowermost portion of the study reach.

These results assume that the hydrology, including operation of Folsom Dam, are identical to the years 1997 – 2008 and repeated for the next 50 and 100 years. Actual results will be different due to uncertainty in future hydrology, anticipated changes to operations of Folsom Dam, and uncertainty of sediment and geology conditions. In general, increased discharge from Folsom Dam is expected to exacerbate the amount of aggradation/degradation in the Sacramento and Lower American River. The HEC-6T model developed by the ARCF GRR (e.g. Figure 5-9) used hydrology that is thought to be representative of changes to operations at Folsom Dam.

It is important to consider that HEC-6T does not simulate local scour or local deposition, bank erosion, natural adjustments in channel widths, or lateral movement of the channel. These other factors are important considerations but are not possible to model concurrently at this time. It should be noted that the channel of the lower American River is highly irregular at many locations (especially in braided reaches upstream of RM 8). These irregular reaches may not be adequately represented in the 1-d HEC-6T model. Therefore, results obtained for the irregular reaches may be subject to simulation errors and should be treated with caution. In general, however, degradation predicted by the model for the lower American River (the HEC-6T model developed for the Sac Bank Project, see Figure 5-5) agrees with the stage-discharge records obtained for the American River gage at Fair Oaks which shows ongoing channel degradation. It should be noted that the HEC-6T model was developed and calibrated primarily for long-term simulations with gradually varying flows and gradual bed adjustments and therefore may be inaccurate for flood-event simulations with rapid changes in flows and rapid bed elevation changes. Along with these limitations, natural variability adds uncertainty to the results. Therefore, results obtained from flood event simulations should be regarded as approximate. The results should also be viewed as reasonable approximations of future trends.

The HEC-6T erosion studies do not consider risk to project levees from other sources such as boat wakes, wind waves, local scour at tree roots or fallen trees, etc. The degradation can also undermine bridges and other structures in or crossing the channel. Site-specific analysis is needed during design for structures such as bridge piers to account for local scour and overall erosion.

5.1.2 Grade Control Considerations

Erosion into the cohesive resistant material is affected by water quality, material history such as weathering, and macro-scale properties such as zones of weakness. The modeling indicates that

expected erosion into the erosion resistant layer is minimal to none. However, there is spatial variability in the material properties and weak zones within the material that may accelerate the overall erosion of this material due to macro-scale processes such as toppling of weakened exposed blocks. In addition, sediment movement during floods can increase erosion beyond the expected clear-water scour limits since the sediment acts as a "sand-blaster" on the erosion resistant material. Given this uncertainty, it is important to consider the possibility of some scour into this erosion resistant layer during future studies, such as for analysis of bridge piers. The underlying erosion resistant layer likely will erode more slowly than less resistant material, but the ultimate equilibrium depth of scour may not be different from a less erosive resistant layer. However, the time required to erode to the equilibrium depth may exceed the expected life of the project and is not expected to occur under a single event. Therefore, it is reasonable to proceed without structural features at this time. Monitoring of the various sites should be included as part of the Operations, Maintenance, Repair, Replacement and Rehabilitation (OMRRR) effort under the project.

The addition of any grade control features on the American River is not currently part of Alternative 1 or 2, or the recommended plan. While the need for future grade control due to erosion of the erosion resistant layer cannot be ruled out, it is considered a lower risk to not include this feature in the tentatively selected plan. It is expected that any issues with erosion into the erosion resistant material will be noticed during regular infrastructure monitoring and necessary OMRRR actions taken in a timely manner to protect levees and other infrastructure as needed due to the expected relatively slow rate of erosion. As previously mentioned, the analysis does not indicate significant erosion of this layer and so the rate of erosion is likely small enough to allow for timely future remedial action if necessary. The panel experts are in disagreement over the need for grade control, with a majority not recommending any features, and the rest saying that there is not enough information to make a conclusion. In addition, including a grade control structure guarantees financial expenditure to address an issue that may not be needed and will create additional impacts to the channel and environment, such as accelerated local erosion downstream of the structure and reduced ecosystem function (e.g., impaired aquatic organism movement). Therefore, not including grade control in the Alternative 1 or 2, or the recommended plan is considered lower risk than including it in the same plans. Not including the grade control is a residual risk to be addressed at some point in the future.

Overall the Sacramento and American River reaches in the Common Features GRR are in an overall degrading state with the American River expected to degrade much more than the Sacramento River. Grade control is not anticipated to be necessary but the need for this should be monitored as part of routine operation of the constructed project.

5.2 Lateral Erosion

Lateral erosion can be the result of channel planform adjustments, changes to the vertical channel profile, or from localized features such as bridges and pipes in the channel. Lateral erosion from local features needs to be considered during future studies and will not be discussed further in detail. Channel planform adjustments that can cause lateral erosion may include river bends migrating outward toward the banks and/or downstream, braided channels attacking the banks, and channel avulsion during a flood event. Changes to the vertical channel profile include aggradation or degradation in response to river channel changes.

5.2.1 Lateral Erosion Potential from Vertical Erosion

As indicated in Section 5.1, the LAR downstream of Folsom Dam has incised into the sediment deposited from the gold mining of the 1800's. An appropriate conceptual model therefore is the Channel Evolution Model (CEM) shown in Figure 5-10. As the channel incises (stage II), the banks are steepened until the banks fail, widening the channel (stage III). Eventually the erosive shear stresses along the channel are reduced along with the ability of the water to remove the sediment from the failed banks. This leads to accumulation of material within the channel that begins to form a new floodplain but also continues to erode the banks (stage IV). Finally a new stable state of dynamic equilibrium is reached (stage V).

Based on the Channel Evolution Model, it is anticipated that channel widening will occur downstream of Folsom Dam as a result of Folsom Dam construction. This is a simplification of complex local processes but shows the long-term expected response for the Lower American River. Similarly, the degradation of the Sacramento River between Verona and the Sacramento Weir noted in Section 5.1 indicates this reach is at risk of lateral erosion as well.

Historic cross-sections at Hazel Street on the Lower American River (see Figure 5-11) illustrate the general trend of the channel degrading and widening consistent with the channel evolution model. This cross-section appears to show this channel at this location in 1992 was in stage III or IV of the channel evolution model and is not stable. Other historical cross-sections show a similar trend indicating possible channel instability. There could also be local instabilities in these selected cross-sections that are not indicative of the entire reach. However, the overall collective information seems to indicate the Lower American River has been unstable in the past and may be widening or stabilizing (phase III or IV) now and in the future.

While some of the levees may be protected from lateral erosion, the 1986 flood indicates that unprotected levees on the Lower American River are still at risk of failure from lateral erosion (see Figure 1-6).

Similar to the Lower American River, the Channel Evolution Model indicates channel widening potential between Verona and the Sacramento Weir due to degradation. The reach between the Sacramento Weir and Freeport is already relatively confined by levees and it is possible the long-term aggrading trend shown in Figure 5-7 becomes degradational during individual flood events. This is supported by HEC-6T model results that show long-term aggradation for this reach (Figure 5-7) but degradation during an individual flood event (Figure 5-8). The Channel Evolution Model is applicable to long-term trends and not individual flood events. However, it is reasonable to conclude the degradation expected in this reach during a single flood event could destabilize channel banks that exceed a critical height threshold, leading to bank failure and channel widening at least in localized areas. Further, Therefore channel widening could be a possible long-term result for this reach as well due to destabilization of channel banks from degradation during flood events. This observation indicates lateral erosion and channel widening can reasonably be expected for both the Lower American River and Sacramento River within the Common Features GRR project.

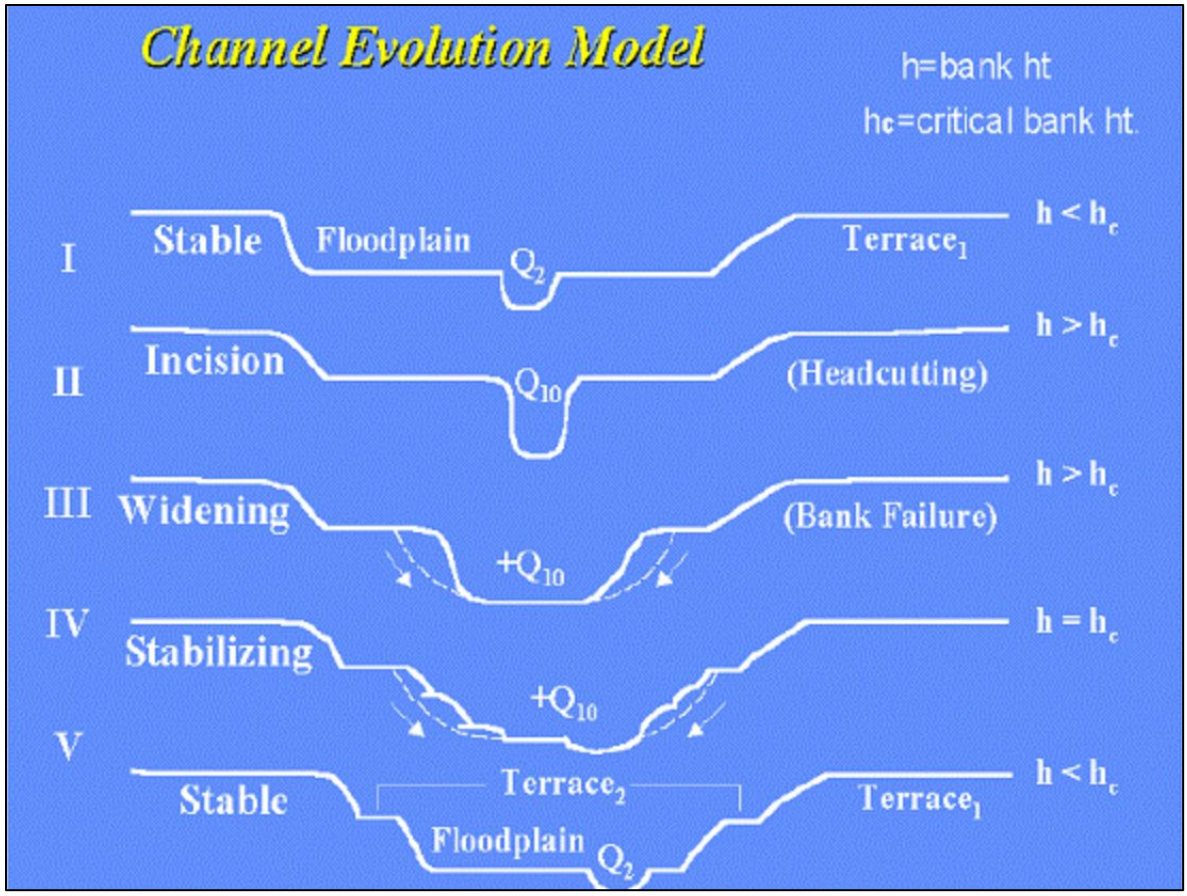

Figure 5-10. Channel Evolution Model describing how a stable channel responds to a disturbance that causes channel incision before reaching a new stable dynamic equilibrium

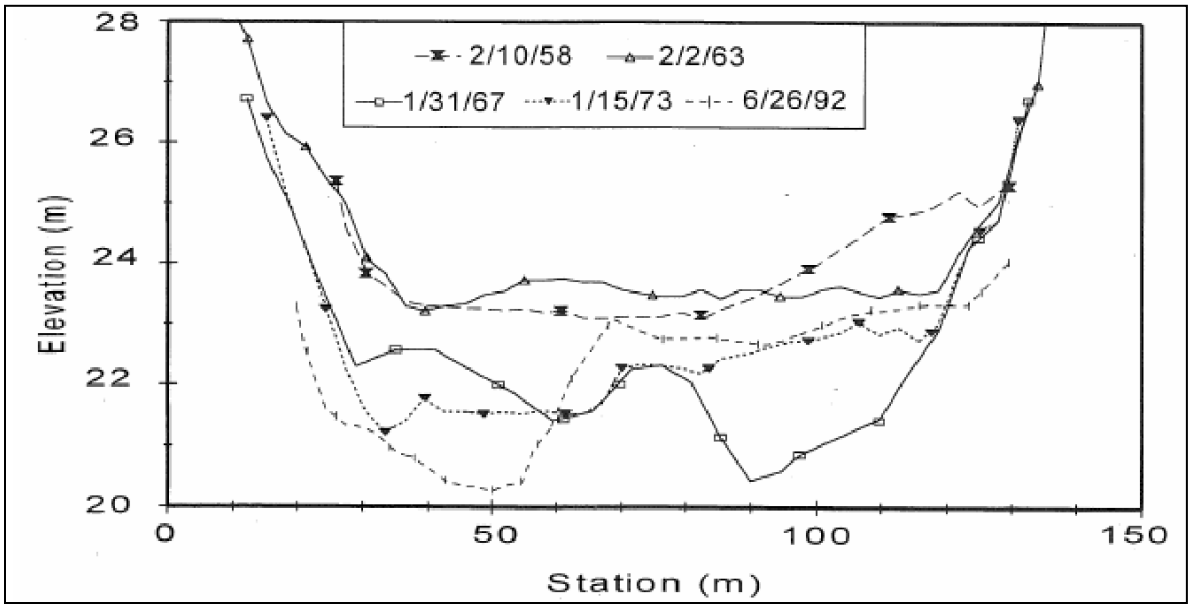

Figure 5-11. Historical erosion at Hazel Street showing vertical and lateral erosion, which shows Channel Evolution Model trends (developed by James 1997 in NHC 2009). Note distances elevations are in meters

This assessment is consistent with the findings of a bankline migration analysis conducted by NHC using historical maps and aerial photography from 1949 to 2005. This analysis shows that the average low flow channel width of the Sacramento River reach between Verona and Freeport increased about 5% to 10% during this time period. Confinement of flows by levees and changes in hydrologic conditions, caused principally by Shasta Dam and the Trinity Diversion, are thought to have contributed to the observed width increase during this time period. Similarly, the analysis of the channel shift maps indicates that there has been about 4% decline in surface area at the 40 largest overbank berm sites in the Sacramento River between Colusa and Freeport. The observed loss of the overbank berms is mostly related to the increase in channel width between 1949 and 2005.

5.2.2 Lateral Erosion Potential from Planform adjustments

Lateral erosion can also occur as a result of natural river channel planform movement such as actively migrating river meanders, braided channels directing flow at the banks, and channel avulsions during flood events. Ayres conducted a bankline shift analysis of the Lower American River from 1957 to 1998 which was updated by NHC in 2010. The NHC analysis indicates that there was no observed bankline shift in the Lower American River between 1998 and 2010. NHC concluded that while there are currently no actively migrating meander bends on the Lower American River, large floods have caused significant instream changes between the channel banklines in the past. It is also noted that lateral erosion and bankline shift is occurring on the Lower American River, but on a scale too small to be accurately identified by air photo interpretation. This is because erosion is often occurring in vertical cutbanks obscured by tree canopy, making them difficult or impossible to see in air photos. In addition, the rate of erosion may not be discernible due to the resolution of the air photos.

NHC also conducted bank migration analysis for the Sacramento River using air photos from 1949 – 2005. Analysis of these maps indicates that significant (>150 ft) river channel shifting has occurred since 1949 over only about 12% of the Sacramento River between Colusa and Freeport. These areas of significant channel shifting are located out of the ARCF GRR study location in areas where one or both levees are set back from the river channel. Lateral channel evolution is limited for the study reach of the Sacramento River from Verona to Freeport because the river channel is closely bordered by revetted levees that limit lateral channel evolution. However, this does not mean that bank erosion is not occurring in this reach. As noted previously the American River is experiencing erosion that is not clearly identifiable from aerial photographs due to steep banks and vegetation obscuring the erosion. This is also likely the case for portions of the Sacramento River between Verona and Freeport as demonstrated in erosion sites along this reach identified during annual reconnaissance surveys of the Sacramento River Bank Protection Project.

5.2.3 USDA BSTEM Analysis

A comprehensive analysis of streambank- and levee-erosion rates over a 48-year period was conducted by USDA-ARS for the Sacramento River Bank Protection Project. The work was conducted along 300 miles (483 km) of the Sacramento River main stem and selected reaches, including the Lower American River. Reconnaissance was conducted by boat and helicopter with fifty sites selected for site-specific intensive analysis. In-situ geotechnical data was collected at these sites including Jet Erosion Tests (JET), borehole shear tests (BST), and soil samples of soil layers for particle size analysis. The percent reach failing along the reaches was estimated using GPS referenced video and a Modified Rapid Geomorphic Assessment.

The 50 intensive sites were analyzed for sediment loading and bank retreat using the Bank Stability and Toe Erosion dynamic model (BSTEM). This model estimates bank retreat and sediment loading by linking hydrology, hydraulics, slope stability failures, erosion from moving water, multiple layers of different soil types, and root reinforcement of the soil. The dynamic version of the model was used that incorporates hydrographic data. Hydrographs from 12 years of record were used (1996 – 2008). BSTEM results were extrapolated to the reach using the estimated percent failure and the results compared to actual gage data of suspended sediment load. This verified the model was producing reasonable results. With this verification of the model, the 12 years of hydrology were repeated 4 times to simulate 48 years of future erosion. This model assumed that the channel is vertically stable which for the purpose of the USDA analysis was found to be an adequate assumption.

The USDA analysis estimated that about 44% of the total suspended sediment load in the Lower American River is from the banks although continued erosion could reduce this to about 20% in about 48 years. The report concludes that it is important that analysis use continuous simulation of streambank processes to predict loadings and rates of lateral retreat to capture the dynamics of erosion processes. The report notes a couple of points:

- Magnitude of lateral retreat are not well correlated with sediment loadings for a site possibly because significant erosion can occur at the toe of a bank without bank retreat at the top of the bank. However, subsequent flows may lead to bank retreat at these over-steepened banks.

- Bank failures are not well correlated with high discharge events because antecedent soil moisture conditions are important and failures often occur on the receding limb of the flood as the confining pressure of the flood water is removed from the relatively saturated and weaker bank.

The study found that in general the portion of the Sacramento River between Verona and Freeport and the Lower American River have between 20% - 40% of the banks failing. One of the highest estimated sediment loadings was found to be near Lower American River USGS RM 16 even though this bank was relatively far from a levee. A relatively moderate sediment loading was found at Lower American River USGS RM 5.5 while a low sediment loading was found at the mouth of the American River. This indicates a general upstream trend of progressively more erosion the closer a location is to Folsom Dam. Of the seven sites analyzed within the Common Features project area on the Sacramento River, 2 had relatively high loadings (between USGS RM 55 – 57), three had relatively moderate loadings (USGS RM 64 – 79), and two had relatively low loadings (USGS RM 48 – 50). The loadings were extrapolated using the percent of the reach failing to estimate the sediment loading from each 2-mile segment of the study area. One site on the Sacramento River between USGS RM 73 and 74 was found to erode such that the river would impinge on the levee within 48 years. However, there could be other sites where this could occur that were not analyzed.

Of the 50 intensive sites analyzed, seven are within the Common Features GRR study area along the Sacramento River and three are located in the Common Features GRR study area along the Lower American River. While this may be appropriate for large scale studies like the Sacramento River Bank Protection Project, it is likely not a large enough sample for more narrowly focused feasibility studies such as the Common Features GRR. Also, no sites were located in the area constricted by levees between RM 5 and 10 on the Lower American River. In addition, the hydrology used for estimating erosion 48 years into the future generally had higher flow rates than long-term averages and therefore

may over predict long-term sediment loading and bank retreat. However, the study still provides valuable insight into erosion in the Common Features GRR project area. The estimated percent of total sediment derived from the banks agrees remarkably well with the results from a historic channel shift analysis (NHC 2012). This study by the USDA confirms the results of the Channel Evolution Model and the observations from annual erosion surveys and air photo analysis.

The magnitude of the erosion does not always correlate well with erosion risk to levees. Distance of the levee from the channel as well as geology need to be considered. For example, a levee set back 300 feet from the channel is not in danger from a channel that only moves a maximum of 200 feet. Similarly, A levee could be set back 300 feet but be at risk of erosion failure if the soil between the levee and the river channel is highly erodible. However, a levee with a 30 foot berm may not be at risk if the soil between the levee and the channel is erosion resistant. See Section 5.4 for more on levee risk from erosion. So while the distance of the levee from the channel is important for estimating levee risk from erosion, soil properties also need to be considered.

5.2.4 Channel Stability and Erosion Risk Findings

The channel evolution model, historical data, and modeling of future conditions indicates that the levees of the Lower American River, and to a lesser extent the Sacramento River between Verona and Freeport, are at risk of erosion related failures. According to NHC (NHC 2012), it is appropriate to say that the Sacramento River between Colusa and Freeport is in a state of dynamic equilibrium. However, there are portions of this channel that appear to be actively degrading (NHC 2012). So while these sub-reaches may not be considered stable by themselves, the entire reach as a whole is considered to by dynamically stable. The Sacramento River between Verona and Sacramento Weir is expected to degrade slightly in the future and un-revetted portions of the levees are at risk from erosion. The Sacramento River between Sacramento Weir and Freeport is expected to aggrade overall in the future but may degrade during individual flood events. Potential implication of the simulated long-term changes in bed profiles can be increased stress along the toe of the project levees or overbank berms in the degrading reaches, which may result in increased scour along un-revetted channel sections. In the aggrading reaches, increase in bed elevations may result in higher flood stages, reduced flood conveyance, and possibly increased local bank and levee erosion from flows re-directed to the sides of the channel due to the deposited sediment. Therefore, levees not protected adequately from erosion between the Sacramento Weir and Freeport are at risk from erosion.

In contrast, the American River does not appear to have reached a state of dynamic equilibrium in the leveed portion of the reach based on recent analysis. A relatively erosion resistant layer may limit vertical erosion, leading to increased bank and levee erosion. Therefore, the levees on the Lower American River not protected adequately may be at risk from erosion. The presence of riprap may increase the rate of erosion into the erosion resistant material in the channel bed at some locations. Erosion protection designs will therefore need adequate toe protection to prevent undermining the toe of the erosion protection.

For both the Lower American River and the Sacramento River, infrastructure encroaching in the floodway, such as bridges and pipelines, need to be adequately protected from reasonably anticipated scour during design and construction. This effort is not included in the tentatively selected plan. It is assumed this effort will occur during future analysis and design efforts and likely needs to be coordinated with multiple agencies and infrastructure owners. Civil Design has also determined that the additional cost of the scour and erosion counter measures for the infrastructure is not significant

compared to the overall cost of the erosion protection currently included in the tentatively selected plan and is well within the associated cost contingency. The tentatively selected plan also does not include grade control as the consequences of including it are higher than the risk of not including it. However, protecting the levees along Sacramento River and Lower American River from erosion is important to reduce the probability of erosion related levee failure and to improve flood damage risk reduction for the protected areas.

5.3 Other Erosion Sources

Other sources of erosion include wind-wave, boat, vegetation, recreational, and bridge scour. These sources are expected to be minor compared to the fluvial process, but are discussed herein for completeness.

5.3.1 Wind Wave Erosion

The potential for wind waves to overtop and erode flood control features (principally levees) near the City of Sacramento was analyzed and alternatives to reduce risks associated with wind wave erosion developed, including costs (USACE 2010). The analysis is based on coincident 1/200 ACE event water levels and extreme wind events. 34 sites were selected where local wave conditions are expected to be maximized yet representative of nearby levee sections. The analysis follows Engineering Circular 1110-2-6067 and other technical publications related to wind wave analysis. This analysis represents the latest guidelines for wind wave erosion analysis adopted by USACE, Sacramento District. Each site was assigned the highest risk computed for the site for either levee face erosion or overtopping for any wind direction at the site. The risk from this site was then generalized to nearby levee locations with similar wave heights, geometry, and erosion protection.

This report identified those study sites where potential erosion due to wind waves could affect levee performance during a 200-year storm event. The report then presented methods to assess the potential for the waterside levee face to erode and determine if the maximum erosion would encroach on the minimum levee dimensions, and evaluate the potential for levee overtopping to threaten levee stability. Results of the quantitative analysis at each site were interpreted to assign a low, moderate, or high wind wave erosion risk at each site. Because the analysis is conservative and general in nature, it is recommended that detailed wind wave analysis be conducted during future studies at sites that may benefit from reduced repair requirement or the extent of the repair due to wind waves (See USACE 2010 for additional information). The study included reaches that are part of the Natomas PAC.

5.3.2 Boat Wave Erosion

Boat wave erosion has not been accounted for in this analysis because the impact of boat wave erosion in the project area is unlikely to be significant. Only smaller recreational boats operate in the Sacramento and lower American Rivers, and the other project reaches do not have enough consistent depth or width of channel to sustain boat traffic. Any repairs needed from boat waves would likely be addressed as part of standard operation and maintenance of the levees.

5.3.3 Vegetation Erosion (Tree Scour)

The preliminary designs for erosion protection include leaving some of the vegetation in place, an option made possible by a waiver process included in ETL 1110-2-571. A pier scour analysis to represent tree scour (likely using HEC-18) is included in the application for waiver. This effort is considered part of the erosion analysis, and is expected to be performed during future studies.

5.3.4 Recreational Erosion

Local bank and berm erosion due to a combination of recreational activities (e.g., biking, hiking, fishing, etc.) and the corresponding infrastructure features including bike paths and maintenance facilities is expected to be minimal compared to fluvial sources of erosion and should be addressed as part of the normal O&M activities.

5.3.5 Bridge Scour

There are over 15 bridges crossing the channel on multiple reaches in the project area. Bridges along the Sacramento and American rivers will likely need an analysis during design or refinement of the selected alternative to account for bridge scour protection. This effort is considered part of the erosion analysis and is expected to be done as part of future studies.

5.4 Expected Levee Performance

5.4.1 American River

As presented in Section 18 of the ARCF GRR Geotechnical Report (Attachment C), plots depicting the combined probability of poor levee performance (a.k.a. fragility curves) for with- and without-project conditions were developed at a series of index points along the various study watercourses. These curves communicate the cumulative (or combined) probability of levee failure versus the water surface elevation of flow in the river channel. Specific considerations taken into account when these curves are developed include underseepage, through-seepage, slope stability, and engineering judgment. Furthermore, the engineering judgment component consists of considerations for vegetation, animal burrows, encroachments, utilities, and erosion. It should be noted that the erosion component was not estimated based on any analyses, but on the experience of an expert elicitation panel, considering the location of the index points, the conditions of the foundation and levee material, the water velocity at that specific location, and on past history. For more information on the expert elicitation process a summary of the document “Geotechnical Office Report, Geotechnical Expert Elicitation Meeting Minutes,” dated July 2009, is available upon request.

The levee performance curves were finalized in 2011 with the judgment curves (erosion as a component) that were developed using an expert elicitation in June 2009. The validity of the erosion component of the performance curves was discussed at the expert panel and project team meetings. It was found that the estimated levee performance captured by the curves was reasonable based on the available data and expertise. In consultation with the project team the decision was made not to develop more rigorous analytical methods to refine the erosion portion of the curve.

Sample fragility curves for the American River at two locations are illustrated for the north levee in Figure 5-12 and for the south levee in Figure 5-13. Inclusion of both the with- and without-project

fragility curves in these figures indicates the change, or reduction, in probability of failure due to with-project improvement measures. Both the with- and without-project fragility curves account for the reduction in probability of poor performance due to the cutoff walls constructed as part of the ARCF WRDA 1996-1999 project. Therefore, the combined fragility curve at these two locations represents the judgment curve, of which erosion is the primary contributor to the without-project curve. The with-project curve accounts for residual risk due to vegetation, animal burrows, encroachments, and utilities that may not be addressed by the project alternatives or structural improvements. In both sample figures, the cumulative probability of poor performance, or levee failure, is less than 20 percent for the condition where the water surface elevation is at the top of the levee crest once the project is constructed. Without the project, the cumulative probability of poor performance is greater than 50% and indicates the erosion protection provided by this project is needed to reduce flood damage risk.

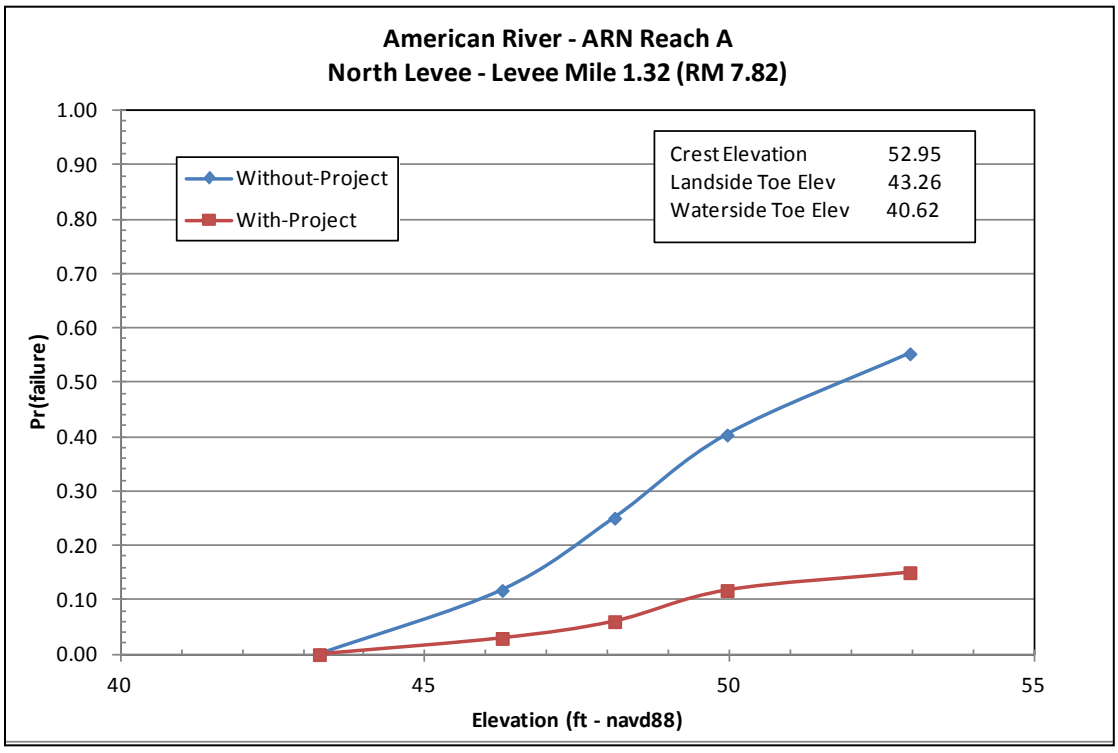

Figure 5-12. "Judgment" component of the levee fragility curves for the American River north levee at RM 7.82

5.4.2 Sacramento River

As discussed above, a series of plots depicting the combined probability of poor performance (a.k.a. fragility curves) for with- and without-project conditions were developed at a series of index points along the various study watercourses. These plots are presented in Section 18 of the ARCF GRR Geotechnical Report (Attachment C). Sample fragility curves for the Sacramento River at one location are illustrated for the east, or left, levee in Figure 5-14. Similar to the above figures for the American River, this figure shows the "judgment" component of the fragility curves. There remains a residual risk due to vegetation, animal burrows, encroachments, and utilities that may not be addressed by the project alternatives or structural improvements. In the sample figure, the cumulative probability of

poor performance, or levee failure, is reduced from a little over 20 percent down to less than 10 percent for the condition where the water surface elevation is at the top of the levee crest.

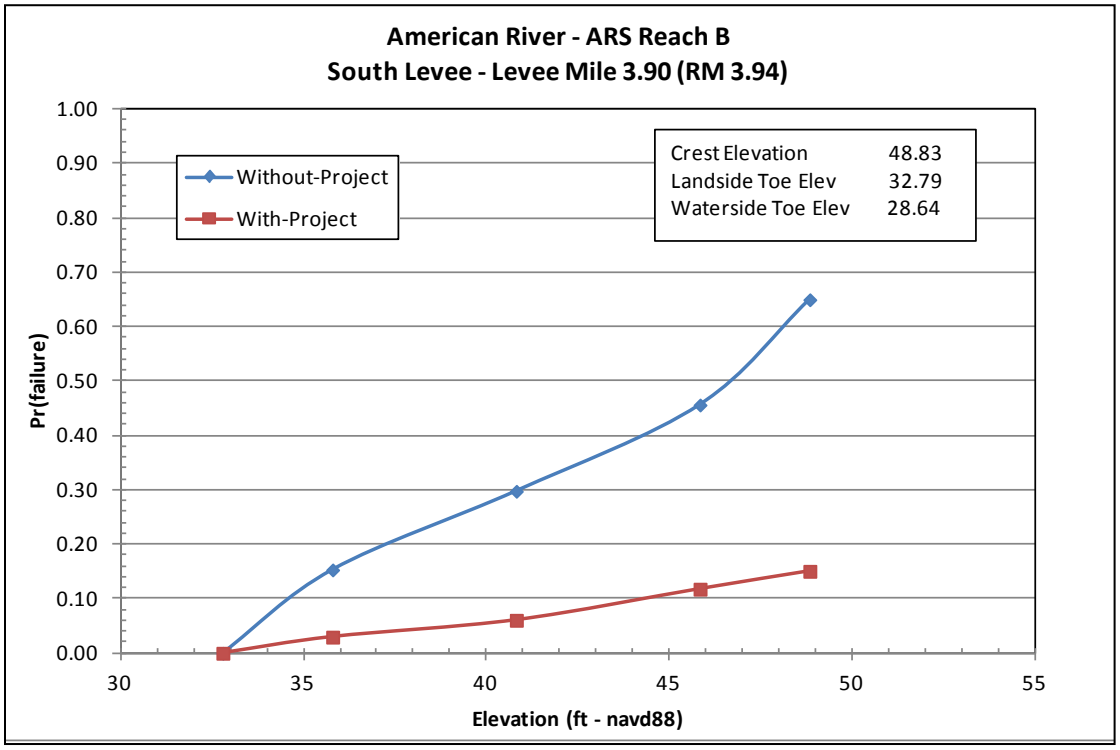

Figure 5-13. "Judgment" component of the levee fragility curves for the American River south levee at RM 3.94

Historic aerial photos in combination with a riprap database showing known riprap locations (as of 2007) was used to develop a rating of relative levee risk from erosion by channel shifting. The results of this effort by NHC (NHC 2012) are shown in Table 5-2 for the portion of the Sacramento River in the ARCF project footprint. This data shows about 18% of the levees in this reach are at higher risk from future erosion from channel shifting. However, this may be overstated as some higher risk sites have since been repaired with large riprap.

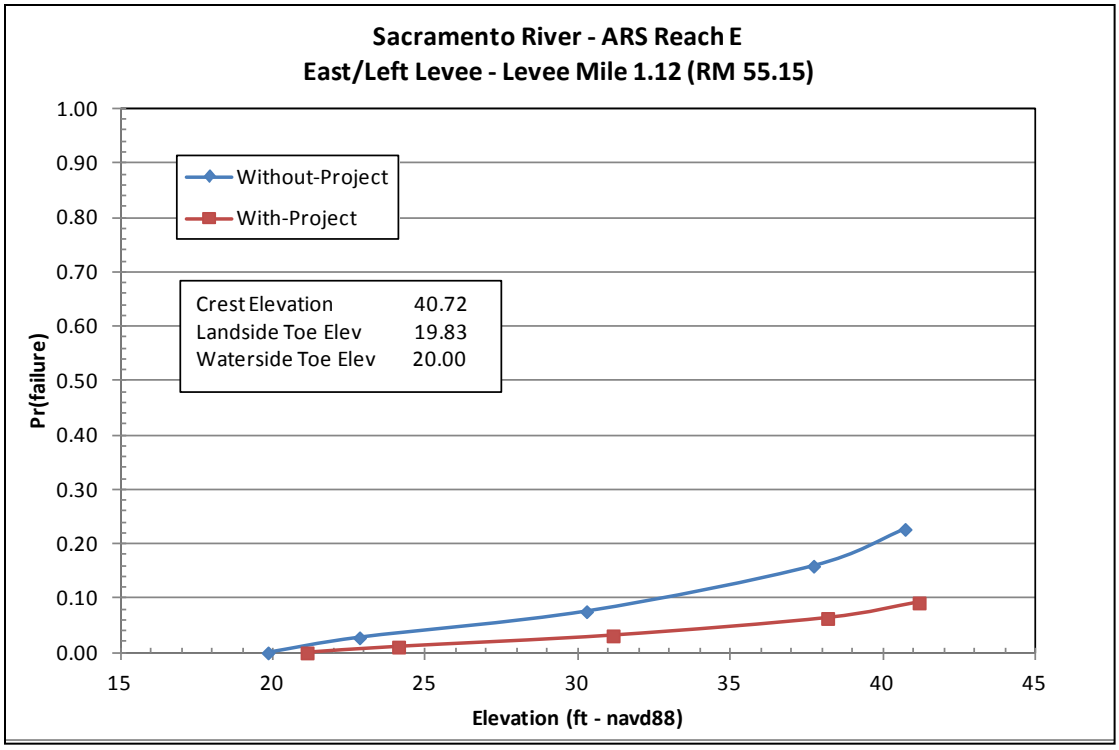

Figure 5-14. "Judgment" component of the levee fragility curves for the Sacramento River east/left levee at RM 55.15

Table 5-2. Levee risk ratings for Sacramento River by reach

Levee risk rating	Feather River to Freeport	
	Cumulative Miles	% total
R1	38.3	55
R2	2.6	4
U1	18.9	27
U2	10.0	14
U3	0.0	0
Total	**69.8**	**100**

Where:
R1 = Revetted bank, lower erosion risk
R2 = Revetted bank, higher erosion risk
U1 = Un-revetted bank, lower erosion risk
U2 = Un-revetted bank, higher erosion risk
U3 = Un-revetted bank, higher erosion risk, higher uncertainty

6 Bank Protection Basis of Design

6.1 General

The erosion protection features to support preliminary cost estimates were developed with input from the PDT with the objective of developing a reasonable cost to support plan selection. The erosion protection features are the same for alternatives 1 and 2. Two methods were used in an attempt to minimize the environmental impact of the features: Bank Protection and Launchable Rock Trench.

While the Bank Protection method is applicable in all areas, the Launchable Rock Trench method is applicable only in areas where there is sufficient bench between the levee toe and river. Both methods have similar rock quantities and costs are roughly equivalent, but the Launchable Rock Trench initially appears to have less environmental impact. For the purposes of the feasibility study, the Launchable Rock Trench was selected as the preferred method when either was technically feasible. It is expected that future studies will take into account many factors including the environmental impact to determine the final design.

The erosion protection was designed to convey the 0.5% ACE (1 in 200) future condition as described in Section 4.

6.2 Bank Protection

The bank protection design concept was adopted from the Lower American River (LAR) Sites I-V which was constructed shortly after the 1998 flood event. The design was developed by Ayres Associates and incorporated a rock protected slope with launchable rock bench. The rock bench has a trapezoidal soil trench “burrito wrapped” in geotextile. The soil trench would house a variety of woody tree species; offer shaded riparian area, and other beneficial habitat. This type of fix has performed well over the last decade and has required very little maintenance.

Several cross sections were analyzed along the American and Sacramento Rivers to develop typical sections that reasonably represented river conditions. For preliminary analysis, two sections were developed and used to develop quantities.

The typical sections were evaluated against project design parameters to ensure they meet minimum criteria. Design criterion was governed by EM 1110-2-1601 “Hydraulic Design of Flood Control Channels” with stone weight data from ETL 1110-2-120. Use of the Engineering Research and Development Center (ERDC) software CHANLPRO was used to develop some example gradations. Table 6-1 is a summary of the design parameters used for multiple cross sections along the American River.

After further evaluation, it was noted that the minimum geometries associated with the design sections resulted in rock quantities that exceeded minimum requirements for launchable rock and mitigation features. Rock gradations were deemed less important for determining costs for this design level. The geometry of the bank protection design (refer to Figures 6-1 and 6-2) yielded sufficient volumes of rock to meet anticipated launchable rock requirements and sufficient mitigation features to offset environmental impacts. The launchable rock volume requirements were determined based on average velocities for above-mentioned typical sections. Site-specific design for erosion protection sites will occur in future studies.

Table 6-1. Summary of the design parameters used along the American River

Description	Typical Section Locations	
	Downstream of Paradise Beach & Upstream of Howe Ave. (Includes all of the Sacramento River)	**Between Howe Ave & Paradise Beach**
Depth of Flow (ft)	37 to 50	47
160k cfs Velocity (ft/s)	7	12
Minimum Rock Thickness (ft)	3	3
Scour Depth => Launch Dist (ft)	10 to 20	10
Design Slopes (upper/lower)	2:1	2:1-3:1
Riparian Bench Slope	10:1	10:1
Minimum Launchable Rock Area per ft (underwater placement) (ft^2)	100 to 200	100

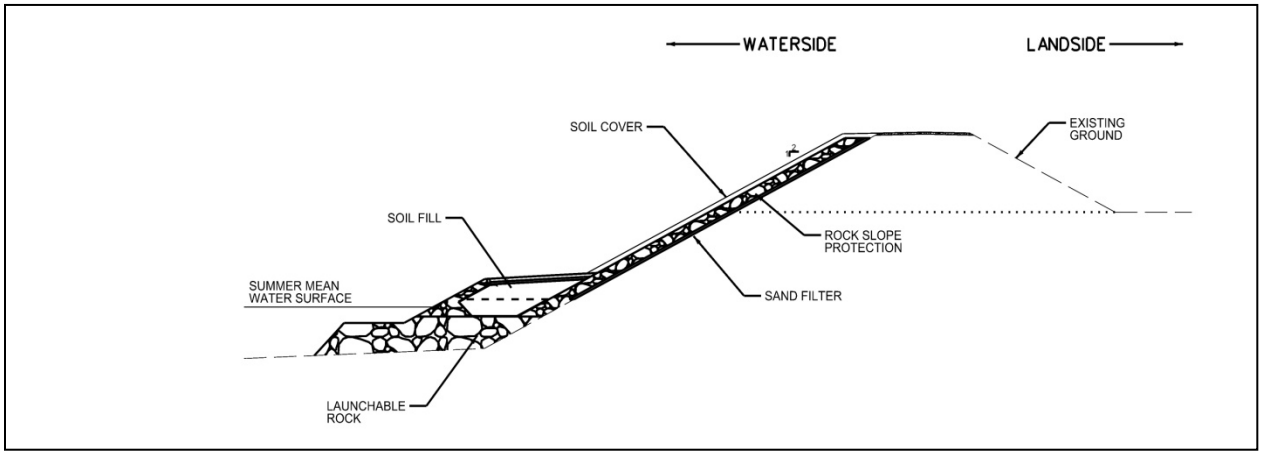

Figure 6-1. Bank protection generic design section and assumptions (insufficient bench)

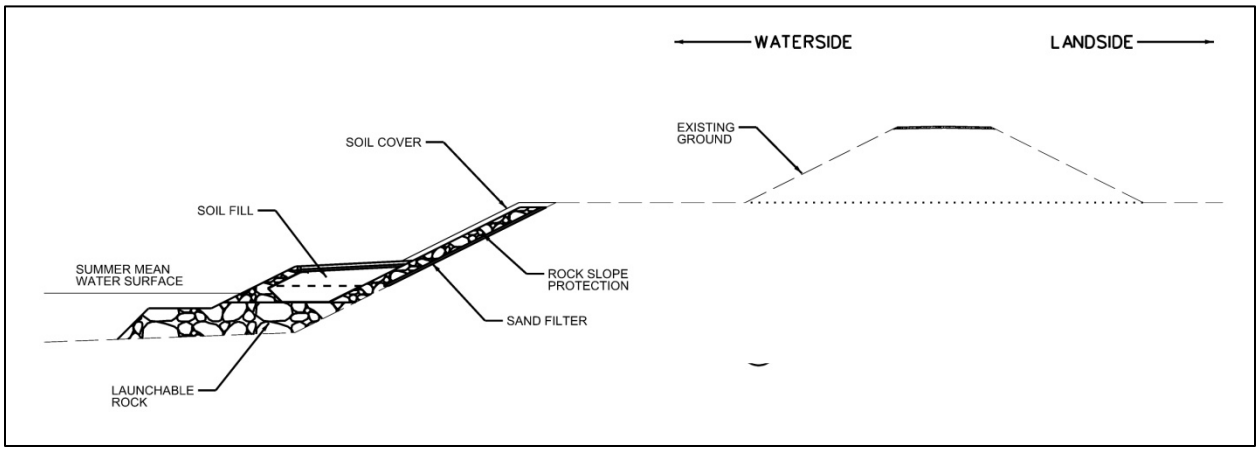

Figure 6-2. Bank protection generic design section and assumptions (sufficient bench)

6.3 Launchable Rock Trench

The rock trench design concept (depicted below in Figure 6-3) comes from the Windrow trenching method of erosion protection widely used along the Mississippi and Missouri Rivers. The trench design was only considered when the width of the existing waterside berm (if any) was enough to accommodate the construction of the trench. This form of passive erosion protection allows the existing berm to erode away naturally and does not require wet work or the disruption of shaded riparian habitat. The design includes trenching waterward of the levee, placing rock, and providing a soil cover for vegetation and other mitigation features.

The rock trench design used many of the same parameters shown under Table 6-1 for bank protection. The placement of the trench invert was a key design parameter and often dictated the required width of the berm. The invert was placed at the Summer Mean Water Surface Elevation (SMWSE) to remove the trench out of the vadose zone and eliminate the need to place rock in the wet. The SMWSE invert also reduced the launching distance and therefore the quantity of rock needed for scour. The reduced launching depth also increased the reliability of the launchable rock trench to launch uniformly and perform as intended. The generic design section and assumptions are shown below prior to any specific section edits.

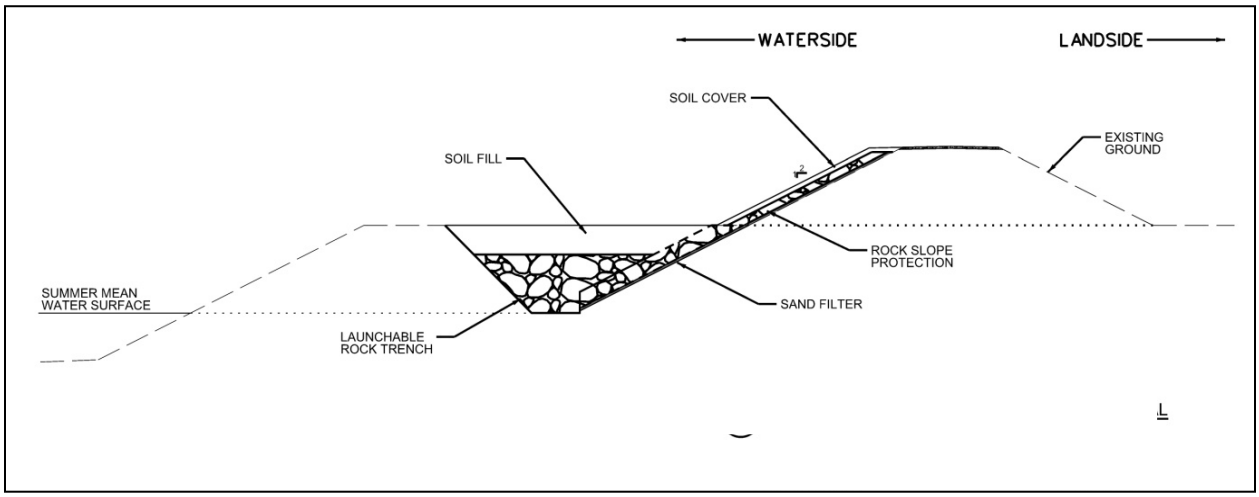

Figure 6-3. Launchable rock trench generic design section and assumptions

The design section would be lowered to the depth of the assumed SMWSE for that location. Rock slope protection was also provided on the waterward slope of the levee and carried all the way to the waterside hinge point. Excavation and fill quantities would vary because of the SMWSE and its relation to the existing elevation of the waterward berm.

It should be noted that the performance of windrow trenches can be compromised in high scour and velocity areas. EM 1110-2-1601 engineering criteria take these into account, however, there's still a level of risk that cannot be mitigated. In the mentioned conditions, the rock may launch all at one time or non-uniformly in such a way that will provide decreased erosion protection performance. The consequences of this situation are greater than bank protection because the existing bank will have already eroded away back towards the toe of the levee. There will be very little time to flood flight and

respond to the eroding site, which could lead to failure or breach of the levee. Conversely, if bank protection fails (undermined, flanked, etc) or stops providing its intended function, there is still bank available to flood fight and prevent the erosion from propagating towards the levee. Both methods offer a proven history of performance, however, the launchable rock trench will inherently have more risk that should be acknowledged by design team, and project sponsors.

6.4 Erosion Protection Footprints

Along the American River, the rationale used to determine where bank protection was required for the feasibility study involved consideration of several factors. The most important factors included: 1) the velocity computed by Ayres' 2-dimensional hydraulic modeling (Ayres 2004) for a discharge of 160,000 cfs, 2) the erodibility of the material near the levee prism, and 3) the past performance of the levee segment with respect to erosion. Figure 6-3 depicts the footprints of the proposed erosion protection for both the Lower American and Sacramento Rivers.

Using the above criteria, bank protection was determined to not be required along two segments of the right bank of the American River. The upstream segment, extending between the upstream end of the levee (~RM 14.4) and RM 10.3 and the downstream segment extending between a point near Cal Expo (RM 5.5) and the confluence with the Sacramento River (RM 0). In addition to following the above criteria, a portion of the upstream segment contains a 4000 foot-long reach wherein the channel includes a wide right overbank consisting of high ground (i.e., the location of a sewage treatment plant) in which the water surface elevation for a discharge of 160,000 cfs does not get near the levee and the levee essentially exists as a "freeboard" levee.

In addition, there are no proposed erosion protection features located along the left levee of the Sacramento River upstream of the American River confluence. The rationale for this approach is the assumption that, as recommended by the 2010 feasibility study for the Natomas PAC, a new levee will be constructed located adjacent to and on the landside of the existing Sacramento River levee (i.e., as a future without-ARCF GRR project condition). Furthermore, it is assumed that with the new proposed levee in place, the new levee template is located sufficiently far enough away from the existing bank that some bank erosion could occur along the entire Sacramento River reach, including into the existing levee prism, without threatening the new levee (e.g., analogous to erosion buffer zone). Nonetheless, O&M of the river bank will still need to occur. These assumptions will need to be verified during site-specific design of the ARCF project to ensure that the subject "new" levee does/or will in fact be constructed and that erosion "buffer" zones are adequate to preclude erosion which could lead to levee failure for flow into the Natomas Basin floodplain.

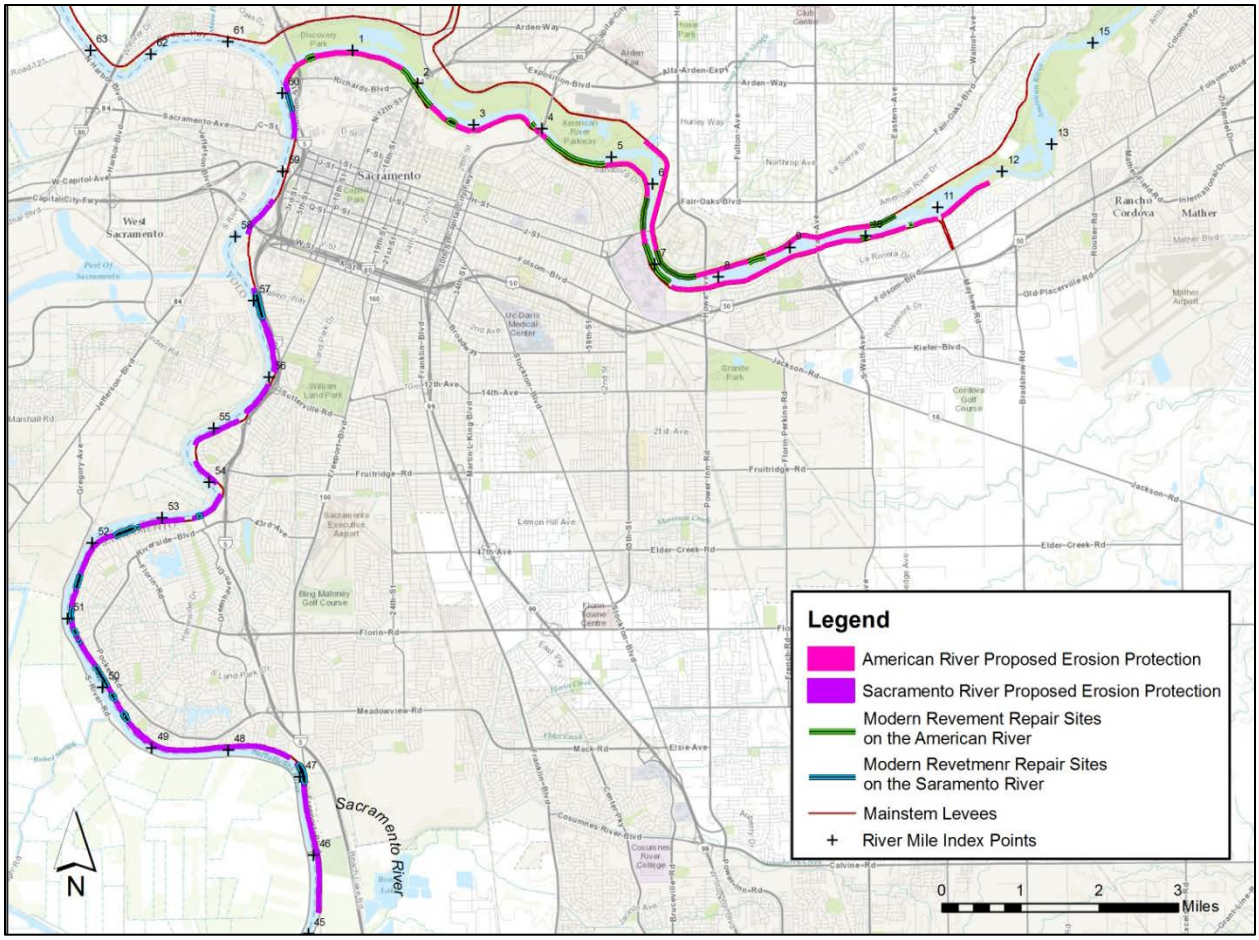

Figure 6-4. Footprints of the proposed erosion protection along the mainstem channels

Table 6-2 lists the cumulative lengths of the existing and proposed erosion protection features along the Lower American River. As illustrated by this table, about 100% of the left bank of the leveed reach will include some form of erosion protection features and about 35% of the right bank of the leveed reach will include erosion protection features.

Table 6-2. Cumulative length of existing and proposed erosion protection features along the Lower American River

	Left Bank		Right Bank	
	Levee Miles	Percent	Levee Miles	Percent
Existing Modern Revetment	3.1	28%	1.3	9%
Proposed Revetment	8.1	72%	3.7	26%
No Protection Proposed	0.0	0%	9.3	65%
Totals	11.2	100%	13.0	100%

Table 6-3 lists the cumulative lengths of the existing and proposed erosion protection features along the left (eastern) bank of the Sacramento River in the GRR study area. As illustrated by this table, about 84% of the left bank will include some form of erosion protection features.

Table 6-3. Cumulative length of existing and proposed erosion protection features along the left (eastern) bank of the Sacramento River

	Left Bank	
	Levee Miles	Percent
Existing Modern Revetment	2.7	18%
Proposed Revetment	9.8	66%
No Protection Proposed	3.3	16%
Totals	14.8	100%

A channel stability analysis (Ayres Associates, 2010) was used to determine areas requiring revetment with the assumption that all areas without modern bank protection will be protected. Modern protection was determined by areas defined as rock riprap with overall condition of good or very good. Additionally, there are some areas of high ground and areas with significant existing berm where protection is not required as shown in Figure 6.3.

6.5 Feasibility Design Considerations

The assumption of the feasibility study is that all modern revetments in the project area are designed to reliably and safely convey the design discharge of 160,000 cfs. The feasibility study assumes older revetments (e.g. “cobblestone” revetments) are unable to reliably and safely convey the design discharge. These historical cobble sites are likely beyond their intended design life and are in varying degrees of disrepair and failure. This leads to the assumption of replacing all historic cobble sites with modern angular bank protection.

However, a few exceptions to replacing the cobble sites exist in areas of lower velocities where the feasibility study assumes new erosion protection is not needed due to the lower velocities. For example, the right bank or “North” levee downstream of RM 5.5 and upstream of RM 10.5 (see Figure 6-3). Portions of the furthest upstream right bank levee are not expected to have water against the levee on the waterside for the design discharge.

These assumptions will need to be checked during implementation using site-specific analysis. Sites needing bank protection will need to be identified, prioritized, and designed for the design discharge during implementation. This may require additional environmental documents as the extent and location of the rock protection could change based on the new analysis and site-specific designs.

The current proposed rock protection locations and rock design for the project is a reasonable approximation of future actions used to estimate a reasonably conservative project cost, associated environmental impacts, and to assist with establishing federal interest. However, site-specific analysis and design needs to occur in the future during implementation and future changes to the location, extent, and design are possible.

While the repairs are expected to be designed and constructed to commonly accepted engineering and construction standards and USACE guidelines for the design discharge, it is expected that continued operations and maintenance will be necessary including:

- Repairing damaged rock protection
- Possibly installing additional rock protection
- Monitoring during floods
- Possible flood fighting

The estimates are reasonably conservative even though uncertainty remains in the location, costs, and environmental impacts of the proposed rock protection. Continued operations and maintenance activities are needed and possibly emergency patrols and emergency response during flood events.

7 Recommendations and Considerations

7.1 Conclusions and Recommendations

This document provides a brief history of erosion along the American and Sacramento Rivers and the nature of the erosion problem given the sediment starved condition of flood flows which occur downstream of the Folsom and Nimbus Dams. A number of investigations have been conducted to quantify the erosion problem. These investigations include 2-D hydraulic analysis and mapping of velocities and shear stresses, 1-D HEC-6T sediment transport analyses, geomorphic analyses, geotechnical and geophysical surveys and investigations, laboratory testing to determine the erodibility of some of the material, and 3-D stratigraphic mapping of the channel materials. These studies were pursued as an extensive attempt at quantifying the erosion problem. The results of these studies are summarized in subsequent subsections.

The studies support the GRR and are primarily focused on providing a reasonably conservative estimate of the project costs, benefits, and environmental impacts. The studies and this document are not site selection, prioritization, or design efforts although they may serve as a useful reference for these future efforts. More detailed site selection, prioritization, and site-specific designs are needed during implementation to more efficiently utilize limited federal funds.

Additional efforts are needed in the future to support implementation. These include but are not limited to:

- Confirm that portions of the levee not included in Figure 6-3 for new bank protection are designed for the 160,000 cfs design discharge on a site-specific basis,
- Develop and implement a site-selection and prioritization process,
- Collect data necessary for site-specific analysis of existing bank protection and design of new bank protection,
- Design the needed rock protection based on site-specific data in accordance with standard engineering practice and USACE guidelines,
- Monitor bank protection performance during and after flood events.

Repair and maintain rock protection as needed on a continual basis to keep the bank protection performance level from deteriorating.

7.1.1 Prototype System Performance

Although analytical analyses can provide a wealth of information regarding expected performance of the river and levee system, the actual performance of the prototype system provides the best insight into the system performance during future large flood events. To that end, significant historical erosion events were identified and the corresponding erosion-based damage discussed. These events indicate that basically all large flood events which have occurred since completion of the Federal flood control system (e.g., the floods of 1955, 1966, 1986, and 1997) have caused considerable damage to the levee system due to erosion. All four of these large events required extensive repair after the event so that the system was ready for the next major flood event.

In the 1986 food event, discharges greater than 115,000 cfs (with a sustained peak flow of 130,000 cfs) were released from Folsom Dam for about 52 hours. Wholesale erosion went undetected during this event at a couple of locations and almost failed the south levee near the Capital City Freeway crossing as illustrated on Figure 1-6. Sacramento was fortunate during this event, for had the discharge been sustained longer, the levee would have likely failed from erosion.

In the Sacramento River system, erosion has even occurred during lower flow events, as documented by the SRBPP. Numerous emergency bank repairs and repairs completed by the SRBPP (over 800,000 linear feet) have been constructed in the last 50 years. Erosion continues along the Sacramento River banks and levees and there are currently numerous sites that are still in need of repair.

7.1.2 Updated Geologic, Geotechnical, and Geophysical Information

Input from subject matter experts was solicited and used to advise on the direction of the study and investigations. Specifically, the experts provided opinions on the current stability of the river channel with regards to erosion and on requirements for additional study, data collection, and analysis. The data collection and analyses focused on improving the geologic and geotechnical characterization of the material properties which comprise the river channel and overbanks.

Data collected as part of this study included soil borings, cone penetrometer tests and geophysics. Samples obtained from the soil borings were testing in geotechnical laboratories for classification properties and erosion rates using JET and EFA testing. The data obtained in the subsurface investigations and laboratory testing were included in geologic mapping and 3-d modeling. Geologic analyses included development of three-dimensional surface contour maps of the erosion resistant unit, and geologic cross sections and longitudinal profiles. The final 3D model contains enhanced information, especially within the area between the levees where young alluvial sediments related to hydraulic mining have been deposited. In addition to showing subsurface alluvial stratigraphy, the final model shows the top of erosionally resistant sediments that are exposed and identified in the channel at several locations.

Field observations suggested that erosion of the exposed erosionally resistant sediment occurs over time at both the granular- and outcrop-scale. However, the mechanisms and time scale associated with that erosion are not well understood and were not studied. Due to the location and properties of the material, the risk posed to the flood control structure from erosion of the erosion resistant sediment were estimated to be low and no further study of its erosion mechanisms or time scale were performed.

Cross sections generated from the 3D stratigraphic are illustrated in Figures 3-4 and 3-5 and indicate that highly erodible mining materials are present in the channel (as berms and channel banks) and, in some cases, underlie the levees. The Lower American River has highly erodible zones which will, in time, erode during high flow events if left unprotected. In some cases, bank and levee failure will result.

Although not conducted as part of the ARCF GRR study, the results and conclusions of the DWR Urban Levee Evaluation circumstantiate the results and conclusions of the analysis performed for the ARCF study and presented herein. Given that the ULE used a different approach and still obtained similar results (i.e., that many of the levees have medium and high erosion risks) significantly adds to the validity of the ARCF conclusions.

7.1.3 Hydrology, Hydraulic, and Sedimentation Impacts

Once the JFP auxiliary spillway is constructed and functioning, new operations criteria are planned which would result in larger flood flows being conveyed through the American River with greater frequency compared to past conditions. These higher flood flows would exert additional pressure on the banklines and levees resulting in greater erosion, sediment transport, and potentially changes to the planform of the low-flow channel. Nonetheless, it is important to note that without inclusion of the proposed erosion protection features, the flood damage reduction benefits intended for the project cannot be fully realized since the lower American River channel will likely not be able to safely convey the new larger discharges and flow restrictions from Folsom would likely be put in place.

Two-dimensional modeling of the Lower American River using RMA-2 was performed to get a more detailed estimate of the velocity and shear in the American River compared to computed one-dimensional values. Results indicate relatively high velocities adjacent to the levees. Additionally, the range of the computed velocities is of concern since the magnitude of the velocities is great enough to erode many of the relatively fine grained material present in the channel lining.

7.1.4 Summary

Given the experience gained by past floods and post-flood repairs and on review and examination of the products of the erosion analyses discussed herein, it is clear that the erosion protection measures proposed by the ARCF GRR must be included along the leveed reaches of the lower American River and along the left bank of the Sacramento River. Failure to include these features will likely result in levee failure leading to catastrophic damages and possibly lives lost. There is a substantial life safety issue related to erosion along the river channels given the magnitude of the flooding coupled with the proximity of densely populated development immediately adjacent to the river channel and levees.

The available information indicates that many of the levee segments without modern bank protection are at risk of erosion related failures along the Sacramento River and Lower American River in the Common Features project study area. The levees therefore need to be protected to provide adequate flood damage risk reduction. Past erosion on the Lower American River (Figure 1-6) indicates that impending erosion failures may be covered by water and may not be observed in time to provide adequate warning to flood fight and/or evacuate residents. This is in contrast to landside seepage or stability related failures that may be more easily visible and allow more time for adequate flood fighting and/or evacuation of residents. The potential for unobserved erosion related failures increases the potential consequences to life and property. A passive approach of fixing erosion damage to levees during or after a flood event is not likely to reduce flood damage risk substantially. A passive approach to erosion is therefore not recommended for this project as the probability of failure and potential consequences of a failure during the design flood event are high. However, an active approach of providing erosion protection as proposed in the tentatively selected plan (TSP) is appropriate and should increase flood damage risk reduction from erosion once constructed.

Future site-specific erosion related data collection, analysis, and design is necessary for implementing the GRR including confirming feasibility assumptions. Future efforts are also needed to monitor the performance of the rock protection and make the necessary repairs to maintain the performance of the bank protection for the life of the project.

7.2 Other Considerations

A number of additional considerations require annotation and will need to be addressed in future studies of the ARCF study in order for the project to be considered "whole" or "complete". These considerations are discussed below.

Given the large increase in the design flow from 115,000 to 160,000 cfs as well as the large increase in discharge for relatively frequent events (discussed above in Section 4.1), the impacts of the project with respect to infrastructure encroaching in the floodway, such as bridges and pipelines, will need to be investigated including features needed for mitigating the impacts. It is unlikely that the subject increase in discharge will not induce a negative impact on the local bridge scour values.

The need for bed or invert protection, at one or more locations, is not a current component of the GRR plan, but has been the focus of discussion by members of the expert panels. The need for bed protection at key locations will need to be monitored in the future as part of project operations.

As discussed above, extensive investigations have been performed to quantify/predict erosion of the lower American River. In some cases, unknowns remain and recommendations are put forth for additional study to potentially fine tune the answer. There is considerable uncertainty related to predicting erosion. It is conceivable that additional investigation may optimistically lead to a reduction in length or volume of the proposed erosion protection features. However, the potential uncertainty in such favorable results may not be worth the impacts to the study schedule or budget.
As depicted in Figure 6-3, a number of existing revetment repair sites will be included as part of the complete erosion protection system. These sites must be assessed in future studies to confirm that these sites are stable, prevent erosion for discharges up to and including 160,000 cfs, and to prioritize sites to be constructed over a period of years.

Given that a primary goal of the ARCF GRR project is to increase the capacity of the American River to 160,000 cfs, the channel stability of downstream receiving channels also needs to be validated. Failure to confirm the downstream channel stability may result in stability problems being moved downstream.

7.3 Qualifications and Limitations

Given that the foundation of this report consists primarily of relevant extracts of other work efforts, coupled with the complexity of river erosion processes, as a standalone work effort the report does not constitute a rigorous analysis quantifying the erosion problem. In some cases, study conclusions on various topics have varied through time. This situation is not of great revelation since the erosion and stability problems have been under study for several years and occasionally new results, based on more detailed information, contradict older conclusions which were frequently based on lesser detailed information. However, the report is sufficient for supporting the proposed erosion protection features and cost estimates consistent with a feasibility study given the new "Smart Planning" paradigm.

It is important to note that there are several limitations in the information in this report and that additional analysis and design will be required in future studies in order to develop a complete and technically workable project.

The threshold analysis, currently ongoing, should produce information relating to how wide the American River channel could get as the availability of bed material available for transport continues to diminish. Additionally, this analysis should also provide valuable insights which will be useful in updating the Folsom Dam Water Control Manual.

The amount of erosion protection is extensive and is not expected to occur at once. During future studies, additional work will be necessary to prioritize sites to be constructed over a period of years.

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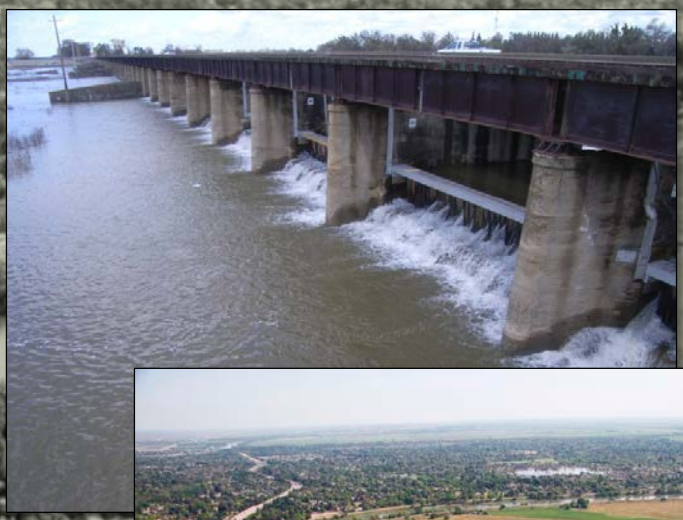
American River Watershed

Common Features
General Reevaluation Report



Appendix D
Real Estate Plan

December 2015

Sacramento Area Flood Control Agency

Central Valley Flood Protection Board

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:
Sacramento Weir during operation
Sacramento River facing south near the Pocket and Little Pocket neighborhoods
High flows on the American River at the Highway 160 overcrossing
Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Real Estate Plan

U.S. Army Corps of Engineers
Sacramento District

December 2015

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REAL ESTATE PLAN
For
American River Watershed
Common Features
General Reevaluation Report
Sacramento and Sutter Counties, California

1. Statement of Purpose

This Real Estate Plan (REP) is intended to support and present the real estate requirements for a general reevaluation study of the authorized American River Common Features Project (ARCF) and is for planning purposes only. Studies that were completed prior to this reevalution report include the following: Congress directed the Corps to investigate additional means to reduce flood risk to the City of Sacramento following the flood of 1986. The Corps completed a feasibility study in 1991, recommending a concrete gravity flood detention dam at the Auburn Dam site and levee improvements downstream of Folsom Dam. Congress directed the Corps to conduct supplemental analysis of the flood control options considered in the 1991 study. The resulting *Supplemental Information Report, American River Watershed Project, California* (March 1996) recommended a similar combination of a gravity flood detention dam at the Auburn Dam site with downstream levee work. It considered, but did not advance, plans for Folsom Dam improvements and a stepped release plan for Folsom Dam accompanied by downstream levee improvements. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features". Thus, the American River Common Features Project was authorized in Water Resource Development Act (WRDA) 1996 (Pub. L. 103-303, Section 101(a)(1)) and the decision on Auburn Dam was deferred. Major construction components for Common Features included construction of levee improvements to reduce seepage along approximately 22 miles of American River levees, and levee strengthening and the raising of 12 miles of the Sacramento River levee in the Natomas Basin. Meanwhile, improvements to other levees adjacent to the Natomas Basin were authorized in the Defense Appropriations Act of 1993 (Pub. L. 102-396, (HR 5504), Sec. 9159, 106 STAT. 1876, 1944-1946 (1992)). The Sacramento Area Flood Control Agency (SAFCA) constructed these latter improvements between 1995 and 1998.

In 1999, Congress authorized improvements to Folsom Dam to control a 200-year flood event with a peak release of 160,000 cubic feet per second. WRDA 1999 also authorized the Folsom Dam Modification Project to modify the existing outlets to allow for higher releases earlier in flood events. At the same time, Congress also directed the Corps to review additional modifications to the flood storage of Folsom Dam, indicating that Congress was looking at maximizing the use of Folsom Dam for flood damage reduction prior to consideration of any additional storage on the American River. The Folsom Dam Raise Project was subsequently authorized by Congress in 2004.

The Common Features project was modified by WRDA 1999 so that it could safely convey an emergency release of 160,000 cfs. These improvements included construction of slurry walls to reduce seepage and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of the Natomas Cross Canal levee in the Natomas Basin. Additional construction components for both WRDA 1996 and 1999 were authorized, and are described in Chapter 5 of main GRR document page 5-1.

All American River features authorized in WRDA 1996 and 1999 have been constructed by the Corps of Engineers or are in design analysis for construction within a year or two. Design and construction have been undertaken under a Project Cooperation Agreement with the California Reclamation Board (now known as the Central Valley Flood Protection Board (CVFPB)) executed July 13, 1998, and amended four times. Cost sharing for these features is 75% Federal and 25% non-Federal.

However, the Natomas Basin features authorized in WRDA 1996 and 1999 have been deferred. Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5 and on both the north and south bank of the American River. Seepage on the Sacramento River was so extensive that soon after the 1986 flood event, Congress funded levee improvements as part of the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas down to the town of Freeport. At the time, seepage through the levees was considered to be the only significant seepage problem affecting the City of Sacramento.

After construction of the Sac Urban project, the Sacramento Valley experienced a flood event in 1997. This led to a geotechnical evaluation of levees in the vicinity of the City of Sacramento which showed that deep underseepage was of concern. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was expected because the levee improvements had not yet been constructed. However, the occurrence of significant seepage on the Sacramento River in the reach improved as part of the Sac Urban project confirmed that deep underseepage was a significant concern in this area, a conclusion later confirmed by the Levee Seepage Task Force in 2003.

Following the recognition of deep underseepage as a major concern, seepage reduction measures on the American River needed to be redesigned to reduce both through- and deep underseepage. The redesign led to considerable cost increases over what was originally authorized by Congress: increasing to $91.9 million from the originally-authorized $56 million under WRDA 1999, and to $205 million under the Energy and Water Development Appropriations Act of 2004 (Pub. L. 108-137).

Because of the considerable cost increase of reducing the seepage problem on the American River, all funds appropriated by Congress for the project in the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a reevaluation study would be required for the Common Features project. Congress was notified in 2004 that additional authorized cost increases would be required for study, design, and construction of levee improvements in the Natomas Basin.

While the reevaluation study was beginning for the Common Features project, the Folsom Dam Post Authorization Change report (PAC) was being completed by the Sacramento District. The results of this study, and of the follow-on Economic Reevaluation Report (ERR) for Folsom Dam improvements, showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to truly capture the benefits of the Folsom Dam projects. These levee problems consisted primarily of erosion concerns on the American River and seepage, stability, erosion, and overtopping problems on the Sacramento River below the confluence with the American River. However, the full extent of these levee problems was not known. Because of this, it was realized that additional reevaluation studies were also needed to include the two remaining basins comprising the City of Sacramento: American River North and American River South. The reevaluation began in 2006.

The project delivery team (PDT) for the ARCF GRR had completed the Feasibility Scoping Meeting (FSM) milestone and was working towards the Feasibility Review Conference milestone. However, in July 2009 the PDT was directed to complete an interim Post Authorization Change Report for the Natomas Basin (PACR) to receive consideration in a potential WRDA 2010. In December 2010, the Natomas Basin Post Authorization Change Report (PACR) and Interim General Reevaluation Report (GRR) was completed, which focused on the problems associated with the existing levees in the Natomas Basin. The interim GRR recommended improving levee performance by addressing seepage and stability problems, but did not address measures to raise the height of the levees. The Natomas Interim GRR has been forwarded to Congress for authorization.

The cost estimates of the real estate requirements necessary to support the various alternatives is discussed in detail in the 2014 ARCF GRR. All alternatives were screened out, with the exception of Alternative 1 Levee Improvements, the National Economic Development Plan and Alternative 2 Sacramento Bypass and Weir widening and Levee Improvements which is the Recommended Plan and locally preferred plan (LPP). This REP specifically identifies the real estate requirements in support of the Recommended Plan. There may be modifications to the project and its plans that occur during Preconstruction, Engineering and Design (PED) phase, thus changing the final acquisition area(s) and or/ administrative and land costs reflected in this REP.

2. Project Authority

The basic authority for the Corps to study water resource related issues in the American and Sacramento Rivers is Section 209 of the Flood Control Act of 1962 (Pub. L. No. 87-875, § 209, 76 Stat. 1180, 1196-98 (1962)), which authorizes studies for flood control in northern California. This report was prepared as a general reevaluation study of the American River Common Features Project, which was authorized by Section 101(a) (1) of the Water Resources Development Act (WRDA) of 1996, (Pub. L. No. 104-303, § 101(a)(1), 110 Stat. 3658, 3662-3663 (1996)) and amended by Section 366 of WRDA of 1999, (Pub. L. 106-53, § 366, 113 Stat. 269, 319-20 (1999)); and Section 130 of the Energy and Water Development Appropriations Act (EWDAA) of 2008, (Pub. L. No. 110-161, § 130, 121 Stat. 1844, 1947 (2003)). Significant changes to the authorized project cost were recommended in the Second Addendum to the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works (ASA(CW)), but Congress acted to raise project costs before the 2002 report could be forwarded to Congress. (*See* Section 129 of the EWDAA of 2004, (Pub. L. No. 108-137, §129, 117 Stat. 269, 1839 (2003)) raising the authorized total cost of the project to $205,000,000. The current estimated cost of the authorized project is $320,700,000.

3. Project Description

The ARCF GRR study area, shown in the map below in Figure 1, has been divided into two basins: American River North and American River South, which were furthersubdivided into study reaches. This report covers the following areas:

- 12 miles of the north and south banks of the American River immediately upstream of the confluence with the Sacramento River
- 26 miles of the Natomas East Main Drainage Canal and tributaries (NEMDC)
- 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek
- Borrow and disposal sites that are within an approximate 25 mile radius of the City of Sacramento

For the purposes of the feasibility planning process, the two study area basins were further subdivided into reaches based on common properties, such as geographic features. In general, this Report presents information either by basin or reach. However, in some cases the report structure deviates from basin or reach based organization. For instance, geology and geomorphology, construction history, and past performance are better related to channel features than basin related reaches. Therefore, for those topics, the information has been presented in the following groups: American River (both banks), Sacramento River (south of the American River confluence), and East Side tributaries (Dry and Robla Creeks, NEMDC east, and Arcade Creek), and Magpie Creek.

The American River North Basin (ARN) includes levees on the north (right) bank of the American River upstream of NEMDC, the east (left) bank of NEMDC from the American River to Arcade Creek and from Arcade Creek to Dry/Robla Creeks, both banks of Arcade Creek, both banks of Dry/Robla Creek, and Magpie Creek. The levees in the American River North Basin have been divided into eight planning reaches; ARN A, B, C, D, E, F, and I.

The American River South Basin (ARS) includes levees on the south bank (left) bank of the American River upstream of the Sacramento River and the east (left) bank of the Sacramento River from the American River to Freeport. The levees in the American River South Basin have been divided into seven planning reaches; ARS A, B, C, D, E, F, and G.

The American River Common Features GRR has identified significant and extensive seepage, stability, overtopping and erosion problems with the levees that reduce the risk of flooding for the Sacramento area, and recommendations to address these problems are the focus of this Recommended Plan. Due to the potential for catastrophic consequences associated with a levee failure in this urban area, all identified problems, including vegetation and encroachment issues require correction in order to reduce the flood risk to an acceptable level. However, risk reduction measures must be implemented in a "worst first" manner in order to immediately maximize the amount of risk reduction realized for each increment of investment. The levee improvement methods would combine a variety of potential designs described in Section 4 description of lands, easements, right of way, relocations and disposals (LERRD's) of this report and keep the project features within the existing footprint of the American River Common Features Project as much as possible. The project area includes portions of the Sacramento and American River Watersheds. The floodplain includes most of the developed portions of the City of Sacramento and portions of Sacramento County. The study area also includes the Sacramento Weir and Bypass in Yolo County,

California.

The final array of alternatives includes:

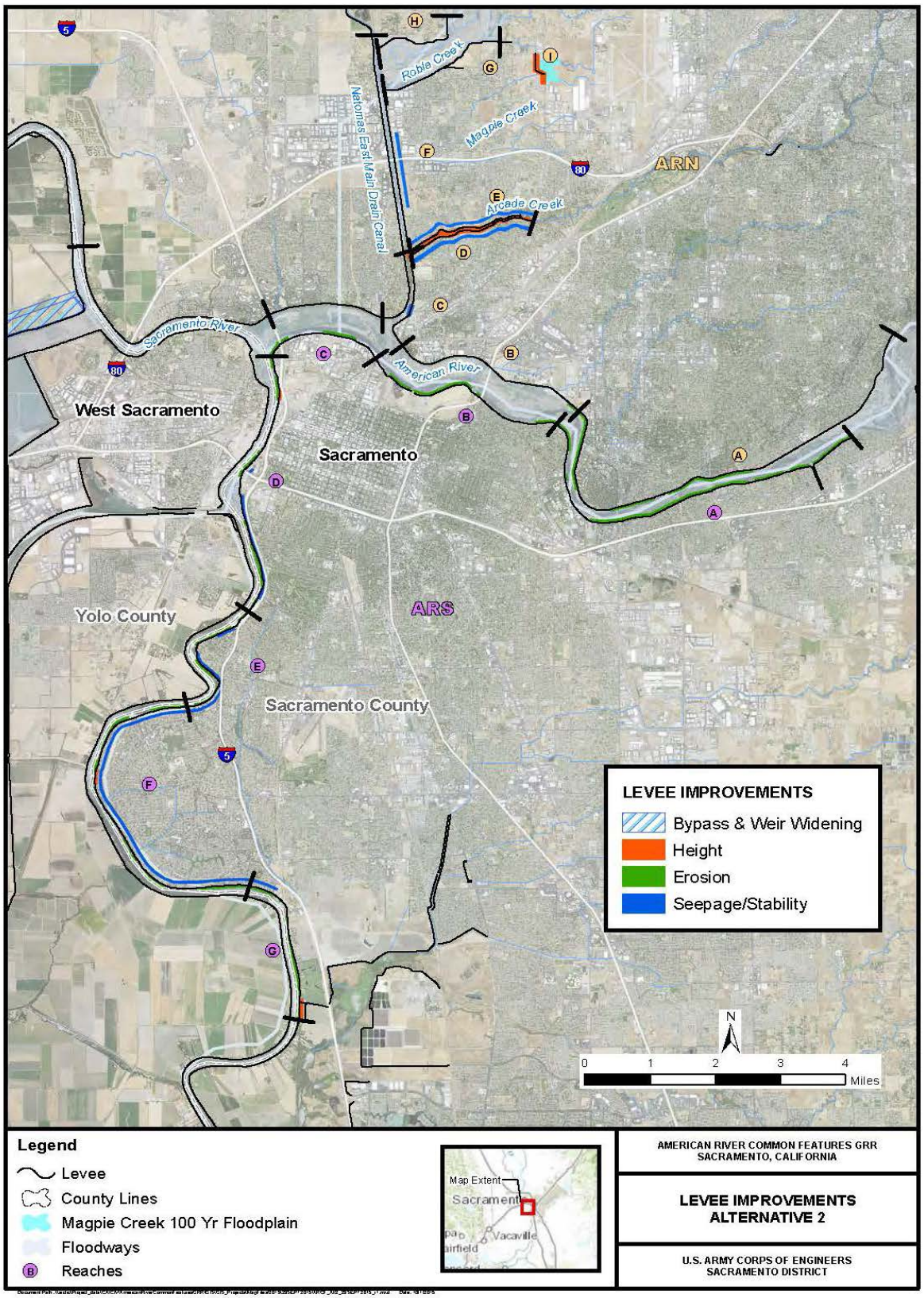
Alternative 1 would include the construction of levee improvement measures to address seepage, stability, erosion, and height measures identified for the Sacramento River, Natomas East Main Drainage Canal (NEMDC), Arcade, Dry/Robla, and Magpie Creeks. Alternative 1 would also include erosion measures for specific locations along the American River. This alternative combines construction of levee improvement measures while maintaining the present levee alignment in its existing location (fix in place). Due to the urban nature and proximity of existing development within the American River North and South basins, Alternative 1 proposes to improve the levees within their existing footprint, with minimal additional real estate requirements. The purpose of this alternative would be to improve the flood risk management system to safely convey flows to a level that maximizes net benefits.

Alternative 2 – Alternative 2 would include the levee improvements discussed in Alternative 1, except for the extent of levee raises along the Sacramento River. While Alternative 1 would include about 7 miles of levee raising, Alternative 2 would only require about 1 mile of levee raising. The Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The levees along the American River North Basin Tributaries, including the NEMDC, Arcade, Dry/Robla, and Magpie Creeks, would be improved to address identified seepage, stability, erosion, and height concerns through the methods described under Alternative 1. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns though the measures described under Alternative 1. Rock erosion protection would be placed on the American River levees to reduce the risk of erosion. Due to environmental, real estate, and hydraulic constraints within the American River North and South basins, the majority of the levees would be improved within the existing levee footprint with minimal additional real estate requirements.

The project alternatives consist of components and cost estimates of the various reaches which will be described in further detail below.

This real estate plan identifies the real estate costs for the Recommended Plan (Alternative 2) – Improve Levees and Widen the Sacramento Weir and Bypass.

FIGURE 1 AMERICAN RIVER BASINS AND PROJECT REACHES



4. Description of LERRD's

The Lands, Easements, Right of Way, Relocations and Disposal (LERRD's) requirements for the REP for the Recommended Plan are estimated at $90,938,477. There are an estimated 495 parcels and 369 ownerships that equate to 1,720 acres that are included in the Recommended Plan.

Bank Protection – There are 287.31 acres of bank protection required along the Sacramento and American Rivers. This easement needed for construction and maintenance of erosion protection features. Included are the rights to trim and cut vegetation, shape and grade slope, and replace riprap. The easement includes all area required to construct and maintain erosion protection features that are outside of the Flood Protection Levee Easement. Two erosion protection measures have been proposed that could be implemented in combination along the levee alignment depending on bank geometry, existing habitat and existing land use. Rock bank protection and launchable rock trenches will address erosion problems along portions of the American River north and south levees and along the Sacramento River.

Flood Protection Levee Easement – There are 142.55 acres of flood protection levee easements needed for new levees, levee raises, flood walls, cutoff walls, and seepage berms. These include the right to construct, maintain, repair, operate and patrol the flood protection features. This easement includes all area from landside toe to waterside toe of the existing and/or proposed levee.

Permanent Road Easement – Easement for O&M inspection zone at the landside toe. .210 acre required for new access road. This easement would allow easier access for flood fighting activities as well as inspections required for the Rehabilitation and Inspection Program (RIP) under Engineering Regulation (ER) ER 500-1-1 and Public Law (PL) 84-99.

Permanent Flowage Easement – There is a total of 337.78 acres of land that will be subject to permanent flooding as a result of new levees in the Sacramento Bypass (257.22 acres) and a new levee with floodgates, levee raise, floodplain preservations with culvert improvements near Magpie Creek. (80.56 acres)

Temporary Work Area Easements – Staging is required every mile along the length of the project. Majority of the staging areas will be located in the river parkways, and other publically owned areas along the rivers. Staging areas will accommodate batch processing stations for slurry walls, construction vehicles, and temporary storage for disposal and construction materials. The total staging acres required are estimated at 40 acres. The haul routes will be existing public roads and utilizing the existing roads on top of levees. For cost estimating purposes we calculated a certain acreage for each reach of the project for staging areas. All staging areas are not yet identified on cadastral maps. The remaining temporary work area easements are located on existing federal levees for a total of over 227 acres.

Borrow Easements – Borrow easements are required for potential borrow and disposal sites as shown in the borrow map Figures 2 and 3. It is anticipated that 407.25 acres or 1,612,009 cubic yards of potential borrow sites material is required for construction of the proposed project. It is anticipated that significant quantities of material will be required for construction of the proposed project. Several different improvement measures such as seepage berms, cutoff walls, embankment construction -reconstruction, and erosion protection are proposed.

The material is expected to be sourced from several sites including; newly identified borrow sites within approximately 25 miles of the study area, existing borrow sites identified for the Natomas Basin by SAFCA, the Deep Water Ship Channel dredge disposal area, the existing levees, and existing commercial sources. Test pits and laboratory testing on materials collected from test pits were provided by SAFCA as part of the Natomas Levee Improvement Program (NLIP) for borrow sites established for the Natomas Basin. Additionally, the Sacramento District has studied the Deep Water Ship Channel spoil areas as a borrow source several time in the past, and a discussion of that borrow source is included below. Typically projects constructed by the Sacramento District utilize commercial borrow sites near the project area.

It is anticipated that the required soil fill import for the proposed project will exceed the capacities of the already identified borrow sites in the Natomas Basin, and obtaining significant quantities of material from commercial sites may be cost prohibitive. Therefore, a desktop regional borrow study was performed to identify potential borrow sites, within 25 miles of the study area, where enough soil could be sourced to satisfy the project needs. This study was performed by obtaining National Resources Conservation Service (NRCS) National Cooperative Soil Survey (NCSS) data, sorting the NCSS data based on material classification and engineering properties, using aerial photographs to identify areas of open or agricultural land, and then merging the sorted NCSS data with the open or agricultural land areas to obtain locations, acreage, and volume of potential borrow sites. Results of the desktop regional borrow study indicate adequate materials available within the assumed 25 mile area.

A map that proposed potential sites was created and several potential sites identified. The rough assumptions the Corps used was the material had to meet geotechnical requirements either by open undeveloped land or agricultural areas, and was located between ground surface and a depth of 2.5 feet below ground surface. In the high confidence areas in each basin the estimated amount of borrow needed within a 25 mile haul route radius is calculated below with costs for borrow. The high confidence areas were defined as areas where up to 48 inches of borrow could be excavated as opposed to the low confidence areas where only up to 12 inches of material would be available where 3 times the amount of land would be required. The below quantities estimate the potential quantities of material required and the cost.

American River South Basin High Confidence Area requires 69.76 AC of land for 275,743 CY of borrow = $453,400 + (35% cont + 15% severance= 226,700) = $680,100

American River North Basin High Confidence Area requires 0.64 AC of land for 2,519 CY of borrow =$4,186 (35% cont + 15% severance $2,093) = $6,279

Natomas Basin High Confidence Area requires 337.43 AC of land for 1,333,747 CY of borrow = $2,193,295 (35% cont + 15% severance = $1,096,647.50) = $3,289,942. The below map shows high confidence areas of available borrow where up to 48" of material can be excavated at one time.

The estates, project features, type of ownership and acreage required by reach for the project are shown in Table 1 with associated location maps.

TABLE 1 - LERRD'S FOR RECOMMENDED PLAN

American River South Basin

ARS REACH A	Erosion Protection		
Features	4 Ownerships	Estate	Acres
Bank Protection Rock Trench	5 City parcels, 29 County of Sacramento parcels, 5 Cal Trans parcels	Bank Protection Easement	61.41
		Total	61.41

American River South Basin

ARS REACH B	Erosion Protection		
Features	7 Ownerships	Estate	Acres
Bank Protection Rock Trench	3 Private parcels	Bank Protection Easement	.970
Bank Protection Rock Trench	1 Cal Trans parcel, 6 City of Sacramento Parcels and 2 County of Sacramento parcels, 1 DOT parcel	Bank Protection Easement	15.076
		Total	16.046

American River South Basin

ARS REACH C	Erosion Protection		
Features	6 Ownerships	Estate	Acres
Bank Protection Rock Trench	6 Private parcels	Bank Protection Easement	2.65
Bank Protection Rock Trench	1 Cal Trans parcel, 5 City parcels/6 County of Sacramento parcels, 1 DOT parcel	Bank Protection Easement	11.11
		Total	13.76

American River

ARN REACH A	Erosion Protection		
Features	8 Ownerships	Estate	Acres
Bank Protection Rock Trench	4 Private parcels	Bank Protection Easement	5.84
Bank Protection Rock Trench	3 Sponsor parcels, 27 parcels County of Sacramento	Bank Protection Easement	39
		Total	44.81

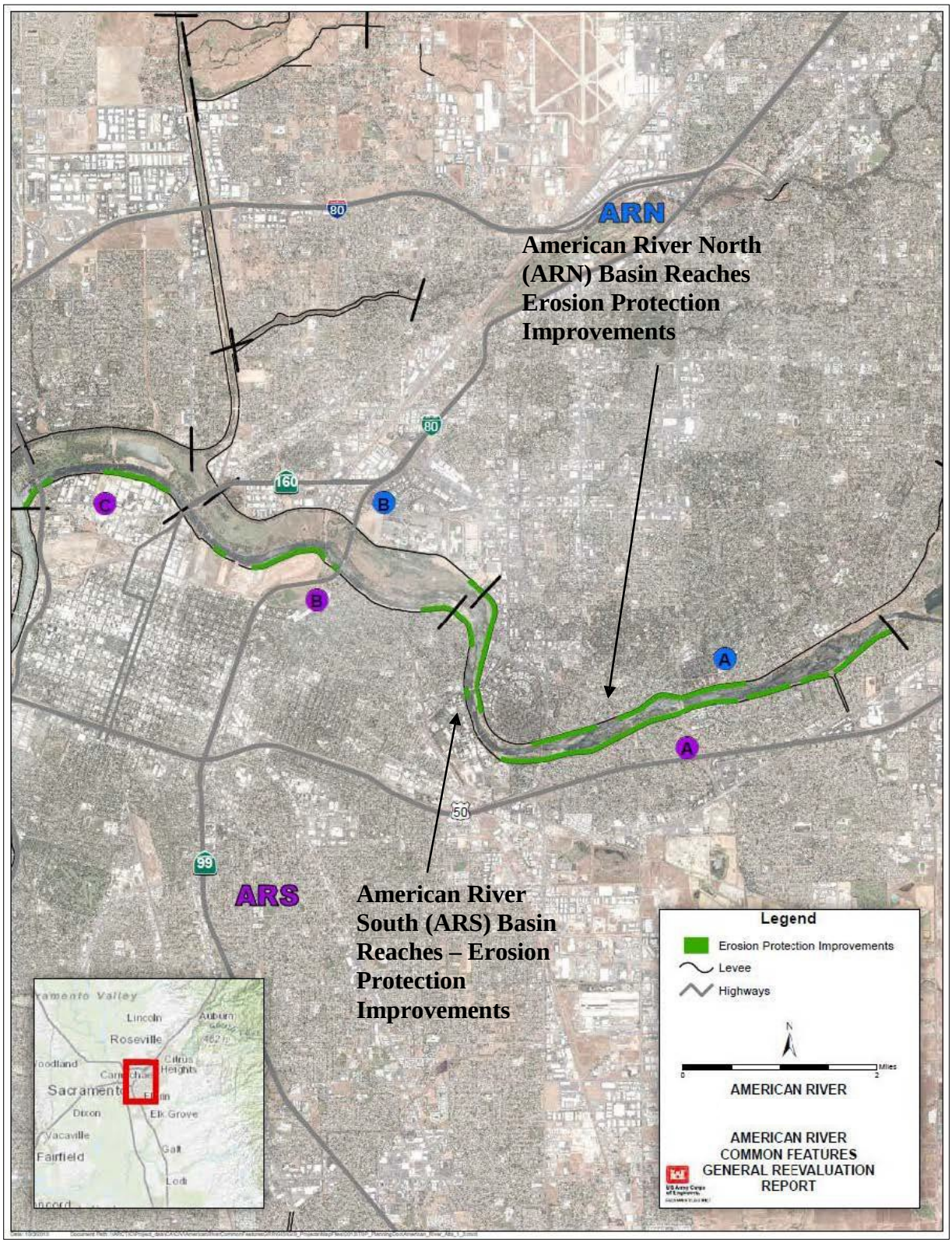
American River

ARN REACH B	Erosion Protection		
Features	2 Ownerships	Estate	Acres
Bank Protection Rock Trench	1 State of CA parcel, 1 County of Sacramento parcel	Bank Protection Easement	2.41
		Total	2.41

American River

ARN REACH C	NEMDC		
Features	2 Ownerships	Estate	Acres
Cut off Wall/Flood Wall	3 City of Sacramento parcels, 4 parcels County of Sacramento	Temporary Work Area Easement	3.71.
		Total	3.71

FIGURE 2: Location Maps of Reaches ARN A, B, and C and ARS A, B and C. Erosion Protection Improvements shown in green.



Sacramento River

ARS REACH D			
Features	9 Ownerships	Estate	Acres
Bank Protection Rock Trench 2 – 4 'Floodwall Cutoff Wall Seepage Berm at Pioneer Reservoir	5 Private parcels	Temporary Work Area Easement for Staging	.344
Bank Protection Rock Trench	2 Private parcels	Bank Protection Easement	1.57
Flood wall, Cut off Wall, Seepage Berm at Pioneer	5 State parcels, 14 City parcels	Flood Levee Protection Easement	3.87
Bank Protection Rock Trench	5 State parcels 13 City parcels	Bank Protection Easement	19.41
Bank Protection Rock Trench 2 – 4 'Floodwall Cutoff Wall Seepage Berm at Pioneer Reservoir	5 State parcels 13 City parcels	Temporary Work Area Easement for Staging	2.49
		Total	27.68

Sacramento River

ARS REACH E			
Features	59 Ownerships	Estate	Acres
120' DSM Cut off Wall	58 Private parcels	Flood Protection Levee Easement	18.02
Bank Protection	3 Private parcels	Bank Protection Easement	3.17
120' DSM Cut off Wall	3 State of CA parcels 2 City of Sacramento parcels, 1 sponsor owned parcel	Flood Protection Levee Easement	8.48
Bank Protection	3 State of CA parcels, 8 City of Sacramento parcels	Bank Protection Easement	17.17
		Total	46.84

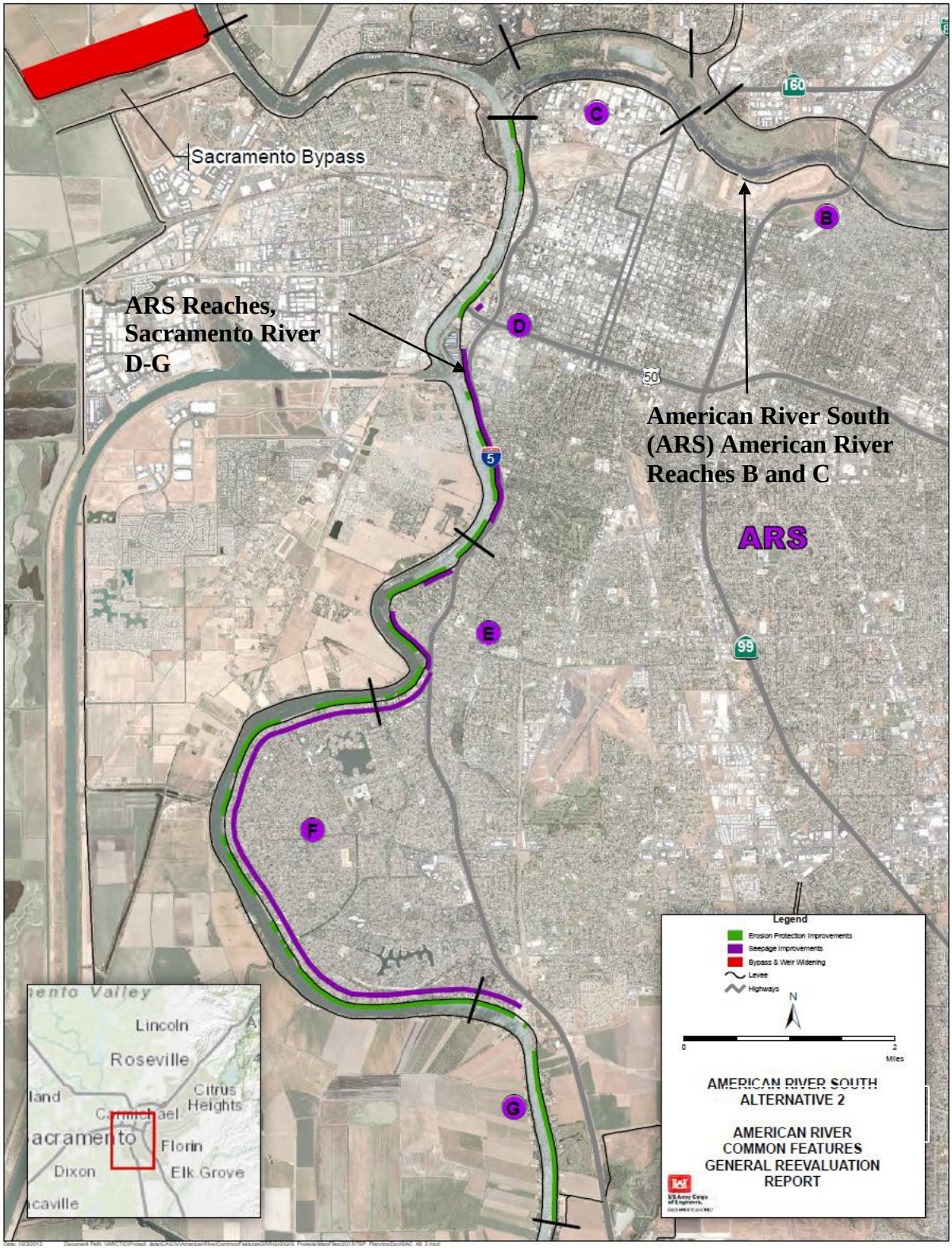
Sacramento River

ARS REACH F			
Features	128 Ownerships	Estate	Acres
Cut off Wall, Flood wall	1 Private parcels	Flood Protection Levee Easement	.499
Bank Protection	5 Private parcels	Bank Protection Easement	14.57
Existing Levee/Levee Raise	130 Private parcels	Temporary Work Area Easement	59.31
Bank Protection Rock Trench	1 State of CA parcel, 35 City of Sacramento parcels	Bank Protection Easement	23.05
Existing Levee/Levee Raise	1 State of CA parcel, 5 City of Sacramento parcels	Temporary Work Area Easement	4.69
		Total	111.32

Sacramento River

ARS REACH G			
Features	20 Ownerships	Estate	Acres
DSM Cut off Wall	Private 21 parcels	Flood Protection Levee Easement	21.20
Geotextile Stabilized Slope	Private 1 parcel	Bank Protection Easement	4.79
Raise Existing Flood Wall	Private 5 parcels	Temporary Work Easement	2.95
DSM Cut off Wall	2 State of CA, 2 City of Sacramento, 1 County parcel	Flood Protection Levee Easement	5.35
Geotextile Stabilized Slope	10 State of CA, 2 City of Sacramento, 1 County parcel	Bank Protection Easement	14.66
Raise Existing Flood Wall	2 State of CA, 2 City of Sacramento, 1 County	Temporary Work Easement	.568
		TOTAL	49.51

FIGURE 3: Sacramento River Improvements ARS Reaches D-G (Erosion Protection = green lines, Seepage improvements = purple lines, Sacramento Bypass widening = red)



Sacramento River

SAC BYPASS	Enlarge existing bypass		
Features	10 Ownerships	Estate	Acres
Bypass Flowage Area	4 Private parcels	Flowage Easement	123.46
New Levee	4 Private parcels	Flood Protection Levee Easement	107.86
Bypass Flowage Area	1 Sponsor owned parcel	Flowage Easement	133.76
New Levee	1 Sponsor owned parcel, 1 County parcel	Flood Protection Levee Easement	1.63
		TOTAL	366.71

Widening of the Sacramento Weir and Bypass to reduce the water surface elevation in the Sacramento River and allow more water to flow into the Bypass system.

Aerial View of Sacramento Weir FIGURE 4

East Side Tributaries

ARN REACH D	Arcade Creek S. Bank		
Features	28 Ownerships	Estate	Acres
Flood wall/Geotextile reinforced slope	3 Private parcels	Temporary Work Area Easement	2.40
Flood wall/Geotextile reinforced slope	20 Private parcels	Flood Protection Levee Easement	17.37
Flood wall/Geotextile reinforced slope	3 American River Flood Control District, 2 City of Sac, 1 Twin Lakes Public School	Temporary Work Area Easement	.085
Flood wall/Geotextile reinforced slope	3 American River Flood Control District, 3 City of Sac, 1 Twin Lakes, Public School	Flood Protection Levee Easement	.516
		Total	20.37

East Side Tributaries

ARN REACH E	Arcade Creek North Bank		
Features	41 Ownerships	Estate	Acres
Cut off Wall/Flood Wall/	23 sponsor owned parcels	Flood Protection Levee Easement	.541
Cut off Wall/Flood Wall	1 Private parcels	Temp work area easement	.042
Cut off Wall/Floodwall	23 Private parcels	Flood Protection Levee Easement	10.62
		Total	11.23

East Side Tributaries

ARN REACH F	NEMDC		
Features	3 Ownerships	Estate	Acres
Cut off Wall/Flood Wall/ Replace existing w/closed box culvert	7 RD 1000 parcels 9 W. Pacific Railroad parcels 1 Cal Trans, 1 City of Sacramento Parcel	Temporary Work Area Easement	20.73
		Total	25.600

East Side Tributaries

ARN REACH I	Magpie Creek		
Features	30 Ownerships	Estate	Acres
New Levee with floodgates, Levee Raise, Floodplain Preservation, Culvert Improvements	4 Sponsor owned parcels, 1 USA AF Base parcel, 3 Private parcels	Temporary Work Area Easement	1.73
New Levee with floodgates, Levee Raise, Culvert Improvements	4 Sponsor owned parcels, 1 USA AF Base parcel, 5 Private parcels	Flood Protection Levee Easement	3.41
Floodplain Preservation	4 Sponsor owned parcels, 20 Private parcels	Flowage Easement	80.37
New Levee with floodgates, Levee Raise, Floodplain Preservation, Culvert Improvements	1 Private parcel	Temporary Work Area Easement	.119
New Levee with floodgates, Levee Raise, Culvert Improvements	1 Private parcel	Flood Protection Levee Easement	.156
		Total	85.78

Figure 5: Eastside Tributaries – Levee Improvements

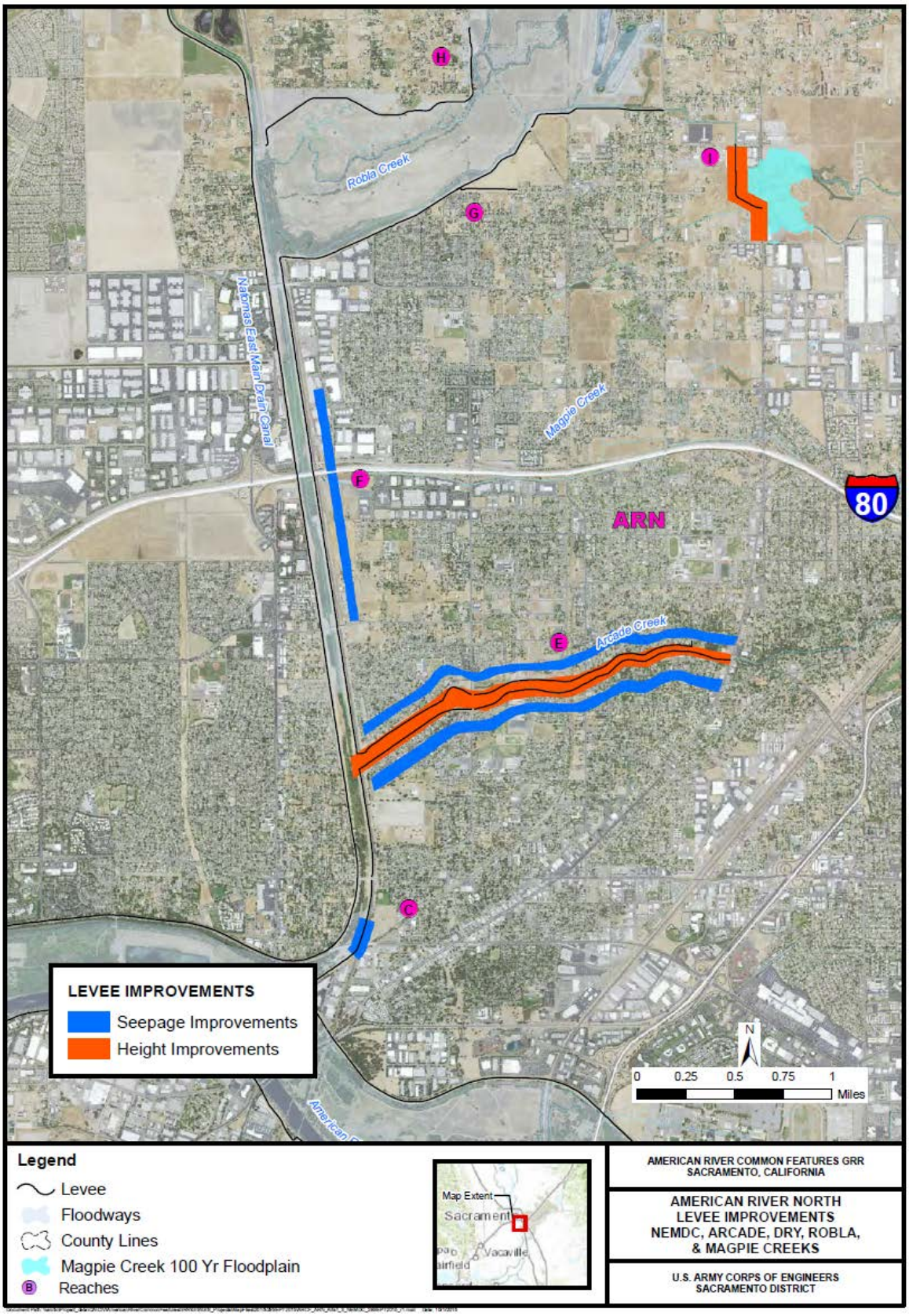
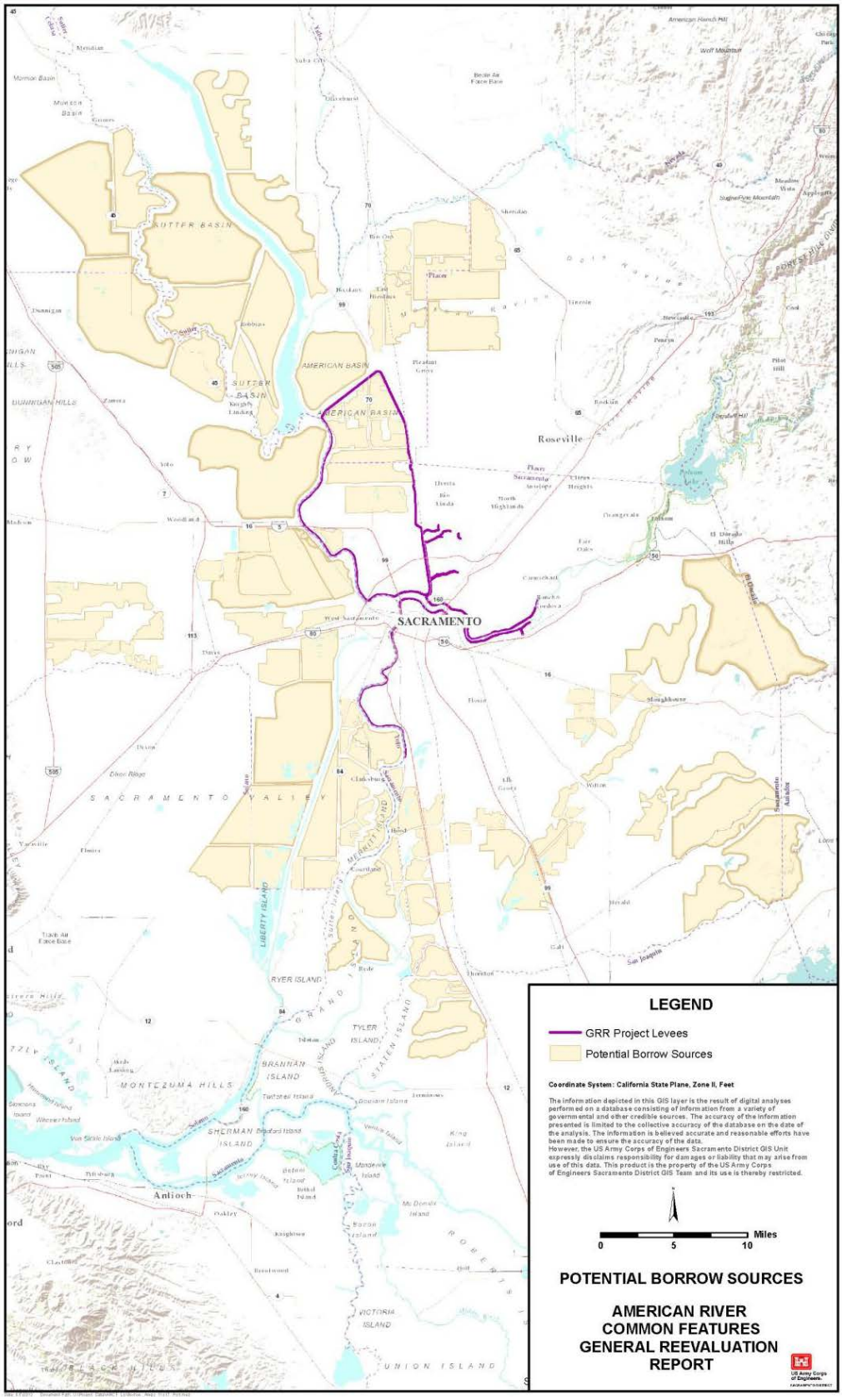


Figure 6: Proposed Borrow Sites within 25 Miles of Construction Sites



Environmental Mitigation – The following table summarizes environmental mitigation needs. Specific lands for compensation have not been identified; however, lands considered will provide similar habitat to that being impacted. The Corps has determined that mitigation for giant garter snake, Delta smelt, wetlands, and vernal pools would occur at a mitigation bank. If available, the Corps would also seek a mitigation bank for green sturgeon mitigation. Due to the significant value of the remaining mature riparian habitat along the Sacramento and American Rivers, and the significant loss of habitat value that would occur due to project impacts, the Corps would mitigate onsite for SRA, riparian, oak woodland, and elderberry habitats. If sufficient acreage is not available onsite for these habitat types, then the Corps would seek offsite options within the American River Parkway. More information regarding the Corps mitigation strategy is included in the Mitigation, Monitoring, and Adaptive Management Plan (Appendix F of the GRR).

Table 2 Environmental Impacts of and Proposed Mitigation/Compensation for the Recommended Plan (1)

Habitat Type	Potential Impacts	Duration of Impact	Mitigation (Acres/Linear Feet)	Cost at Mitigation Bank	Cost On- or Off-Site within Study Area
GGS Uplands	30 acres 75 acres	Permanent Temporary	90 acres 75 acres	$4,500,000	N/A*
GGS Aquatic	15 acres	Permanent	45 acres	$2,250,000	
Riparian	150.6 acres	Permanent	301.2 acres		$16,566,000
Shaded Riverine Aquatic Habitat	82,325 lf	Permanent	82,325 lf		$19,020,000**
Elderberry Shrubs	3,292 stems	Permanent	1,715.6 credits 70.89 acres		$6,026,000
Vernal Pools	1 acre	Permanent	1 acre	$275,000	---
Green Sturgeon	20 acres	Permanent	Restore acres, monitoring, and fish passage features		$16,259,000
Delta Smelt Spawning Habitat	34 acres	Permanent	34 acres	$4,160,000	
Shallow Water Habitat (Delta Smelt)	14 acres	Permanent	42 acres	$5,460,000	
Oak Woodland	2 acres	Permanent	4 acres		$200,000
Wetlands	0.4 acres	Permanent	0.8 acres	$130,000	---
Sub-Total				**$16,775,000**	**$58,341,000**

* 75 acres of temporary effects to GGS habitat from the relocation of the Sacramento Bypass toe drain would consist of standard site restoration erosion control features such as hydroseeding. This is contained within construction costs and is not considered a mitigation cost.

** SRA habitat mitigation is provided in the project's cost estimate as a separate construction cost rather than a mitigation cost, since it is a feature of the bank protection designs and would be included as a part of the construction contract. The cost is displayed under the Fish and Wildlife Facilities account as "Construction" costs and is estimated to be approximately $231 per linear foot.

Additionally, during the design phase of the project, opportunities will be taken to choose a design that will minimize effects to the American River Parkway where feasible. After coordination with federal and state agencies, potential mitigation sites will be displayed in the design memorandum and refined during design phase.

Overall, after implementation of mitigation components, the mitigation sites would be monitored throughout the year for a minimum of 3 years, or until the mitigation sites are considered successful. A mitigation, monitoring, and adaptive management plan was developed and is included as Appendix I of the EIS/EIR.

In an effort to modernize the levee system to meet current engineering standards, vegetation and encroachment issues (including landside levee access) in the study area will be resolved through a combination of construction actions associated with implementation of the recommended plan and formal agreements such as a System Wide Improvement Framework Policy (SWIF) which allows specific vegetation and/or encroachments to remain in place permanently or defer their resolution to some future date. A SWIF provides committed sponsors the opportunity to transition their levees over time to USACE standards. By using a SWIF, sponsors can prioritize deficiencies to address the highest risk first to achieve system-wide risk reduction.

In preparing the requirements for a SWIF, USACE recognized that sponsors may engage at the federal, state, and local levels to address complex levee system issues in a more long-term, comprehensive approach to identify solutions that optimize resources; prioritize improvements and corrective actions based on risk; and coordinate overlapping or competing programs and requirements.

A SWIF is appropriate when a longer-term, holistic approach may be necessary to address multiple engineering deficiencies and operation and maintenance deficiencies; when broader improvements involve multiple levee segments/systems; or when additional time and coordination are needed to consider complex, endangered species habitat or Native American concerns, or encroachment concerns in highly urbanized areas while meeting requirements for levee safety.

In the case of construction associated with the recommended plan, vegetation and encroachment removal is anticipated as ancillary to the primary flood risk management measure (i.e. seepage cutoff barrier, levee raise, slope flattening) being constructed. In the case of a formal agreement, the integrated use of a SWIF and a variance from vegetation standards would both be required to ultimately assure compliance with Engineering Technical Letter (ETL) 1110-2-571 "*Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*".

The SWIF would address vegetation and encroachment issues (including landside levee access) not removed as part of construction associated with the recommended plan but deemed unacceptable in terms of compliance with the engineering technical letter (ETL). A variance to vegetation management will be developed during PED to allow for vegetation to remain on the lower portion of the waterside levee slope. If a variance is not approved, the recommendations for this portion of the project will be reformulated.

Complete implementation of the Recommended Plan will be assumed to occur at the same time as complete implementation of the SWIF. Based on current experience in the watershed, the complete implementation of these two plans can reasonably be expected to occur within 20 to 40

years from the approval of the Chief's Report for the GRR.

Two assumptions were made in this SWIF analysis – (1) that the existing levee easement locations are continuous and extend from waterside toe to 10 feet beyond landside levee toe which would eliminate new permanent road easements (2) The cost estimate assumes the State has existing right of way on existing levees. If it is confirmed that the state has existing rights prior to construction a temporary construction easement would be executed in lieu of a permanent flood protection levee easement.

Figure 7: Sacramento River Levee Improvements with System Wide Improvement Framework Policy no Levee raises

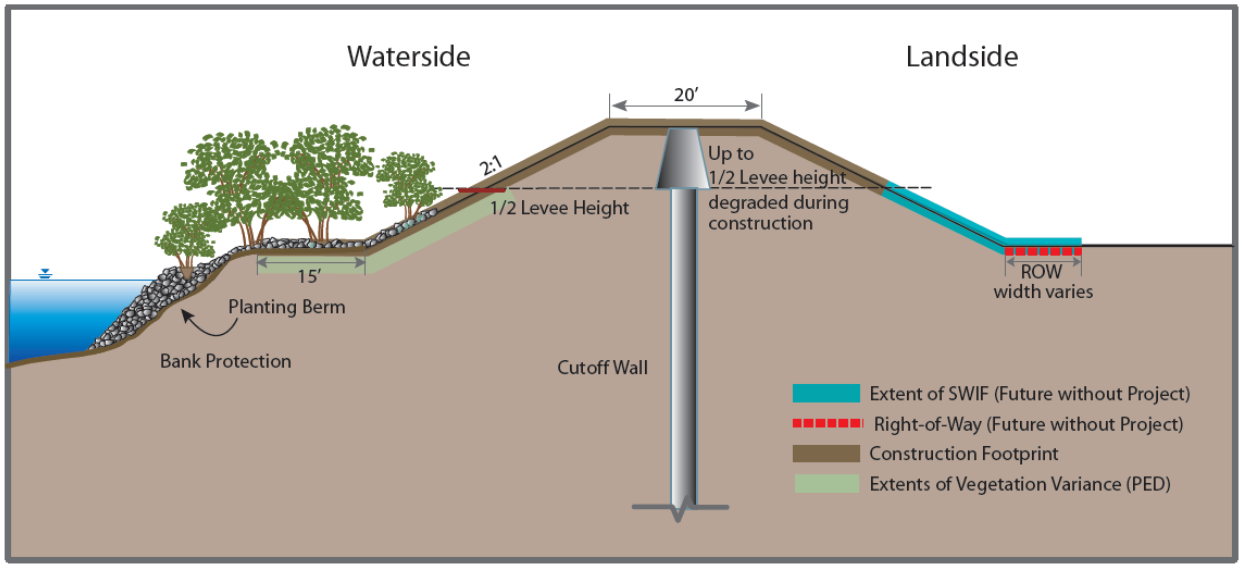
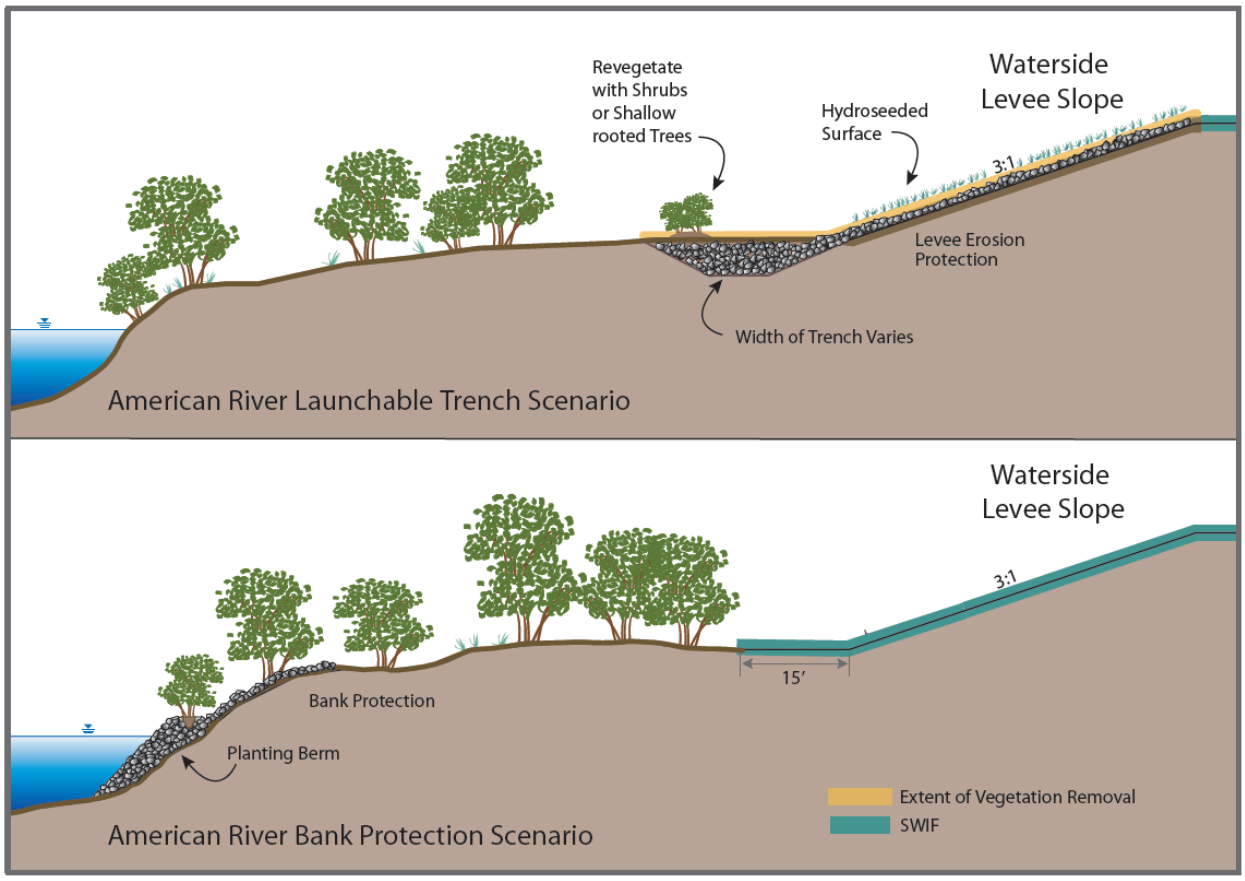


Figure 8: American River Levee Improvements with System Wide Improvement Framework Policy no Levee raises



Disposal Sites

Majority of the deconstructed levee material will be recycled and reused in this project. There may be small amounts of disposal material that will be disposed of at the local landfill. Disposal areas need to be selected on least costly areas.

Railroad Parcels

An inventory of the railroad parcels impacted by this project is as follows:

Reach	Railroad	Easement Required
ARS Reach G	Southern Pacific Railroad	Temporary easement 2 parcels
ARN Reach B	Southern Pacific Railroad	Bank Protection easement 1 parcel
ARN Reach D	Northern Sacramento Railway	Temporary Easement 1 parcel
ARN Reach F	Western Pacific Railroad	Temporary Easement 3 parcels
Sacramento Bypass	Sierra Northern Railway Trestle	Levee Easement & Flowage Easement 1 parcel

Figure 9: Sierra Northern Railway Bridge crossing over the Sacramento Weir

The construction of the widened Sacramento Weir and the adjoining railroad will likely be phased as follows. First, the new weir and railroad trestle will be constructed adjacent to the existing Sacramento River levee and the embankment of the railroad. Second, a slight jog in the railroad alignment will be constructed tying in the new trestle to the existing railroad line (both to the south tying into the existing weir/trestle structure and to the north tying into the continuation of the rail line. Then, after the new north levee has been constructed and the Sacramento River levee that would then be within the bypass has been removed, the entire widened Sacramento Bypass would be operational.

The actual disruption to the railroad is expected to be minimal because they will be kept in operation during the entire duration of construction of the new weir and trestle and would only need to be shut down during the time it takes to tie into the existing tracks which is expected to take not more than one month. With this plan, there will not need to be a temporary railroad line established and the associated costs would not need to be incurred. Coordination with Sierra Northern Railroad General Manager in Woodland will continue through the planning and construction phases of the project.

The other easements areas crossing over railroad parcels should not prevent the trains from moving and include no closure structures.

5. LERRD'S Owned by the NFS and Crediting

The following parcels represent sponsor owned lands as shown in Table 3. The primary non-Federal sponsors are the State of California Central Valley Flood Protection Board, California and the Sacramento Area Flood Control Agency (SAFCA). The State has a joint use agreement with Reclamation District 1000 in Natomas Basin for access. The State has a joint use agreement for access with the American River Flood Control District. The non-Federal sponsors already have access easements in the prior federally constructed levees. Those existing rights will not be cost- shared items. The project foot print of the levees has expanded and many additional areas

are now required for this project. Parcels already owned by Sacramento and San Joaquin Drainage District (State of California) and the SAFCA are included in this inventory as well. State owned lands associated with Department of Water Resources and Sacramento and San Joaquin Drainage District are considered to be sponsor owned and available for the project. Other California State agencies such as Cal Trans and State Parks are not considered to be sponsor owned and will require a new easement executed. For Alternative 2 the Non Federal sponsors own a total of 64.32 acres. There are two parcels in the Sacramento Bypass owned by the Sacramento and San Joaquin Drainage District but the construction footprint parcels for the Bypass expansion are owned by private farmers. However, these 64.32 acres identified in the tract registers are assumed sufficient to support project purposes/functions, and no inconsistent encumbrances and/or restrictions on said land is anticipated. The potential impact to project costs and/or plan selection as a consequence of this uncertainty is minimal inasmuch as the gross appraisal conservatively estimates the unit costs for the estates required for project purposes and includes seven incremental and improvement contingencies for various unknowns including severance damages, unknowns for level of study definition, unforeseen aspects due to inaccessibility and lack of onsite inspections, cost/value increases from time and development pressure, negotiation latitude above fair market value, potential for excessive cost/awards, potential for unknowns natural resources or minerals, improvement/building contingencies. Accordingly, this contingency assessment should reduce risk and cause no impact to plan selection.

The non-Federal sponsors have existing access easements in the prior federally constructed levees and it has been assumed for purposes of this study that the non-Federal sponsors will be required to acquire temporary work area easements to implement the Recommended Plan and the easement costs have been included in the total project cost estimate. If, during the PED Phase existing levee easements in prior Federally-constructed levees are discovered and available, those existing rights will not be cost-shared, which may lower total project costs.

TABLE 3 Sponsor-Owned Lands Summary

Location of Lands	Acreage
Total Acres Required Sponsor owned ARN	32.66
Total Acres Required Sponsor owned ARS	31.66

6. Standard Federal Estates and Non Standard Estates

Fee

The fee simple title to, subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Flood Protection Levee Easements (FPLE)

A perpetual and assignable right and easement in to construct, maintain, repair, operate, patrol and replace a flood protection levee, including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Temporary Work Area Easements (TWAE)
A temporary easement and right-of-way in, on, over and across for a period not to exceed 2/3 years after the execution of the construction contract, beginning with date possession of the land is granted to the Sponsor or United States, for use by the United States, Sponsor, its representatives, agents, and contractors as a (borrow area) (work area), including the right to borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the American River Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Permanent Road Easement (PRE)
A perpetual and assignable easement and right-of-way in, on, over and across [the lands described in the Exhibit D] for the location, construction, operation, maintenance, alternation and replacement of (a) road(s) and appurtenances thereto; together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way; (reserving, however, to the owners, their heirs and assigns, the right to cross over or under the right-of-way as access to their adjoining land at the locations indicated in [the lands described in the Exhibit D] subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Borrow Easement
A perpetual and assignable right and easement to clear, borrow, excavate and remove soil, dirt, and other materials from [the lands described in the Exhibit D] subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges in said land as may be used without interfering with or abridging the rights and easement hereby acquired.

Bank Protection Easement
A perpetual and assignable easement and right-of-way in, on, over and across the land hereinafter described for the location, construction, operation, maintenance, alteration, repair, rehabilitation and replacement of a bank protection works, and for the placement of stone, riprap and other materials for the protection of the bank against erosion; together with the continuing right to trim, cut, fell, remove and dispose therefrom all trees, underbrush, obstructions, and other vegetation; and to remove and dispose of structures or obstructions within the limits of the right-of-way; and to place thereon dredged, excavated or other fill material, to shape and grade said land to desired slopes and contour, and to prevent erosion by structural and vegetative methods and to do any other work necessary and incident to the project; together with the right of ingress and egress for such work; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however to existing easements for public roads and highways, public utilities, railroads and pipelines.

Flowage Easement
The perpetual right, power, privilege and easement occasionally to overflow, flood and submerge [the lands described in the Exhibit D] (and to maintain mosquito control)in connection with the operation and maintenance of the project as authorized by the Act of Congress approved_____,

together with all right, title and interest in and to the structure; and improvements now situate on the land, except fencing (and also excepting____(here identify those structures not designed for human habitation which the District Engineer determines may remain on the land); provided that no structures for human habitation shall be constructed or maintained on the land, that no other structures shall be constructed or maintained on the land except as may be approved in writing by the representative of the United States in charge of the project, and that no excavation shall be conducted and no landfill placed on the land without such approval as to the location and method of excavation and/or placement of landfill; the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired; provided further that any use of the land shall be subject to Federal and State laws with respect to pollution.

7. Description of Any Existing Federal Projects in or Partially in the Proposed Project

All project designs have taken into account all previous federal projects in the project area and specifically designed around those previous projects. There will be no overlapping areas with the new construction. All previous federal projects are described in the main report in section 1.5 of the main General Reevaluation Report. If any other Federal project completes work contemplated by this GRR, it will be removed from this project's footprint such as Sacramento River Bank Protection Project.

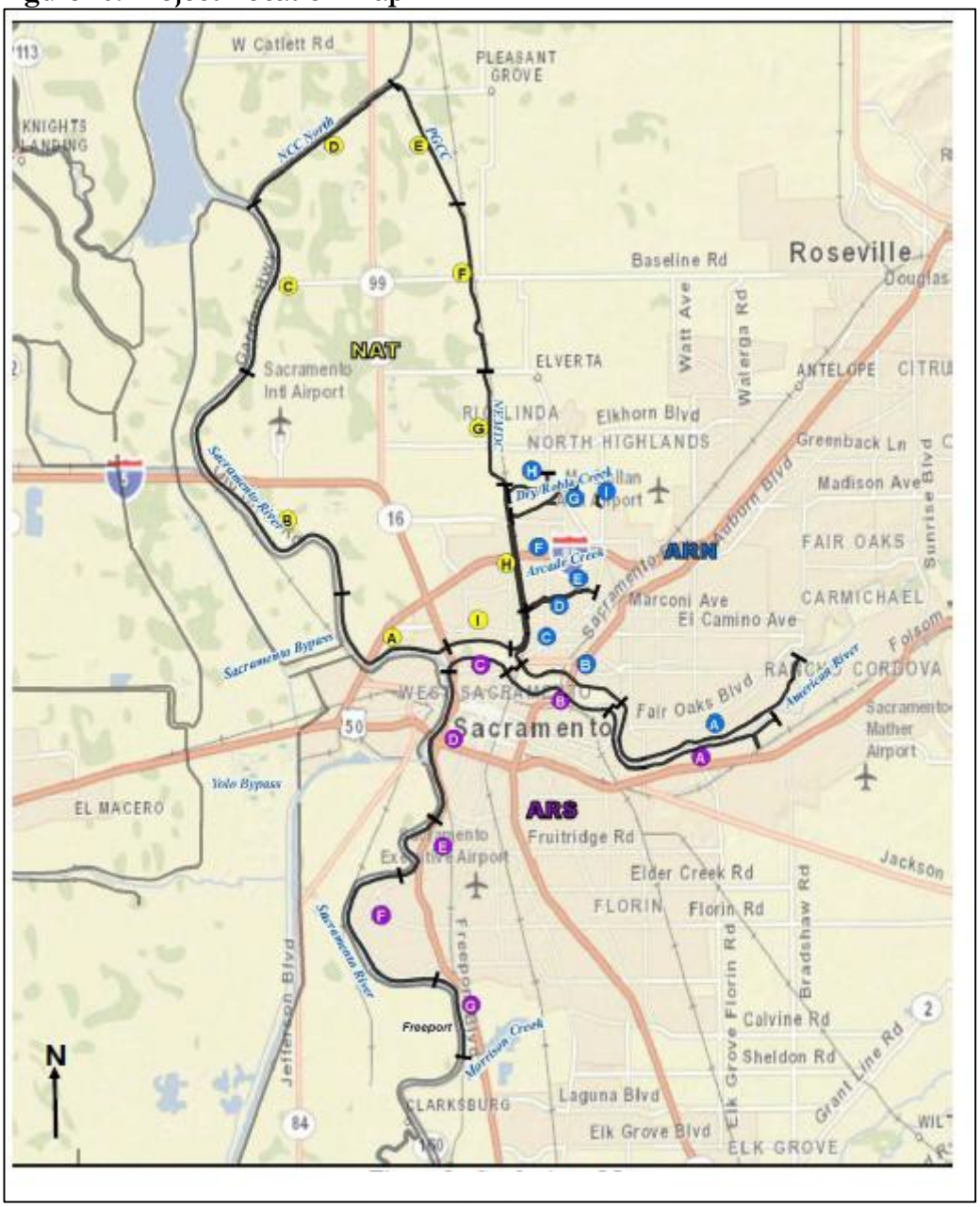
8. Description of any Federally Owned Land Needed for the Project

There is one federally owned parcel (215-0244-011) in ARN Reach I. This area was formerly McClellan Air Force Base. One parcel in the flowage easement area of Magpie creek still belongs to the base according to the county assessor's office. There is one Department of Transportation parcel near the Capitol City Freeway located near the bank protection. It is unknown if the bank protection will encroach into the freeway easement based on the conceptual design. Further refinements will be needed during PED. The remaining lands needed for the construction, operation and maintenance of the Alternative 2 are state, county, city or privately owned.

9. Application of Navigational Servitude to the LERRD's Requirement

The Recommended Plan for erosion/bank protection components meet navigational servitude criteria for rock revetment erosion improvement work completed along the Sacramento and American River (water) side of the levees below the high water mark. The first criterion the federal government must determine is whether the project features serve a purpose in the aid of commerce, navigation, flood control and hydro-electric power. The second step is to determine whether the land at issue is located below the mean or ordinary high water mark of a navigable water course. Construction barges will stay below the ordinary high water mark and the project will not acquire interests in any real property that is already possesses or over which its use or control is or can be legally exercised. Work within the navigable water way will require a permit from the State Lands Commission.

Figure 10. Project Location Map



11. Anticipated Increased Flooding and Impacts

Magpie Creek ARN Reach I – Currently a total of approximately 49 acres on both sides of Raley Blvd. experience flooding during storm events with a 10-year frequency and 70 acres for a 100-year event. The area inundated by a 170-year event with the project in place is estimated to be 72 acres (excluding roadways and channels, the inundated land would be 64 acres). Construction of the proposed improvements would slightly increase the water surface elevation during all flood events greater than a 5 year frequency. During a 170-year event, the increase in water surface is projected to be 0.5 feet at Raley Blvd and 0.1 feet at the western boundary of what was formerly known as the McClellan Business Park. This would increase the inundated area to 78 acres (excluding roadways and channels, 70 acres). Because this is already a floodplain, this project proposes to purchase and preserve the area as floodplain in perpetuity. The proposed project is designed to contain a flood

with a 1 in a 170 chance of occurrence in any given year with 95% reliability. Our sponsors have indicated that they would like to acquire a flowage easement is this area of increased water surface elevations. A physical takings analysis was conducted in December 2000 for Magpie Creek. A final takings analysis will be conducted when the final designs are completed for the Magpie Creek.

Figure 11: Magpie Creek proposed flowage easement general area)

Sac Bypass Reach - Sacramento Bypass Reach is already a designated floodway with executed flowage easements. We will be acquiring additional acreage of flowage easement when we widen the existing bypass. No other increased flooding is anticipated for the project.

12. Cost Estimate

The following is a preliminary analysis estimating the costs of acquiring the required LERRDs to support the NED Plan and the Recommended Plan). There are only two differences between the alternatives. Alternative 2, the LPP, is the Recommended Plan. This alternative costs more than Alternative 1 which is the NED. This Real Estate Plan does not include a detailed description of the Real Estate requirements for Alternative 1 because the features are very comparable between the two

alternatives. This section describes by watercourse the differences, if any, between the two alternatives.

American River North and South Bank: For the American River north and south bank, there is no difference in real estate requirements between the two alternatives.

Natomas East Main Drainage Canal, Arcade Creek, Dry/Robla Creeks, and Magpie Creek: For the Natomas East Main Drainage Canal, Arcade Creek, Dry/Robla Creeks, and Magpie Creek, there is no difference in real estate requirements between the two alternatives.

Sacramento River: For the Sacramento River below the American River, the real estate requirements for seepage, stability, and erosion improvements are identical between the two alternatives. This footprint includes the top half of the levee for seepage and stability improvements as well as the waterside footprint for bank protection construction. On the landside, because of the extent of levee raising is where there is somewhat of a difference between the two alternatives.

Alternative 1 includes approximately 9 miles of levee raising which is being constructed on the landside of the levee. The levee raise is approximately 2 feet, and at a 2 to 1 landside slope, requires four feet of levee easement. In addition to this four feet, an additional 10 feet of access is require for construction purposes. Alternative 2 reduces the extent of levee raising from approximately 9 miles down to below 1. Therefore, Alternative 1 as compared to Alternative 2 has an additional 8 miles of landside real estate take required to accomplish the levee raise required for that alternative. The assumptions used for the reaches of levee raise on the Sacramento River for Alternative 2 were used for the additional 8 miles of levee raising needed for Alternative 1.

Sacramento Bypass: The Sacramento Weir and Bypass widening is not included in Alternative 1 but is in Alternative 2. This feature is fully described in the Real Estate Plan, Section 4, since it is part of the Recommended Plan. The NED, if it were to be fully described in the RE Plan would omit this feature.

In summary, the NED plan, if it were to be fully described in the RE Plan would include a description of approximately 15 feet of landside take (both permanent and temporary) on an additional 8 miles of Sacramento River levee beyond the one mile that is already described in the RE Plan for Alternative 2. The magnitude of these differences are included in the attached tables.

The tables below estimate the costs associated with acquiring real property interests necessary to construct, operate and maintain a local levee project primarily located along the Sacramento and American Rivers within the County of Sacramento. The date of the approved cost estimate was June 11, 2013. The appraiser conservatively estimates the unit costs for the estates required for project purposes and includes several incremental and improvement contingencies for various unknowns including unknowns for level of study definition, unforeseen aspects due to inaccessibility and lack of onsite inspections, cost/value increases from time and development pressure, negotiation latitude above fair market value, potential for excessive condemnation cost/awards, potential for unknowns natural resources or minerals, and improvement/building contingencies.

The below is a summary of Real Estate Costs provided to Cost Engineering:

TABLE 4A NED PLAN COST SUMMARY

Alternative 1 – NED Plan Features	Ownerships	Lands and Damages Incremental RE Cost 25 % Severance	Includes a 35% and

01 ACCOUNT[1] - LANDS AND DAMAGES (Non Fed)		
Non Federal RE Administrative Costs (1377 parcels)		$24,039,500
P.L. 91-646 Payment Assistance relocations		$1,907,000
Subtotal		$25,946,500
Non-Federal Lands/ Damages	Ownerships	
ARS Sacramento River Reach D	9	$1,768,000
ARS Sacramento River Reach E	59	$1,350,000
ARS Sacramento River Reach F	127	$47,090,000
ARS Sacramento River Reach G	24	$4,107,000
ARS American River A	4	$2,434,000
ARS American River B	7	$519,000
ARS American River C	6	$458,000
ARN American River A	8	$1,444,000
ARN American River B	2	$96,000
ARN American River C	2	$326,000
ARN American River D	28	$835,000
ARN American River E	41	$1,228,500
ARN American River F	3	$340,000
ARN American River G	12	$149,000
ARN American River I (Magpie)	30	$29,580,000
Ownership Total	362	
Subtotal Lands and Damages + (Non Federal Admin) Total		(Rounded) $91,724,500 $25,946,500 $117,671,000
Federal RE Admin Costs		(ROUNDED) $9,582,000
	Sub total	(ROUNDED) **$127,253,000**
02 ACCOUNT - RELOCATIONS		
*Utility/Facility Relocation Costs		$101,612,000
Contingency 28.6 %		$27,435,000
Total:		**$129,048,000**
TOTAL LERRD'S COSTS (01 AND 02 ACCOUNTS)		(ROUNDED) $256,301,000

Note - Total Project Cost Summary displayed in Cost Engineering Appendix will include accounts 30 and 31 for all relocations and construction items combined.

TABLE 4B RECOMMENDED PLAN COST SUMMARY

Alternative 2 –Recommended Plan Features	Ownerships	Lands and Damages Includes a 35% Incremental RE Cost and varying Severance Damages
01 ACCOUNT[1] - LANDS AND DAMAGES (Non Fed)		
Non Federal RE Administrative Costs		$24,967,975
P.L. 91-646 Payment Assistance relocations		$690,625
Subtotal		$25,658,600
Non-Federal Lands/ Damages		
ARS Sacramento River Reach D	9	$880,000
ARS Sacramento River Reach E	59	$1,190,000
ARS Sacramento River Reach F	128	$14,370,000
ARS Sacramento River Reach G	20	$2,758,000
ARS American River A	4	$2,434,000
ARS American River B	7	$519,000
ARS American River C	6	$458,000
ARN American River A	8	$1,444,000
ARN American River B	2	$96,000
ARN American River C	2	$326,000
ARN American River D	28	$835,000
ARN American River E	41	$1,228,500
ARN American River F	3	$340,000
ARN American River I (Magpie)	30	$29,580,000
Sac Bypass Widening	10	$4,000,000
Subtotal Lands and Damages + (Non Federal Admin) Total	369	(Rounded) $60,458,400 $25,658,600 $86,117,000
Federal RE Admin Costs		(Rounded) $9,216,000
		$95,333,000
02 ACCOUNT - RELOCATIONS		
*Utility/Facility Relocation Costs Contingency 29.6% Total:		$122,813,000 $34,368,000 **$157,201,000**
TOTAL COSTS (01 AND 02 ACCOUNTS)		**$**252,534,000

* Note - Total Project Cost Summary displayed in Cost Engineering Appendix will include accounts 30 and 31 for all relocations and construction items combined.

13. Relocation Assistance Benefits (PL 91-646)

In addition to Real Estate administrative costs the relocation assistance payments to the property owners is calculated separately. A Relocation Assistance Plan will be provided to the Corp for review by the non federal sponsors. Relocation is dealt with on a case by case basis and costs will vary. Real Estate costs include totaling the land value, improvement value, and severance damages. This inventory of potential full take relocations was based on a >10 percent conceptual design and actual relocations can decrease or be eliminated in design phase. This inventory is for planning purposes only to assist in the development of total project cost for relocation assistance costs. It is estimated for the Recommended Plan that approximately 17 structures will be impacted due to construction of the project. The relocations include 13 residential takes, 2 temporary marina relocations, and 2 commercial building takes.

TABLE 5 RELOCATIONS

Locations	Reach	Number of Structures	Relocation Assistance Payments
American River South	Reach E	1	$32,500
American River South	Reach F	8	$260,000
American River South	Reach G	8	$260,000
		25% contingency ($138,125)	Total = $690,625

Availability of Replacement Housing/Business Properties: There are currently hundreds of single family homes for sale in Sacramento County. At this time there is replacement housing available. There are hundreds of businesses for sale or lease available in Sacramento County as well.

The foregoing impacts and estimates relating to potential displacements, and the anticipated need to provide relocation assistance benefits, are provided exclusively for project cost estimating purposes only and are not intended to be relied upon for provision of benefits and/or the payment of the estimates referenced herein. A draft relocation assistance plan has been provided by the State of California, Department of Water Resources and will be refined during final designs.

14. Mineral/Timber Activity

There are no active timber harvesting or mineral activities currently along the American or Sacramento River along the levees in our project area at this time.

15. Non-Federal Sponsor's Ability to Acquire

The State of California, Central Valley Flood Protection Board, have partnered with the Corps on several prior projects and have a full Real Estate staff capable of fulfilling their responsibilities as the non-Federal sponsor. The State of California, Central Valley Flood Protection Board, have a local partnership agreement with Sacramento Area Flood Control Agency who participate in this project as well.

16. Zoning Anticipated in Lieu of Acquisition

The Corps does not propose use of a zoning ordinance that would essentially facilitate property acquisition by prohibiting certain uses of property instead of purchasing the property. No such ordinance is proposed. The plan assumes purchasing property along the levee.

17. Acquisition Schedule

For economic and construction assessment, it was assumed that once authorized the project would receive annual appropriations ranging from $154M to $177M for construction of the selected plan. The Sponsor cost share was assumed to range from $54M to a maximum of $77M (applied to LERRD's) with $100M as the yearly allotment for the PED and Construction.

The non-Federal sponsors will be directed to begin real property acquisition for the project only after the PPA is fully executed. A risk letter has been sent from the Corps to both the Sacramento Flood Control Agency and the State of California alerting them to the risks associated with purchasing project lands in advance of the PPA execution. The construction contracts extend out ten years. Durations of each tasking after the PPA is executed is estimated at 3 to 6 months per construction contract.

Table 6. Real Estate Acquisition Schedule

REAL ESTATE ACQUISITION SCHEDULE				
Project Name: American River Common Features General Evaluation Report	COE Start	COE Finish	NFS Start	NFS Finish
Receipt of preliminary drawings from Engineering	2011	2015		
Receipt of final drawings from Engineering	2019	2020		
Execution of PPA/Finalize Chief's Report	April 21, 2016			
Formal transmittal of final drawings & instruction to acquire LERRDS (Assumes 4-5 years before appropriations and authorities are in place for PED phase of Project)	2016	2016	2016	2018
Construction Contracts				
(Reach ARS F) Years 1 to 6	2018	2023		
(Reach ARS E) Years 4 to 7	2021	2025		
(Reach ARS A) Years 1 to 4	2018	2021		
(Reach ARS G) Years 4 to 9	2021	2026		
(Reach ARS D) Years 7 to 10	2024	2027		
(Reach ARS B) Years 4 to 5	2021	2022		
(Reach ARN A) Years 5 to 7	2022	2024		
(Reach ARS C) Years 7 to 8	2024	2025		
(Reaches ARN D) Years 4 to 8	2021	2025		
(Reaches ARN B) Years 8 to 9	2025	2026		
(Sacramento Bypass Widening) Years 1 to 7	2018	2024		
(Reach ARN F) Years 7 to 10	2024	2027		
(Reach ARN E) Years 5 to 10	2022	2027		
(Reaches ARN C, G, I) Years 8 to 10	2025	2027		
Conduct Landowner Meetings			2018	2027
Prepare/review mapping & legal descriptions			2018	2027
Obtain/review title evidence			2018	2027
Obtain/review tract appraisals			2018	2027
Conduct negotiations			2018	2027
Prepare/review condemnations			2018	2027
Perform condemnations			2018	2027
Obtain control			2018	2027
Complete/review PL 91-646 benefit assistance			2018	2027
Certify all necessary LERRDS are available for construction			2018	2027
Prepare and submit credit requests			2018	2027
Review/approve or deny credit requests	2020	2030		
Establish value for creditable LERRDS	2020	2030		

18. Description of Facility and Utility Relocations

On July 14, 1998, the Assistant Secretary of the Army issued a letter directive relating to the American River Common Elements Project which provided, in relevant part, that the removal and replacement of a utility, or other public facility, owned by the State of California, or a political subdivision thereof, (including the Sacramento Area Flood Control Agency (SAFCA) and its constituent members) and which delivers public services, should be treated as a relocation where such work is required as a direct result of the construction of the project. Such relocations, provided they met the required criteria, were to be included as a shared total project cost with credit issued to the non-federal sponsors for relocating the affected utilities/facilities. This letter applied only to publically owned utility and facilities and did not include any privately owned permitted or unpermitted encroachments.

Due to the passage of time and the current scope of the project—now known as the Common Features project—Corps RIT Vertical Team agreed that ongoing reliance upon the scope of the ASA's 1998 letter and its application to the current project must be coordinated with the current ASA-CW. Provided agreement is reached and assuming consistency with the preliminary findings set forth in the Relocation Inventory Tables, below, costs incurred in relocating eligible utilities/facilities that are owned by the following entities will be included as total project costs with credit given to the non-federal sponsors: the State, SAFCA and its constituent members (which include the City of Sacramento, the Counties of Sacramento and Sutter, Reclamation Districts, the American River Flood Control District, the Sacramento County Water Agency and the Sutter County Water Agency) and the Sacramento Municipal Utility District (SMUD). This letter is located in Exhibit C.

The Corps has drafted modifications to the Project Partnership Agreement for the Common Features Project implementing this determination. These modifications and implementation guidance have been provided to the Sacramento District for coordination with the State of California and SAFCA.

A Preliminary Opinion of Compensability was prepared regarding proposed utility/facility relocations based upon information and data submitted to the Sacramento District Real Estate Division Office for review as of September 4, 2014. Various utilities/facilities are located within the project boundaries and must be relocated to facilitate project construction. The utilities/facilities consist of electrical distribution and service facilities, telephone communication lines, irrigation facilities, roadways, water delivery facilities and natural gas pipelines. A summary of their compensability analysis, referencing the data set forth in the Relocation Inventory Table, is as follows:

The following utilities/facilities are compensable relocations under the 1998 ASA letter and have demonstrated need for the provision of "substitute facilities." Exhibit E provides the table with the utility/facility inventory.

For Relocations, utilities and various encroachments were researched and identified using a variety of sources including: State DWR Levee Logs, USACE Periodic Inspection data, and Central Valley Flood Protection Board (CVFPB) permitting data. All of these sources were compiled into a central spreadsheet for organization and priority identification purposes. Field surveys were conducted following the research in an attempt to verity description, materials and sizes. Typical fixes were created to reflect existing conditions and proposed improvements to accommodate levee construction features and USACE policy compliance. Features such as replacement/relocation of

pipe, impervious fill around pipes, and positive closure represented a majority of the reoccurring items requiring relocation. Exhibit E provides the table with the utility/facility inventory.

Utility Power Poles-ARS Reach D Item 28, ARS Reach E Item 35, ARS Reach F Item 44, ARS Reach G Item 44, ARN Reach E Item 35, ARN Reach G item 82, Sac Bypass Reach Items 7, 11
Discharge Pipes/Storm Drains/Intake Pipes/Culverts/City Sumps/- ARS Reach D Items 2, 6,7,11,12,19,24,26, ARS Reach E Items 30, 31,32,33, ARS Reach F Items 36, 37,41 ARS Reach G Item 50,ARN Reach C Item 1,4 ARN Reach D Item 12,19 ARN Reach E Items 39,44,57,60,61,62, ARS Reach G Item 83, ARS Reach H 98, 100, 101, Sac Bypass Items 9, 10
Force Main/ Sewer pipes/Water Main- ARS Reach D Items 16, 21, 23 ARS Reach E Item 34 ARS Reach G Item 52, 59, ARN Reach D Items 14, 17,18,20,24 ARN Reach E Items 38,42,43,45,49,63,64 ARN Reach G Item 94
Electrical Conduits/Electrical Pipes ARS Reach D Items 20,25, ARS Reach F Item 38, ARS Reach G Item 57, ARN Reach D Item 21, ARN Reach E Item 46
Gas Mains – ARS Reach G Item 51
Telecommunications ARS Reach G item 48, ARN Reach D Item 11, Sac Bypass Item 8
Gaging Station – Sac Bypass Reach Item 2
Railroads ARS Reach G, Remove and replace tracks 11,050 LF, ARS Reach D, Sacramento Bypass (replace rail road bridge over weir- construction cost not a relocation)
Roads – Restoring public and private haul routes if damaged back to their existing condition or replace new if needed. Levee access ramp repairs if needed. ARS Reaches A,B,C,D,E,F,G ARN Reaches A,B,C,D,E,F,G,I Description of road work located in MII report level 3, Exhibit E.

The following utilities/facilities have no public purpose or ownership and, accordingly, are not compensable relocations: All of these items are various pipe penetrations through levees the majority of which have been abandoned and are no longer needed. There is one electrical conduit and one communications conduit that are proposed to be cut and abandoned and no longer appear to be in use ARS Reach D: Item Nos. 1, 8-10, 14, ARS Reach F 39,40 ARS Reach G, Item Nos. 45- 46,47, ARN Reach C Item Nos. 2

The following utilities/facilities may have compensable interests under the 1998 ASA letter, however, there is insufficient information at this time to make a preliminary determination as to whether the utilities/facilities are compensable relocations doctrine. The submission of additional data such as ownership and public purpose is required.

ARS Reach D Nos. 3,4,27(storm drain, man hole and a culvert, ARS Reach E Nos. 29(multiple pipes near La Rivage marina), ARS Reach G: Item Nos. 58, 60, 61, (pump, pipe, electric feed), railroad stop log closure structure raise, railroad tracks remove and replace 11,050 LF – MII page 18, ARN Reach D: Item Nos. 9, 22, 28, 29(2 overhead utilities, man hole, culvert), Page 7 MII, ARN Reach E, Item Nos. 35, 47, 52, 53, 55, 56, 58, 59 (five storm drains and three overhead utilities) ARN Reach F, Item Nos. 66, 67 69, 70, 72, 73, 75, 76 (two drop inlets, four culverts, two overhead utilities) ARN Reach G: Item Nos. 80, 84, 85, 86, 87,90, 91, 92 95, 96, 97(four overhead utilities, five culverts, water well and a manhole) ARN Reach H, Item Nos. 99,102 (two overhead utilities) ARS Reaches A,B,C,D,E,F,G and ARN Reaches A,B,C,D,E,F,G,I (haul route surface road repairs/asphalt repairs, ramp repairs)

A utility inventory is provided below by basin and reach. A summary table of the cost estimate is provided and includes construction costs and engineering contingency. Utility/Facility relocation inventory with detailed unit costs are shown in Exhibit E. For cost estimating purposes the utilities were all assumed compensable.

TABLE 7. CODE OF ACCOUNTS 02 UTILITY/FACILITY RELOCATIONS SUMMARY

UTILITY/FACILITY RELOCATIONS	COST
ARS Reach A	$4,899,000
ARS Reach B	$2,313,000
ARS Reach C	$400,000
ARS Reach D	$25,524,000
ARS Reach E	$4,143,000
ARS Reach F	$11,421,000
ARS Reach G	$26,383,000
ARN Reach A	$1,972,000
ARN Reach B	$81,000
ARN Reach C	$1,180,000
ARN Reach D	8,344,000
ARN Reach E	$10,665,000
ARN Reach F	4,237,000
ARN Reach I	$50,000
Sac Bypass Widening	$21,201,000
Subtotal	$12,281,3000
Contingency 28%	$34,368,000
Total	$157,201,000

Total Project Cost Summary provided by Cost Engineering Section will include accounts 30 and 31 for all relocations and construction items combined.

ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REAL ESTATE PLAN (AND THE REPORT) THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION TO BE PERFORMED BY THE NON-FEDERAL SPONSOR AS PART OF ITS LERRD RESPONSIBILITIES AND/OR IS OTHERWISE COMPENSABLE OR NON-COMPENSABLE IS PRELIMINARY AND FOR DISCUSSION PURPOSES ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION, OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF THE FINAL ATTORNEY'S OPINIONS OF COMPENSABILITY FOR EACH OF THE MPACTED UTILITIES AND FACILITIES DURING FINAL DESIGNS.

19. Hazardous, Toxic, and Radiological Waste Impacts

A Phase 1 Environmental Site Assessment was performed in accordance with the scope and limitations of ASTM E 1527-05 and USACE ER 1165-2-132 for the American River Common Features GRR project. Any exceptions to, or deletions from, these practices have been outlined within the report. There are many contaminated properties adjacent to the levees on the dry side that are considered to be avoidable due to the nature of the contamination or the nature of the work proposed on the levees. This assessment has identified sites with recognized and probably unavoidable environmental conditions at the locations shown in Table 7 below.

TABLE 7. Sites with Recognized Environmental Conditions

Site Name	Location	Reach	Issue
1 - Full Stop Mini Mart EDR 41-5	251-0292-016 3200 Rio Linda Blvd. Sac CA 95815	ARN Arcade Creek	TPHg plume at levee bridge crossing with air sparging
2 - Old North Sacramento EDR 69-8	275-0111-001 EDR 69-8	ARN Reach B/N Natomas East Main Drainage Canal	CVOC, TPH Groundwater Plumes adjacent to levee, multiple properties
3 - TOSCO Corp. Conoco-Phillips Sacramento Terminal EDR 174-11	009-0020-001 66 Broadway Sac CA 95818	ARS_D	Petroleum release site on wet side of the levee.
4 -TOSCO Corp./ Conoco-Phillips Sacramento Terminal EDR 174-11	76 Broadway Sacramento, CA 95818	ARS_D 009-0030-054 009-0012-071 009-0012-072	Petroleum release site on dry side of the levee. Petroleum pipelines pass through the levee.
5-Robertson Harbor Sand & Gravel EDR 92-8 EDR 128-8	001-0160-001 200 28th Street Sacramento CA	ARS Reach B American River	Levee Encroachment, recycled pavement
6 -Southern Pacific Rail Yard Museum EDR 120-7	501 Jibboom St. Sacramento CA 95814	ARS Reach D Sac River	CVOC, TPH Groundwater Plume, land use restrictions
7 - Old Bryte Yard Landfill EDR Site 79-6	042-280-011 50035 County Rd 126 West Sac, CA 95691	Sacramento Bypass	Lead in Soil

The historical land uses of the region may also contribute to residual contamination of the entire project area with agricultural fertilizers, herbicides, and pesticides as well as arsenic and mercury from mining operations in the region. Additional sampling will be required during subsequent investigations to determine if project areas have been impacted by these historical contaminants.

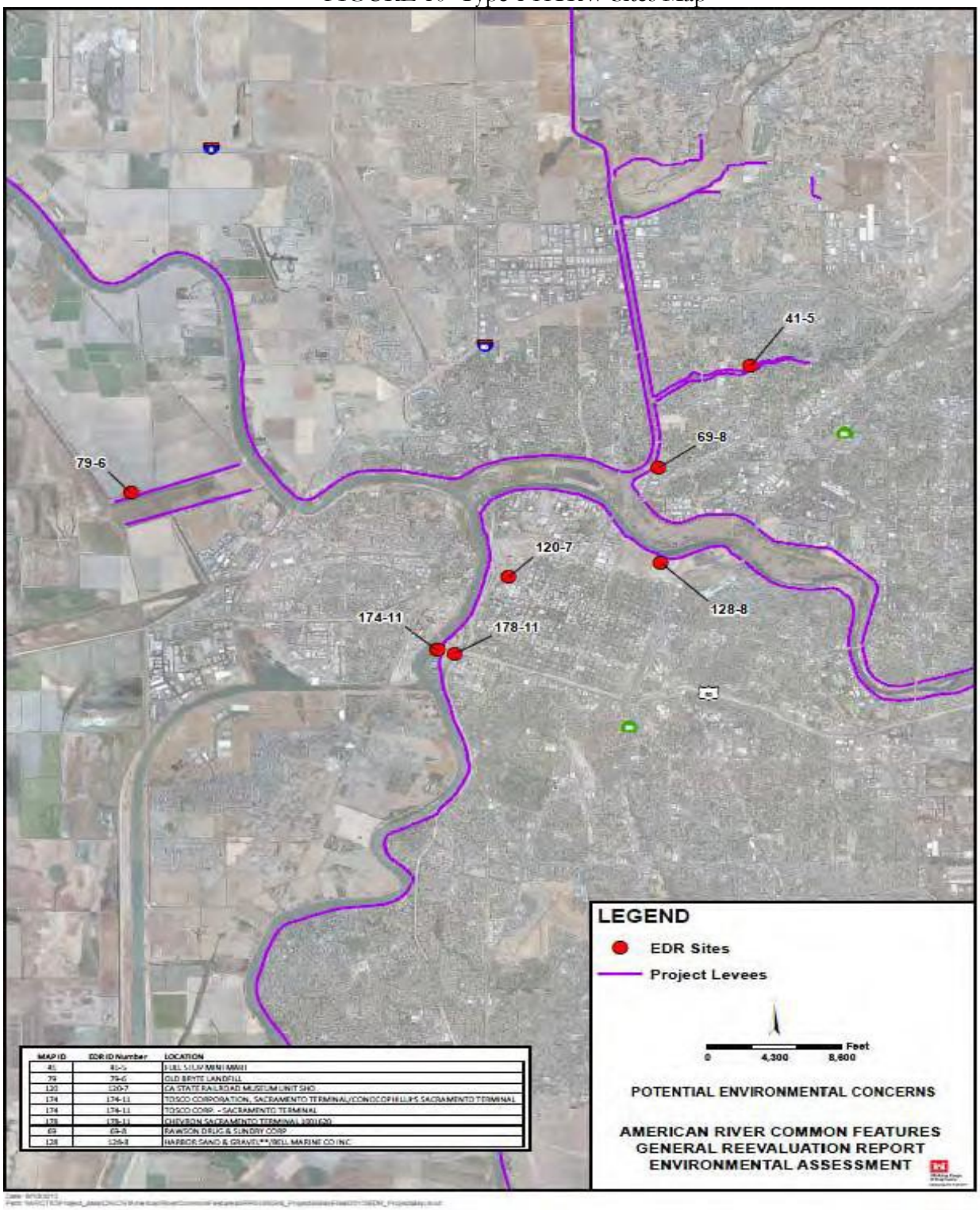
On-line records are limited. For contaminated sites identified as unavoidable under the alternatives considered by the American River Common Features GRR, a public records review is recommended at the Central Valley Regional Water Quality Control Board office and the Sacramento Regional Office of the Department of Toxic Substances Control as the next step to determine if additional investigation is required to determine the impact of these sites on the project. Current groundwater plume maps and environmental liens / deed restrictions incorporating land use controls are particularly needed. Emphasis is needed on the Sacramento Terminal bulk fuel handling facility, the old Southern Pacific rail yard, and the old Bryte yard landfill.

The subsequent Phase 1 ESA(s) during Design Phase will investigate if new sites have emerged and if existing sites still pose a threat to planned construction.

If any evidence of potential HTRW is found during construction, all work would cease, and the Corps and non-Federal sponsor would be notified for further evaluation of the potential contamination. Any unanticipated hazardous materials encountered during construction would be handled according to applicable federal, state, and local regulations. The Corps would require that a contingency plan that outlines steps to be taken before and during construction activities to document soil conditions, as well as procedures to be followed if unexpected conditions are encountered, be prepared by the contractor.

The non-Federal sponsor is responsible for 100 percent of the cost to develop the clean-up procedures (remedial action plan) and to treat the contaminates in place or relocate the material (ER 1110-2-1150).

FIGURE 10 Type 1 HTRW Sites Map



MAP ID	EDR ID Number	LOCATION
41	41-5	FUEL STOP MINI MART
79	79-6	OLD BRYTE LANDFILL
120	120-7	CA STATE RAILROAD MUSEUM UNIT SHO
174	174-11	TOSCO CORPORATION, SACRAMENTO TERMINAL/CONOCOPHILLIPS SACRAMENTO TERMINAL
174	174-11	TOSCO CORP - SACRAMENTO TERMINAL
178	178-11	CHEVRON SACRAMENTO TERMINAL 100160
69	69-8	RAWSON DRUG & SUNDRY CORP
128	128-8	HARBOR SAND & GRAVEL**/BELL MARINE CO INC

HTRW – FIGURE 11 ARS Reach B(5)/C Asphalt Concrete Recycling Company encroaching on the levee between Sacramento City Landfill/Sutters Landing Regional Park and Scollan/Old Sacramento Landfill

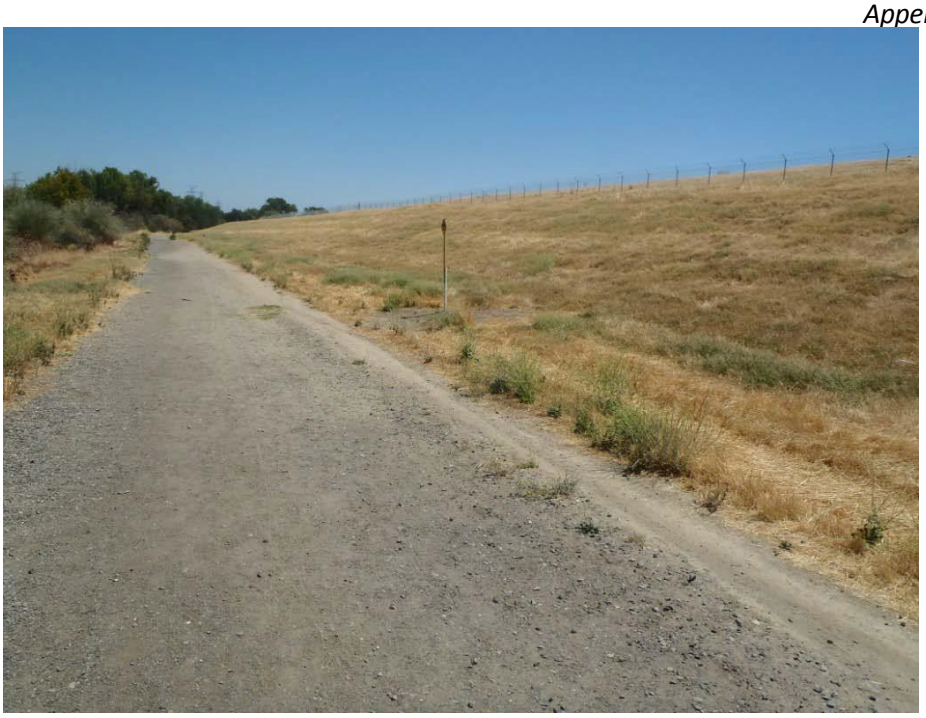
HTRW FIGURE 12 -ARN Reach N (2) Full Stop Mini-Mart SVE/AS treatment system located adjacent to levee

HTRW FIGURE 13 - ARS Reach C Monitoring well cluster in the levee crown near Martin Sprocket & Gear

HTRW FIGURE 14 -Old Bryte Landfill adjacent to Sacramento Bypass (7) north levee.

HTRW FIGURE 15 -Monitoring well between Old Bryte Landfill and Sacramento Bypass levee (7)

HTRW FIGURE 16 -ARN Reach N/I Contaminated property in old North Sacramento viewed from Dry Creek levee



HTRW FIGURE 17 - ARS Reach B(5) Kinder Morgan Energy Partners buried petroleum pipeline warning sign at the toe of the levee at Sacramento City Landfill /Sutter Landing Regional Park

HTRW FIGURE 18 -ARS Reach B (5)/C Sacramento City Landfill rises above levee crown in the left side of the photo. Stormwater collection drain is visible. Landfill gas collection system is obscured by the weeds.

HTRW FIGURE 19 -ARS Reach D (6) This former PG&E manufactured gas plant site is currently under remediation. Contamination has been solidified in place at the foot of the levee. Remediation is planned to be completed in November 2012. Active railroad tracks are also present on top of the levee in this area.

HTRW FIGURE 20- ARS Reach D (6) This site is owned by the Sacramento Redevelopment Agency and is next door to the PG&E site. The site has been certified by DTSC and has various land use restrictions. Currently, the site is used for horse carriage storage. Some empty drums are stored on site.

HTRW FIGURE 21 -ARS Reach D 66 Broadway (3) is a fuel terminal used by TOSCO Corporation. The site is located on the water side of the levee. A petroleum release that is still undergoing cleanup occurred in this area. Underground utilities and monitoring wells are present.

HTRW FIGURE 22 - ARS Reach D 76 Broadway (4) is a bulk fuel terminal used by Conoco Phillips. Underground infrastructure and at least 7 above ground storage tanks containing petroleum substances are located on both sides of the levee.

HTRW FIGURE 23- ARS Reach D (4) Fuel lines cross through the levee at 76 Broadway.

HTRW FIGURE 24 -ARS Reach D 2420 Front St This bulk fuel terminal used by Chevron is on the water side of the levee. Monitoring wells, underground infrastructure, and at least 12 above ground storage tanks containing petroleum substances were observed on site.

HTRW FIGURE 25- ARS Reach D (3&4) Fuel lines cross to and from the water and land sides of the levee to the following sites: 76 Broadway (ConocoPhillips Bulk Fuel Terminal), 66 Broadway (TOSCO Corp Sacramento Terminal), and 2420 Front St (Chevron Bulk Fuel Terminal).

20. Attitude of Land Owners

To date, the results of the outreach program from the public scoping meetings have been favorable, constructive, and supportive with the exception of the construction of the levee access corridor by residents and businesses along the Sacramento River particularly in the Pocket areas. Lands adjacent to the existing levees have been developed for several decades. The proposed plan will fix the existing levees in place in order to minimize additional land requirement.

In an effort to partner with our sponsors and minimize impacts to the public a System Wide Improvement Framework Policy (SWIF) will allow specific vegetation and/or encroachments to remain in place permanently or defer their resolution to some future date. A SWIF provides committed sponsors the opportunity to transition their levees over time to USACE standards. By using a SWIF, sponsors can prioritize deficiencies to address the highest risk first to achieve system-wide risk reduction and to meet current engineering standards, vegetation and encroachment issues (including landside levee access) in the study area. This will be resolved through a combination of construction actions associated with implementation of the recommended plan and formal agreements.

21. Cultural Resource Sites

Records searches of pertinent cultural resource information were conducted in 2006 and

2007, and updated in 2010 and 2013 for the overall study area. Most of the searches were conducted at the North Central Information Center (NCIC) of the California Historical Resources Information System, located at California State University, Sacramento. The NCIC records search covered portions of the study area in Sacramento and Yolo Counties. The northern portion of the Natomas area is within Sutter County so records searches for that area were also conducted at the Northeast Information Center (NEIC). The NEIC reported seven previous cultural resource studies in the study area within Sutter County, and the NCIC reported 278 previous studies in the Sacramento and Yolo County portions of the study area; thus a total of 285 studies have been conducted in the study area. From those previous studies, a total of 175 cultural resources (archaeological and historical sites) were identified within the overall study area.

Due to the large geographic scope of the study area, limitations in access, the alluvial nature of the watershed, because levees and other structures have been built on top of much of the original native soil of the study area, and due to the high potential for buried cultural resources that will not be discovered until during construction, a 100% pedestrian survey of the entire study area could not be completed. However, data from the records and literature search, concerns relayed by American Indians, knowledge of the prehistory and history of the study area, and recent archaeological surveys conducted as part of Natomas Levee Improvements Project provide information on the types of cultural resource sites that may be found within the study areas. The known cultural resources within the study area can be categorized as the following general types within the Sacramento Valley:

- **Mounds** – Refers to relatively low natural or anthropogenic mounds occupied by Native Americans as habitation sites and burial locations. Discarded refuse and numerous fires frequently generated significant accumulations of midden soil on these features.
- **Midden** – Refers to prehistoric or proto-historic trash deposits containing food refuse, such as discarded bone, shell, and other organic matter; along with broken, discarded or lost artifacts made of various raw materials, including stone, wood, bone, antler, etc. The organic nature of middens tends to produce softer, darker, and greasier soils in contrast to the natural soils on which they rest. Deposition of midden often expanded the size of natural knolls or mounds both horizontally and vertically. Because of the softer soils in middens, they were also used as locations for human and/or animal burials. Middens generally include the full suite of artifacts, materials, and remains that would be encountered in a lithic scatter.
- **Lithics/Lithic Scatter** – The term "lithic scatter" refers to scatters of lithic (stone) debris (or debitage) resulting primarily from manufacture of chipped stone tools such as knives, dart points, arrow points, scrapers, adzes, and other tools. The process of manufacture by chipping or "knapping" resulted in percussion and pressure flakes removed from the raw natural resources of chert, obsidian, basalt, felsite and any other stone raw materials. Lithic scatters often contain fire-cracked rock distinguished by its fire reddened colors and sharp fracture patterns. Such rocks were often used for cooking by dropping heated rocks into baskets full of water and food. The sudden temperature change would commonly cause the rocks to fracture in a distinctive way. Ground stone tools used for processing foods and pigments are also common in lithic scatters. Less commonly, baked clay artifacts and shell or bone tools and ornaments may also occur. Finally, broken fragments of tools used for lithic manufacture such as hammerstones may also be associated with lithic scatters.
- **Traditional Cultural Properties** – Often referred to as "TCPs," Traditional Cultural Properties may be geographic features, locations, rural communities, urban neighborhoods, or other areas associated with cultural practices or beliefs of a living community that are rooted in that community's history, and are important in maintaining the continuing cultural identity of the community. TCPs may include locations associated with the traditional beliefs of an Native American group about its origins, its cultural history, or the nature of the world; may include buildings and structures, objects or landscapes; and may be associated with religious or

cultural practices of Native Americans.

- **Traditional Cultural Landscapes** – As described by the Advisory Council on Historic Preservation (ACHP), the term "traditional cultural landscape" has not been formally defined by the National Park Service. Although there is no single defining feature or set of features that comprise a traditional cultural landscape, such places could be comprised of natural features such as mountains, caves, plateaus, and outcroppings; water course and bodies such as rivers, streams, lakes, bays, and inlets; views and view sheds from them, including the overlook or similar locations; vegetation that contributes to its significance; and manmade features including archeological sites; buildings and structures, circulation features such as trails; land use patterns, evidence of cultural traditions, such as petroglyphs and evidence of burial practices; and markers or monuments, such as cairns, sleeping circles, and geoglyphs.
- **Historic Debris** – This term may refer to a great number of different artifacts 50 years of age or older that may be considered historical in nature. Cans, metal fragments, nails, glass fragments, glass bottles, and a variety of remnant material may be considered historic debris. In the Sacramento Valley this occasionally includes material thrown from railroad cars as passengers passed through the area, as well as abandoned machinery and equipment. Historic debris may be linked to a number of different historic subsistence activities such as farming, irrigation, construction of infrastructure, mining, and homesteading.
- **Water Related** – The history of the Sacramento Valley is intertwined with that of flood control, reclamation, farming, and irrigation in the city of Sacramento and the surrounding areas. Much of the flood control infrastructure of the area dates back to the turn of the twentieth century. Water-related features may include levees, canals, weirs, bypass channels, drainage ditches, pump houses, wells, pipes, and farm-related structures and equipment.
- **Transportation** – A great number of roads, bridges, railroad tracks, and railroad trestles appear within the study area. These may include dirt or paved roads; bridges over canals, culverts, or other topographic features; and a variety of railroad features. Railroad features may include portions of the Transcontinental Railroad, the Walnut Grove Branch Line Railroad, raised berms that supported railroad rights-of-way, railroad trestle bridges, and lengths of railroad alignments. Within Sacramento, a number of historic railroad features are still in use today, both for the transport of goods, and recreationally and educationally associated with the California Railroad Museum in Old Town Sacramento just east of the Sacramento River.
- **Structures** – This refers to a variety of buildings or structures 50 years of age or older. Within the project area these may include government offices, farmsteads, homesteads, residential structures, barns, ranches, power plants, and sheds. These structures may be made from materials such as wood, concrete, brick, masonry, stucco, and corrugated metal.

In addition to the conclusions regarding the various cultural resources site types that may be found within the study area, an archaeological sensitivity assessment for prehistoric resources was conducted The sensitivity assessment was built using existing survey data to identify correlations between the occurrence of archaeological sites and environmental variables including proximity to water, historic vegetation, and lithology. This was accomplished in GIS using environmental data and information from the record search indicating where archaeological sites do and do not exist in areas that had been previously surveyed.

As a result of the various efforts (records and literature searches, archaeological sensitivity assessment, consultation with American Indians, consultation with the interested public, review of existing and recent archaeological inventories and discoveries) to identify cultural resources within the study area, the Corps has determined that the project will likely have an adverse effect on properties that are either included in, or are eligible for inclusion in the NRHP. Due to the large geographic scope of the project, the lack of detailed designs to determine construction specific APEs, and limitations in available funding to complete full identification of potential historic

properties prior to approval of the project, the Corps has also determined that they cannot fully determine the effects of the project on NRHP eligible properties for all phases and segments of the project at this time.

In order to provide a framework for the Corps to identify cultural resources, evaluate cultural resources for their eligibility for inclusion in the NRHP, determine possible effects to historic properties, and mitigate effects to historic properties as a result of the project, a programmatic agreement (PA) has been developed by the Corps in consultation with the State Historic Preservation Officer (SHPO) the Advisory Council on Historic Preservation (ACHP), and Native American tribes with concerns in the area as potential Concurring Parties. The draft PA was provided to the DWR, the CVFPP, SAFCA, and potentially interested American Indians for review and comment in the development of the PA. Specific individual determinations of effect for historic properties that may be affected by the selected alternative would be completed under the stipulations of the PA, which includes a framework to identify historic properties, evaluate NRHP eligibility, and assess effects.

The PA covers the ARCF Project. The PA provides a process for the identification and evaluation of historic properties and, if necessary, the resolution of adverse effects to identified historic properties. The PA also provides a process for handling post-review discoveries. Per the PA, all Corps construction activities will avoid archaeological sites/historic properties, both eligible and non-eligible, to the maximum extent practicable. Per the PA, all Corps construction activities will avoid historic properties to the maximum extent practicable. The draft PA was provided to DWR and the CVFPB on April 11, 2012 and February 22, 2013, and to SAFCA on February 12, 2013, and potentially interested Native Americans on April 5, 2013, June 6, 2013, June 12, 2014, and June 25, 2014 for review and comment as part of the development of the PA. The final PA was executed by signature by the Corps and the SHPO on September 10, 2015.

EXHIBIT A

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY
AMERICAN RIVER COMMON FEATURES GENERAL REEVALUTION STUDY

SPONSORS: The State of California, Central Valley Flood Protection Board (CVFPB) with the USACE and the local agreement between State of California, CVFPB and Sacramento Flood Control Agency (SAFCA)

I. Legal Authority:

a. Do the sponsors have legal authority to acquire and hold title to real property for project purposes? Yes CVFPB; Yes SAFCA

b. Do the sponsors have the power of eminent domain for this project? Yes CVFPB; Yes SAFCA

c. Do the sponsors have "quick-take" authority for this project? Yes CVFPB; Yes SAFCA

d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? No CVFPB; No SAFCA

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? No CVFPB

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? Yes CVFPB;

b. If the answer to a. is "yes," has a reasonable plan been developed to provide such training? Yes CVFPB

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? Yes CVFPB; Yes SAFCA

d. Is the sponsor's project in-house staffing level sufficient considering its other workload, if any, and the project schedule? Yes CVFPB; Yes SAFCA

e. Can the sponsor obtain contractor support, if required, in a timely fashion? Yes CVFPB; Yes SAFCA

Prepared by:

Laurie Parker

Laurie Parker
Realty Specialist
Acquisition Branch

Date: 25 November 2015

Reviewed and Approved by:

_____

Diane Simpson
Chief, Real Estate Division
U.S. Army Engineer District,

Sacramento

Date: _____

EXHIBIT B POLICY GUIDANCE LETTER 31- REAL ESTATE SUPPORT TO PLANNING PARADIGM (3x3x3)

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET NW
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CEMP-CR

JAN 1 0 2013

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Real Estate Policy Guidance Letter No. 31-Real Estate Support to Civil Works Planning Paradigm (3x3x3)

1. References.

a. Memorandum, CECW-CP, 8 February 2012, Subject: U.S. Army Corps of Engineers Civil Works Feasibility Study Program Execution and Delivery

b. ER 5-1-11, USACE Business Process, 1 November 2006

c. EC 405-1-04, Appraisal, 30 Dec 2003

d. ER 1105-2-100, Planning Guidance Notebook, 22 Apr 2000

e. ER 405-1-12, Chapter 12, Real Estate Roles and Responsibilities for Civil Works, Cost Shared and Full Federal Projects, Change 31, 1 May 1998

2. Purpose. In accordance with reference a, this memorandum provides interim policy and guidance for real estate efforts associated with feasibility studies under the new Planning Paradigm, "SMART Planning," and the 3x3x3 rule. In accordance with the 3x3x3 rule, all feasibility studies should be completed within three years, at a cost of no more than $3 million, utilize three levels of vertical team coordination, and be of a "reasonable" report size.

3. Background. Real Estate has been fully engaged in the implementation of the 3x3x3 by actively participating in each webinar, the planning modernization workshop, and serving as part of the HQ Transition Team. In accordance with references b-e, Real Estate involvement is essential to the development and implementation of any pre-authorization project. Paragraph 12-16 of reference e. outlines the significant topics that must be covered in a real estate plan (REP). The level of detail necessary to apply the requirements of real estate policy and guidance will vary depending on the scope and complexity of each project.

As outlined in Chapter 12, the minimum interests in real property necessary to support various types of projects must be identified. As projects are scoped at the beginning of the feasibility phase (via a Charette or other forum), it is essential that Real Estate become familiar with the project authority and purposes to make a determination of the minimum interests and estate(s), both standard and non-standard, necessary as projects are scoped and alternatives evaluated. If a

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SUBJECT: Real Estate Policy Guidance Letter No. 31-Real Estate Support to Civil Works Planning Paradigm (3x3x3)

non-standard estate will be needed, this should be discussed with MSC and HQ Real Estate as early as possible to ensure that the justification is sound and will serve the project purpose.

4. Policy. Typically, the attorney's preliminary opinion of compensability and gross appraisals are two areas that require more detail than may be readily available during the start of the feasibility phase, and are critical to determination of accurate estimates for real estate and total project costs. Due to the focus on 3 years or less for study duration, it will be essential for Real Estate to be adaptable and scale its requirements, decision making, and risk management in proportion to the significance of total project costs.

a. Gross Appraisals:

Specific to gross appraisals, EC 405-1-04 provides that cost estimates are utilized for preliminary planning of projects and in other cases, brief gross appraisals are acceptable. For purposes of the feasibility phase, the detail will vary as outlined below.

(1) For projects in which the value of real estate (lands, improvements, and severance damages) are not expected to exceed ten percent of total project costs (total cost to implement project), a cost estimate (or rough order of magnitude) will be acceptable for purposes of the feasibility phase.
(2) For projects in which the value of real estate (lands, improvements, and severance damages) do not exceed 30 percent of total project costs (total cost to implement project), a brief gross appraisal will be acceptable for purposes of the feasibility phase. A brief gross appraisal will follow format issued by Chief Appraiser.
(3) For projects in which the value of real estate (lands, improvements, and severance damages) exceed 30 percent of total project costs (total cost to implement project), a full gross appraisal will be prepared in accordance with the appraisal regulation and guidance provided by EC 405-1-04 and the Chief Appraiser.

b. Attorney's Opinion of Compensability:

As described in paragraph 12-17 of Chapter 12, utility/facility relocations may require preliminary attorney's opinions of compensability. While the practice of obtaining preliminary attorney's opinions of compensability provides a high degree of certainty with regard to project costs during the feasibility phase, such opinions can be time consuming and may provide more certainty than may be optimal for feasibility purposes when potential utility/facility relocation costs do not constitute a large percentage of total project costs. In support of the goals set out in the new planning paradigm described in reference a., Districts shall adhere to the following guidance:

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(1) Where the estimated total cost to modify all project utility facility relocations, including the value of any additional lands that may be required to perform the relocations does not exceed 30 percent of estimated total project costs, the District Office of Real Estate shall, in lieu of an attorney s opinion of compensability prepare a real estate assessment. Such a real estate assessment, will address the following questions:

(a) Is the identified utility facility generally of the type eligible for compensation under the substitute facilities doctrine (e.g., school, highway, bridge, water and sewer systems, parks, etc.)
(b) Does the District have some valid data or evidence that demonstrates that it has identified an owner with a compensable interest in the property

If the answer to both questions is yes, then the District Office of Real Estate shall reflect the cost of providing a substitute facility in the Real Estate Plan (REP) and all other feasibility study cost estimates. If the answer to either or both questions is no, the District shall not reflect the cost of a substitute facility in the REP or other feasibility study cost estimates. However, the REP narrative should still include a discussion on the facility with results of analysis and project impact. For cost shared projects, the non-federal sponsor must be advised that the inclusion of substitute facilities costs in the REP or other use feasibility study estimates is for planning and budgeting purposes only and does not constitute a preliminary or final determination of compensability by the agency regardless of whether the cost of substitute facilities are reflected in the feasibility study documents. Using a real estate assessment does not eliminate the need to obtain a final attorney s opinion of compensability prior to execution of the PPA.

(2) Where the estimated total cost to modify all project facility relocations, including the value of any additional lands that may be required to perform the relocations, has public or political significance or the costs exceed 30 percent of estimated total project costs, a preliminary opinion of compensability shall be prepared for each owner s facilities. The level of documentation for each relocation item should be based on the significance of the relocation item to project formulation and estimated project costs.

Real Estate products, such as the REP, must be adaptable and scaled based on the project scope. Additionally, Real Estate must utilize the risk register to highlight areas where cost, schedule or uncertainty is greater in order to manage risk. Going forward, the Real Estate Division will continue to work closely with the Planning and Policy Division, Engineering and Construction Division, the Programs Integration Division and the National Law Firm on the Planning SmartGuide. This SmartGuide will provide more on procedures, tips, techniques and tools for

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specific types of planning projects to aid in implementation of the new Planning Paradigm. All bulletins and updates on the SmartGuide can be found at: http://planning.usace.army.mil/toolbox/.

5. Duration. The policies stated herein will remain in effect until amended or rescinded by Policy Memorandums, Policy Guidance Letters, Engineers Circulars or Engineer Regulations.

FOR THE COMMANDER:

SCOTT L. WHITEFORD
DIRECTOR OF REAL ESTATE

DISTRIBUTION:
COMMANDER,
GREAT LAKES AND OHIO RIVER DIVISION (CELRD-PDS-R)
MISSISSIPPI VALLEY DIVISION (CEMVD-TD-R)
NORTH ATLANTIC DIVISION (CENAD-PD-E)
NORTHWESTERN DIVISION (CENWD-PDS)
PACIFIC OCEAN DIVISION (CEPOD-RE)
SOUTH ATLANTIC DIVISION (CESAD-PDS-R)
SOUTH PACIFIC DIVISION (CESPD-ET-R)
SOUTHWESTERN DIVISION (CESWD-ET-R)

CF:
COMMANDER,
DETROIT DISTRICT (CELRE-RE)
HUNTINGTON DISTRICT (CELRH-RE)
LOUISVILLE DISTRICT (CELRL-RE)
NASHVILLE DISTRICT (CELRN-RE)
PITTSBURGH DISTRICT (CELRP-RE)
MEMPHIS DISTRICT (CEMVM-RE)
NEW ORLEANS DISTRICT (CEMVN-RE)
ROCK ISLAND DISTRICT (CEMVR-RE)
ST. LOUIS DISTRICT (CEMVS-RE)
ST. PAUL DISTRICT (CEMVP-RE)
VICKSBURG DISTRICT (CEMVK-RE)
BALTIMORE DISTRICT (CENAB-RE)
NEW ENGLAND DISTRICT (CENAE-RE)
NEW YORK DISTRICT (CENAN-RE)
NORFOLK DISTRICT (CENAO-RE)

EXHIBIT C – WAIVER LETTER FOR COMPENSABILITY FOR PUBLICALLY OWNED UTILITIES AND FACILITIES

File: Common Elements
1-copy - John B

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

14 JUL 1998

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REPLY TO
ATTENTION OF

Mr. F. I. Hodgkins
Executive Director
Sacramento Area Flood Control Agency
1007 7th Street, 5th Floor
Sacramento, California 95814-3407

Dear Mr. Hodgkins:

This letter is in response to your letters of April 28, 1998 and May 6, 1998, relating to a cost sharing issue associated with utility relocations required for construction of the Common Elements Project in Sacramento, California.

Generally, the Corps treats relocations as creditable items of non-Federal work and includes such costs in total project costs. The exception is when the sponsor has the authority to compel relocations at no cost to the sponsor. Here, however, the authorizing documentation refers to both the State of California and the Sacramento Area Flood Control Agency (SAFCA) as the project sponsors. Requiring the State to revoke permits issued to SAFCA's member agencies would recognize neither the highly interrelated sponsorship of the project that includes the State, SAFCA, and SAFCA's constituent members, nor equitably reflect the joint contributions of these municipalities are making to project financing. Accordingly, we have determined that the removal and replacement of a utility, or other public facility, owned by the State of California, or a political subdivision thereof, and which delivers public services, should be treated as a relocation where such work is required as a direct result of the construction of the project. The Corps will include the costs incurred by the State in performing these relocations as part of shared total project costs and credit the State for such costs.

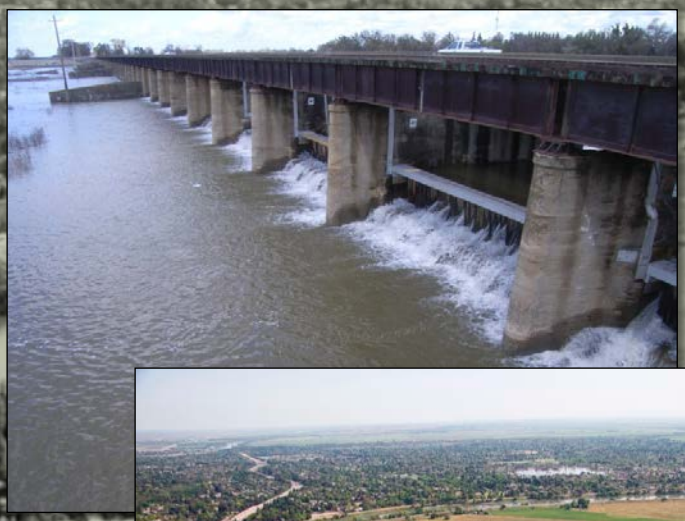
The Army Corps of Engineers has drafted modifications to the Project Cooperation Agreement for the Common Elements Project implementing this determination. These modifications and implementation guidance have been provided to the Sacramento District for coordination with the State of California and SAFCA.

Sincerely,

Joseph W. Westphal
Assistant Secretary of the Army
(Civil Works)

American River Watershed

Common Features
General Reevaluation Report



Final Economics
Appendix E

December 2015

SAFCA
Sacramento Area Flood Control Agency

CENTRAL VALLEY FLOOD PROTECTION BOARD
PUBLIC SAFETY
FLOOD MANAGEMENT
STATE OF CALIFORNIA

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:

Sacramento Weir during operation

Sacramento River facing south near the Pocket and Little Pocket neighborhoods

High flows on the American River at the Highway 160 overcrossing

Folsom Dam releasing high flows

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ATTACHMENT 1 – SUPPORTING DATA

ATTACHMENT 2 – CONSTRUCTION COST ESTIMATES & CONSTRUCTION SCHEDULES FOR ALTERNATIVES 1 AND 2

ATTACHMENT 3 – OTHER SOCIAL EFFECTS (OSE) & REGIONAL ECONOMIC DEVELOPMENT (RED) ANALYSES

CHAPTER 1
INTRODUCTION

1.1 PURPOSE & SCOPE

This Appendix documents the economic analysis performed for the American River Common Features General Reevaluation Report (ARCGF GRR). The main purposes of this report are to:

- Describe the framework of the economic analysis, including the major assumptions, data, methodologies, and analytical tools used.
- Describe the flood risk, in terms of probability of flooding and consequence of flooding, associated with the without-project condition, which assumes that three previously authorized projects (1996/1999 Common Features, the Joint Federal Project (JFP), and the Folsom Dam Raise) are in place and functional.
- Describe the residual flood risk -- the remaining flood risk once a project is built -- associated with each alternative in the Final Array.
- Summarize the results of the net benefit and benefit-to-cost analyses for each alternative in the Final Array.
- Identify the National Economic Development (NED) Plan, which is the alternative that reasonably maximizes net benefits.

1.2 BACKGROUND

In February of 1986, major storms in Northern California caused record flows in the American River Watershed. Outflows from Folsom Reservoir, together with high flows in the Sacramento River, caused water levels to rise above the safety margin on levees protecting Sacramento. The effects of the 1986 storms raised concerns over the adequacy of the existing flood control system. These concerns led to a series of study authorizations and investigations into the need for additional flood protection for the Sacramento area. Some of the key milestones and reports in this process, spanning more than 20 years, are listed in Table 1.

Table 1: Timeline of Key Events and Reports

YEAR	KEY EVENT	REPORT
1986	Severe storms in Northern California raise concerns over level of flood protection in Sacramento area	
1988	Continuing Appropriations Act funds American River Watershed Investigation	
1989	The Sacramento Area Flood Control Agency (SAFCA) is established	
1991		American River Watershed (ARW) Investigation Feasibility Report and Environmental Impact Statement/Report (EIS/EIR) recommends levee improvements in portions of Sacramento and detention dam at Auburn
1993	Defense Appropriations Act (DAA) authorized	

	a portion of the Natomas Basin levee improvements proposed in 1991 Feasibility Report and directs USACE to conduct new FRM study	
1996	Congress defers decision on Auburn Dam, but authorizes more levee improvements common to all candidate plans outlined in SIR; these "common features" authorized in WRDA 1996; Auburn Dam rejected in late 1996/early 1997	ARW, Supplemental Information Report (SIR) and EIS/R identifies 3 plans to reduce flood risk: Folsom Dam Modifications, Stepped Release Plan, Auburn Dam Plan (NED Plan)
1997	Severe storms in the region once again highlight flood risk in the Sacramento area	
1998		SAFCA releases Folsom Dam Modifications Report – New Outlets Plan; report presents alternatives to lower spillway under 1996 SIR's Folsom Dam Modifications Plan
1999	1999 WRDA authorizes 1996 SIR's Folsom Modifications Plan (as modified by SAFCA) and directs USACE to conduct additional FRM studies	
2001		Common Features (CF) Limited Reevaluation Report (LRR) identifies improvements to reduce flood risk to Lower American River area; Section 366 of WRDA 1999 further modifies 1996 WRDA in regard to CF – specific direction is given related to levee modifications that would allow increase outflows from Folsom Dam to a sustained 160,000 cfs without high likelihood of levee failure along Lower American River
2002		ARW Long-Term Study and EIS/R recommend raising Folsom Dam by 7
2003	Energy and Water Development Appropriations Act (2004) authorizes 7-foot dam raise at Folsom Dam	Folsom Dam Modification Project LRR and Environmental Assessment (EA)/EIS reconcile conflicts between authorized Folsom Modification Project and 2002 Long-Term Study Feasibility Report recommendations
2005	Energy and Water Development Appropriations Act (2006) directs the USACE and Bureau of Reclamation to collaborate on FRM planning (USACE mission) and dam safety (Bureau mission) efforts related to Folsom Dam	
2005	In the aftermath of 2005 Gulf Coast hurricane (Katrina), the limitations of the FRM system in the Sacramento area and the need to improve this system gain increased public attention	
2007		Folsom Modification and Dam Raise Project, Post-Authorization Change (PAC) Report describes recommended changes to 2 authorized projects (Folsom Modification and Folsom Dam Raise Projects), and evaluates Joint Federal Project (JFP), which addresses both FRM and dam safety objectives

2008	Start of American River Common Features (ARCF) GRR	Folsom Modification and Dam Raise Projects, Economic Reevaluation Report (ERR) describes potential FRM alternatives at Folsom Dam; analysis revised 2007 PAC Report by updating economic inventory, economic models, and evaluating Regional Economic Development (RED) and Other Social Effects (OSE) accounts
2009	F3 without-project condition milestone conference is held in Sacramento, CA; following conference, decision made to evaluate potential FRM alternatives in Natomas Basin on accelerated schedule and separately from other basins	
2010	Continuation of ARCF GRR efforts from 2009	Natomas Basin PAC and Interim GRR approved and sent to Congress; recommends improving existing levees surrounding the basin, but defers levee raise analysis to full GRR

1.3 STUDY AREA AND BASINS

The American River Watershed drains about 2,100 square miles northeast of Sacramento and includes portions of Placer, El Dorado, and Sacramento counties. Runoff from this basin flows through Folsom Reservoir and passes through Sacramento within a system of levees. Folsom Dam and Reservoir, located on the American River about 25 miles east of the city of Sacramento, form a multi-purpose water project. The project was constructed by the U.S. Army Corps of Engineers (USACE) and is operated by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) as part of the Central Valley Project (CVP). The reservoir has a normal full-pool storage capacity of 975,000 acre-feet with a minimum seasonally designated flood control storage space of 400,000 acre-feet.

Within the watershed, the study area includes three distinct areas:

- Natomas Basin, which lies to the north of downtown Sacramento
- American River North area (hereafter referred to as ARN), which lies east of the Natomas Basin and north of the American River
- American River South area (hereafter referred to as ARS), which lies east of the Sacramento River and south of the American River.

Each area is at risk of flooding from multiple sources. Table 2 below lists these sources; Figure 1 below displays these sources on a map of the study area.

Table 2: Sources of Flooding by Basin

BASIN	SOURCES OF FLOODING
Natomas (NAT)	Sacramento River
	Natomas Cross Canal (NCC)
	Natomas East Main Drainage Canal (NEMDC)
	Pleasant Grove Creek Canal (PGCC)
	American River
American River North (ARN)	American River
	Natomas East Main Drainage Canal (NEMDC)
	Pleasant Grove Creek Canal (PGCC)
	Dry Creek
	Robla Creek
	Magpie Creek
	Arden Creek
American River South (ARS)	American River
	Sacramento River

Figure 1: Study Area, Basins, and Major Sources of Flooding

1.4 ECONOMIC ANALYSIS IN PRIOR REPORTS

Prior reports associated with the American River Watershed Study are listed in Figure 2 below. These reports serve as an historic timeline for which to better understand the basis for the economic analysis contained in this GRR. For each study listed, a brief description is given of the conclusions of the economic analysis; additionally, any parts (e.g., assumptions, data, models, etc.) of one analysis that were carried forward to subsequent analyses are also described.

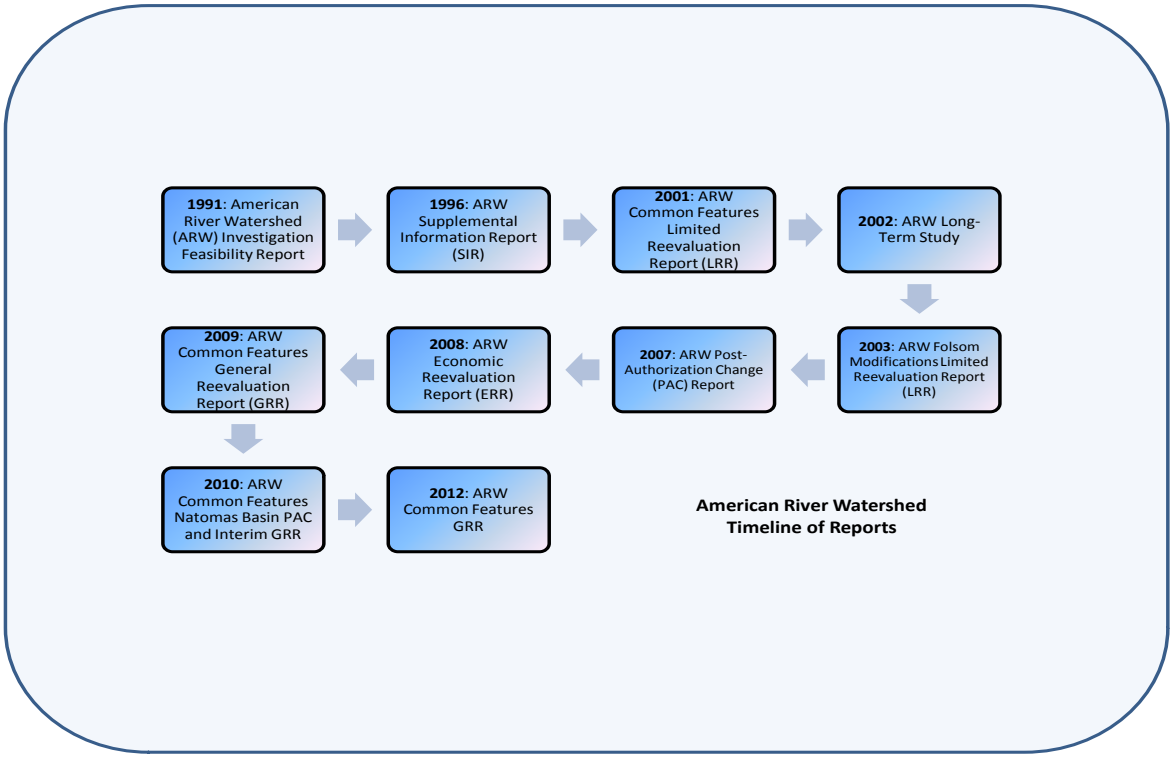


Figure 2: Prior American River Watershed Study Reports

- *American River Watershed Investigation Feasibility Report, 1991*

  This report recommended a detention dam at Auburn, which ultimately was not authorized by Congress. It was estimated that a detention dam at Auburn would have reduced Sacramento's flood risk to about a 1 in 200 chance in any given year based on non-risk analysis methodologies.[1] Following this report, two of many incremental projects, including the Sacramento Area Flood Control Agency (SAFCA) North Area Levee Improvement Project (NLIP) in Natomas and the reoperation of Folsom Dam from 400,000 acre-feet fixed flood control space to a 400,000/670,000 acre-feet variable flood control space, were adopted to help reduce flood risk to Sacramento.

  For the 1991 economic analysis, long-duration non-residential structural depth-percent damage curves were developed; these curves were used to modify the Federal Emergency Management Agency (FEMA) curves for the 2008 ERR, and were then applied to those areas prone to deep and long-duration flooding. These adjusted FEMA curves were carried forward to the 2010 Natomas PAC and Interim GRR, as well as to this current GRR effort. Much of the other engineering and economic data developed for the 1991 Feasibility Report has been replaced by more current data.

[1] Risk analysis methodologies were not implemented at the USACE until after the completion of the 1991 Feasibility Report.

- *American River Watershed Supplemental Information Report, 1996*

  This report was the first American River Watershed report to use a risk analysis methodology to determine economic benefits. The report identified three final alternatives: the Stepped Release, the Folsom Modifications, and the Detention Dam plans. While the Detention Dam was determined to be the National Economic Development (NED) Plan, it was not recommended in the Chief's report and therefore not authorized. Instead, a less controversial Common Features alternative was authorized. A benefit of this alternative, which included features that were part of all three final alternatives, was that it would not preclude future selection of any of the three final alternatives.

- *American River Watershed Common Features LRR, 2001*

  The 2001 Common Features LRR estimated that, with levee improvements in place, outflows from Folsom Dam could be increased to 160,000 cubic feet per second (cfs) for a sustained period of time without introducing a high probability of levee failure along the American River. Annual exceedance probability (AEP) on the Lower American River was estimated to be 0.0099, or about a 1 in 100 chance. Annual flood risk management (FRM) benefits of approximately $19 million and annual FRM costs of $10 million resulted in a benefit-to-cost ratio (BCR) of 1.9.

  The 2001 LRR split Common Features into the Lower American River levee improvements and the Natomas Basin area. The Natomas Basin area required significant reformulation and development of a GRR, which subsequently was included as part of the 2008 Common Features GRR, the 2010 Natomas Basin Post-Authorization Change Interim & General Reevaluation Report, and finally this current effort for the Common Features GRR.

  Additionally, levee performance assumptions documented in the 2001 LRR served as the basis for subsequent reports, including the 2007 PAC and the 2008 ERR; however, differences in the economics, hydrology, hydraulics, and geotechnical inputs preclude a direct comparison of damages, benefits, and project performance between the 2001 LRR and the 2007 PAC, 2008 ERR, and this current GRR.

- *American River Watershed Long-Term Study, 2002*

  The purpose of the Long-Term Study was to address the residual flood risk remaining once the Folsom Modifications project was completed. The Long-Term Study evaluated an array of FRM alternatives that included dam raises ranging from 3.5 to 12 feet. The study determined that a 7-foot raise of Folsom Dam that provided both additional FRM and dam safety[2] would be the most optimal economic solution, exclusive of the Detention Dam alternative.

  Congress, through the Energy and Water Development Appropriations Act for fiscal year 2004, authorized several project features which were recommended by the Long-Term Study: raising Folsom Dam by 7 feet, modifying the L.L. Anderson Dam spillway, constructing a permanent bridge downstream from Folsom Dam, and modifying the emergency release operations to permit surcharge. First costs for this project were estimated at around $249 million, with $128

[2] Dam safety in this instance refers to enabling the dam facility to pass one-hundred percent of the probable maximum flood, or PMF.

million allocated to FRM. Annual FRM benefits of $19 million and annual FRM costs of $10 million provided a BCR of 1.9 to 1. At the time, this project was estimated to reduce the risk of flooding to a 0.0057 annual exceedance probability (AEP)[3], or about a 1 in 175 chance.

Two project components of the 2002 Long-Term Study, the 3.5-foot dam raise and the 7.0-foot dam raise, were also evaluated in the 2007 PAC and 2008 ERR. The 2007 PAC recommended an alternative that included a 3.5-foot dam raise component, and the 2008 ERR confirmed this recommendation as the most optimal amongst the alternatives evaluated. Section 1.5 describes in greater detail the projects previously authorized and either have been or will be constructed.

- *American River Watershed Folsom Modifications LRR, 2003*

  The 2003 LRR reconciled conflicts between the authorized Folsom Modifications Project elements and recommendations in the 2002 Long-Term Study. As directed by Congress in WRDA 1999, the plan identified in the 2002 Long-Term Study included raising Folsom Dam, modifying downstream levee improvements, and implementing other elements necessary to meet current Federal dam safety standards. These authorized features, which make up the Folsom Dam Raise Project, carry design implications for the previously authorized Folsom Modifications Project.

  The 2003 LRR refined the elements related to increasing release capacity to be consistent with gate modifications in the 2002 Long-Term Study. These changes included constructing two new upper-tier outlets, enlarging the four existing upper-tier outlets to 9 feet 4 inches by 14 feet and the four existing lower-tier outlets to 9 feet 4 inches by 12 feet, and modifying the existing main spillway stilling basin.

  In addition, for the surcharge storage aspect of the project, the three emergency spillway tainter gates would be replaced with larger gates, as authorized, but the design would permit expansion of these gates in the future should the Folsom Dam Raise Project be authorized (which it has been) and implemented.

  The Folsom Modifications revised economics report (November 2003) identified the recommended project as new and enlarged existing outlets capable of releases of 115,000 cfs and improvements allowing for the use of surcharge storage up to Elevation 474 feet. First costs for this project were estimated at around $214 million with annual benefits of $32 million and annual costs of $16 million providing a benefit-to-cost ratio of 2.0 to 1. At the time this project was estimated to reduce the risk of flooding to a 0.0071 annual exceedance probability, or about a 1 in 140 chance.

  During the construction proposal process, the cost estimates exceeded the fully funded authorized costs (Section 902 limit). Consequently, dam operations and performance and alternate structural methods to achieve the risk reduction provided by the outlet modifications were reexamined. Subsequent studies also found that modification of the two outboard lower-tier outlets was infeasible, and offered only a marginal increase in performance.

[3] In the Long-Term Study, advanced forecast releases were evaluated as part of the alternatives. With advance releases factored in, project performance (as measured by AEP -- the probability flooding will occur in any given year considering the full range of possible annual floods), improved to 0.0047. Advance releases were not considered in the 2007 PAC, 2008 ERR, or in this current GRR effort.

The alternatives evaluated in the 2008 ERR included construction measures (eight of the total 10 outlets described) included in the 2003 LRR.

- *American River Watershed PAC Report, 2007*

  The purpose of the PAC report was to document changes to two authorized projects: the Folsom Modifications Project and the Folsom Dam Raise Project. Both projects share an objective of improving flood risk management on the Lower American River, primarily through structural modifications to the existing Folsom Dam.

  In the PAC report, project elements from both the Folsom Modifications and the Long-Term Study were considered not only for the purpose of flood risk management but also for dam safety. During the design refinements for Folsom Modifications, it was believed that due to significant increases in the cost estimates that the authorized project may not be optimal or even economically feasible. During this preliminary analysis, it appeared that adding operational gates to the proposed Bureau of Reclamation dam safety auxiliary spillway may provide a more efficient way to meet two project purposes.

  The Folsom Dam Joint Federal Project was intended to meet the goals of the Corps of Engineers as well as the Bureau of Reclamation; its analysis became one of the main focuses of the PAC. As mentioned, the PAC economic analysis included elements of three authorizations, the Folsom Modifications, the Dam Raise, and Reclamation's dam safety project. The combined project's objectives in terms of economic outputs and project performance were: (1) Reduce flood damages as effectively and efficiently as possible within a limited schedule and without complete reformulation, (2) effectively pass the 200-year design flow event without levee failure (based on design non-risk-based criteria), and (3) pass the PMF without placing the dam structure in danger of failure.

  The PAC and follow-on ERR evaluated a final array of four action alternatives. Alternative C, as described below, was the recommended plan from both studies. Alternative C included six submerged tainter gate auxiliary spillway, 3.5-foot dam raise, and three emergency spillway gate replacements. The recommended plan is summarized in Table 3 below.

Table 3: Benefits, Costs, and Project Performance of 2007 PAC Recommended Plan

SUMMARY CRITERIA	RECOMMENDED PLAN
Performance:	
Passes PMF	Yes
Annual exceedance probability (AEP)	0.0054
Design flood event (non-risk-based criteria)	1 in 240
Costs and benefits:	
First costs (FRM only)	$788 million
Annual costs (FRM only)	$40 million
Annual benefits (FRM only)	$107.1 million
Net benefits (FRM only)	$67.1 million
Benefit-to-cost ratio (BCR)	2.7
Residual damages	$91.1 million
Percent damage reduction	54%

Notes: 1) Values in October 2006 prices 2) FRM = flood risk management

- *American River Watershed ERR, 2008*

  The main purpose of the ERR was to affirm that the recommended plan from the PAC was economically feasible and was the most efficient among the array of alternatives considered.

  The focus of the ERR was to update the economics and the HEC-FDA modeling (including the hydrologic and hydraulic data) from previous analyses to develop a more accurate, comprehensive, and system-wide characterization of flood risk for the study area. This update included evaluation of the National Economic Development (NED), Regional Economic Development (RED), and Other Social Effects (OSE) accounts, development of a new structure inventory, re-estimation of structure and content values using data collected through extensive fieldwork and an expert-opinion elicitation panel, and a re-computation of damages and benefits using new, locality-specific non-residential content depth-percent damage curves, seven event-based floodplains (instead of only one as in previous analyses), and more defined consequence areas.

  The ERR estimated that total without-project expected annual damages (EAD) was approximately $277 million, not including the Natomas Basin. The with-project residual damages and benefits were estimated for the same four action alternatives that were evaluated in the 2007 PAC. The results of this alternatives analysis are presented below in Table 4.

Table 4: Net Benefit and Benefit-to-Cost Analyses from ERR

ITEM	ALT A	ALT B	ALT C	ALT D
Total Project First Costs	650.4	918.1	1,042.1	1,555.6
Annual Benefits (2018-2067)	98.1	116.3	143.8	172.2
Annual Benefits During Construction (2012-2017)	32.6	26.9	29.9	26.9
Total Annual Flood Risk Management Benefits	130.7	143.2	173.7	199.1
Annual Costs	46.6	62.3	68.0	98.2
Savings in Avoided Dam Safety Costs	0	(15.3)	(15.3)	(15.3)
Net Flood Risk Management Annual Costs	46.6	47.0	52.7	82.9
Net Benefits	84.1	96.2	121.0	116.2
Benefit-to-Cost Ratio	2.8	3.0	3.3	2.4

Notes: 1) Values in millions, October 2007 prices, 50-year period of analysis, 4.875% discount rate 2) Alternative A includes eight main dam outlets and fuse plug spillway; Alternative B includes a six submerged tainter gate auxiliary spillway; Alternative C includes a six submerged tainter gate auxiliary spillway, a 3.5-foot dam raise, and three emergency spillway gate replacements; Alternative D includes a six submerged tainter gate auxiliary spillway, a 7-foot dam raise, and eight emergency and service spillway gate replacements 3) Alternatives B, C, and D would eliminate the need for construction of the dam safety only fuse plug as part of the future without-project condition; the $15.3 million reduction in dam safety costs was taken as a savings from the net flood risk management annual costs.

The ERR confirmed the 2007 PAC recommendation of Alternative C – which included a six submerged tainter gate auxiliary spillway, a 3.5-foot dam raise, and three emergency spillway gate replacements. Total annual FRM benefits of Alternative C were estimated at $173.7 million, of which $29.9 million was attributed to benefits during construction. Residual expected annual damages of Alternative C were estimated to be approximately $133 million (American River North and South Basins).

- *American River Watershed Common Features F3 GRR, 2009*

  Key data used in the ERR were carried forward to the 2009 GRR, including the extensive structure inventory and the non-residential content valuations/depth-percent damage curves. Other data were updated for the GRR, including the number of sources of flooding (American River, Sacramento River, Natomas Cross Canal, Pleasant Grove Creek Canal, Natomas East Main Drainage Canal) used to estimate flood risk, the consequence areas considered (Natomas was included where it was not in the ERR), the levee fragility curves (geotechnical), the Folsom Dam routings (hydrology), and the rating curves/floodplains (hydraulics).

  In the economic analysis for the 2009 GRR, EAD for the future without-project condition (Authorized Common Features + Joint Federal Project + Folsom Dam Raise) for the ARN, ARS, and Natomas Basins were estimated to be approximately $27.7 million, $132.5 million, and $2.4 billion, respectively. Project performance in terms of annual exceedance probability (AEP) for each area was estimated to be approximately 0.007 (ARN), 0.008 (ARS), and 0.390 (Natomas). In March of 2009, an F3 (without-project condition) milestone conference was held at the Sacramento District office. Based on the outcomes of this conference, the path forward was determined to be to study the Natomas Basin area separately from the rest of the study area (ARS and ARN) via a Natomas Basin Post-Authorization Change & Interim GRR.

- *American River Watershed Natomas Basin PAC Interim GRR, 2010*

  Soon after the March 2009 F3 milestone conference, the American River Common Features project delivery team (PDT) was charged with studying the Natomas Basin as a separate entity from the rest of the Common Features GRR study area, recommending an alternative(s) for the Natomas Basin via a Post-Authorization Change & Interim GRR, and completing this report within a highly accelerated schedule. This report was in fact completed in December 2010, approximately 20 months following the initial charge, and subsequently was approved by the Civil Works Review Board, signed by the Chief of Engineers, sent to the Office of Management and Budget (OMB), and submitted to Congress. Congress authorized the project in 2014.

  The Natomas Basin PAC & Interim GRR focused on improving the existing levees (either in place or via adjacent levees) surrounding the Basin along all five waterways, including the Sacramento River, American River, Natomas East Main Drainage Canal (NEMDC), Pleasant Grove Creek Canal (PGCC), and the Natomas Cross Canal (NCC); analysis of levee raises were deferred to the GRR. However, the Natomas Basin has since been removed from the GRR alternatives.

  The Natomas PAC Interim GRR recommended improving the levees along all waterways surrounding the Natomas Basin. It was estimated that the Recommended Plan would reduce without-project EAD by about 96%, or from approximately $462 million in EAD to approximately $19 million in EAD, producing average annual benefits of approximately $443 million. The project cost was estimated to be approximately $67.8 million (average annual). Net benefits and the BCR were estimated to be approximately $375.2 million (average annual) and 6.5, respectively. Once completed, the improvements were expected to reduce the probability of flooding in any given year from about a 1 in 5 chance to about a 1 in 67 chance.

1.5 SUMMARY OF PREVIOUSLY-AUTHORIZED FLOOD RISK MANAGEMENT IMPROVEMENTS ALREADY CONSTRUCTED OR CURRENTLY UNDER CONSTRUCTION

Three major American River Watershed projects have been previously authorized by Congress as outlined above. These include the 1996/1999 Authorized Common Features Project, the Joint Federal Project (JFP), and the 3.5-foot Folsom Dam Raise Project. Figure 3 below lays out these improvements, starting with no improvements in place and leading up to the 3.5 foot Folsom Dam Raise (rectangles); the large oval represents the alternatives that were considered for this current GRR effort.

It is important to point out that while these projects have been authorized and/or implemented in an incremental nature, these improvements are interdependent and rely on one another to fully maximize risk reduction from a system-wide perspective.

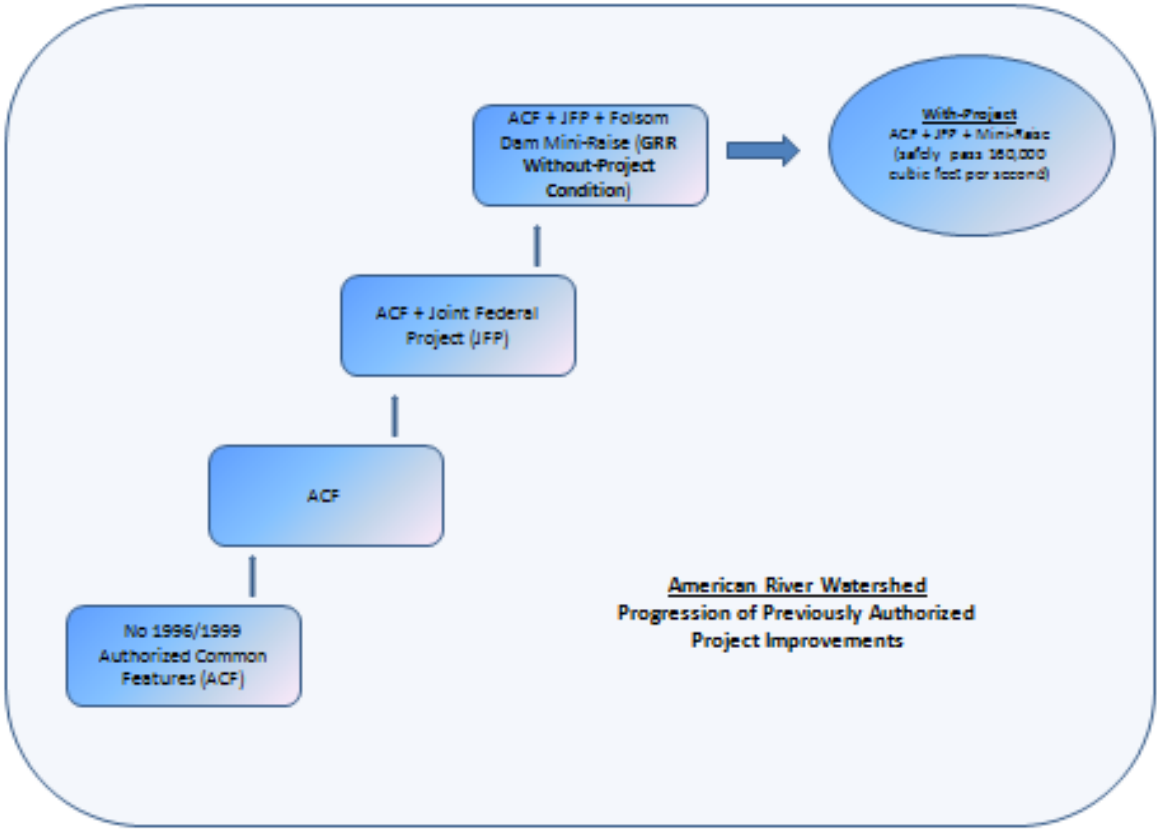


Figure 3: FRM Improvements Authorized Under the American River Watershed Study

1.6 FUTURE WITHOUT-PROJECT CONDITION

For this current GRR effort, the future without-project condition assumes that the previously authorized 1996/1999 Common Features improvements, JFP, and Folsom Dam Raise are in place and functional by the year 2020. This without-project condition is represented by the top rectangle in Figure 3. System-wide risk reduction was estimated by comparing the economic outputs of each alternative evaluated (represented by the large oval in Figure 3) against the future without-project condition.

1.7 ORGANIZATION & CONTENT

This report is organized around four main chapters. The contents of each chapter are summarized in Figure 4 below.

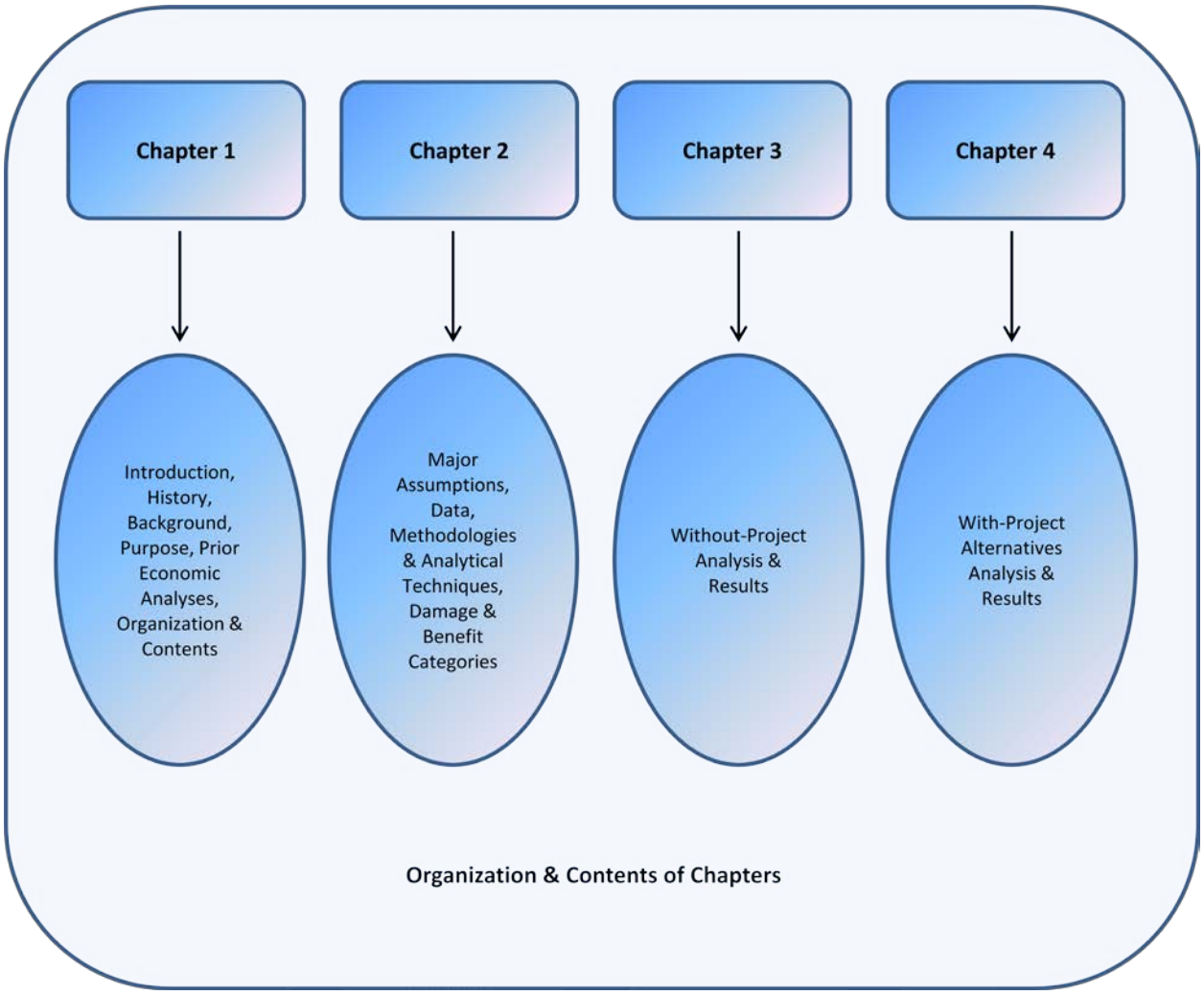


Figure 4: Content of Chapters

CHAPTER 2
FRAMEWORK OF ECONOMIC ANALYSIS

2.1 CONSISTENCY WITH CURRENT REGULATIONS & POLICIES

The analysis presented in this document was performed using the most up-to-date guidance and is consistent with current regulations and policies. Various references were used to guide the economic analysis, including:

- The *Planning Guidance Notebook* (ER 1105-2-100, April 2000, with emphasis on Appendix D, Economic and Social Considerations, Amendment No. 1, June 2004) serves as the primary source for evaluation methods of flood risk management (FRM) studies
- EM 1110-2-1619, *Engineering and Design – Risk-Based Analysis for Flood Damage Reduction Studies* (August 1996)
- ER 1105-2-101, *Planning Risk-Based Analysis for Flood Damage Reduction Studies* (Revised January 2006)
- Economic Guidance Memorandum (EGM) 01-03, *Generic Depth-Damage Relationships* (2000)
- Economic Guidance Memorandum (EGM) 04-01, *Generic Depth-Damage Relationships for Residential Structures with Basements* (2003)
- Economic Guidance Memorandum (EGM) 09-04, *Generic Depth-Damage Relationships for Vehicles* (2009)

2.2 PRICE LEVEL, PERIOD OF ANALYSIS, AND DISCOUNT RATE

Values listed in this document are based on an October 2015 price level. Annualized benefits and costs were computed using a 50-year period of analysis and a current federal discount rate of 3.125%. Unless otherwise noted, annualized values are presented in thousands of dollars.

2.3 MAIN ASSUMPTIONS

Several main assumptions were relied upon in order to reasonably and efficiently study the problem (i.e., flooding) and its solutions (i.e., flood risk management alternatives), and then ultimately reach a conclusion using the limited resources available:

- The without-project condition assumes that the 1996/1999 Authorized Common Features improvements, Joint Federal Project, and Folsom Dam Raise are in place and functional; this assumption is reflected in the hydrologic (transform flow), hydraulic (floodplains and rating curves) and geotechnical (levee fragility curves) engineering data used in the economic analysis
- The future without-project operations at Folsom Dam assume a target release of 160,000 cubic feet per second (cfs) for the 200-year event; this assumption is reflected in the hydrologic transform flow curves used for the without-project condition
- The with-project operations at Folsom Dam assume a target release of 160,000 cfs for the 200-year event, also known as the 0.5% annual chance exceedance (ACE) event, and which has a 1 in 200 chance of occurrence (these terms will be used interchangeably throughout this document); this assumption is reflected in the hydrologic transform flow curve used for the with-project condition

- All areas except the Natomas Basin assume build-out and no future development
- For the Natomas Basin, additional development was accounted for but only to describe the residual risk associated with a project; no benefits were claimed for future development. (A discussion on residual risk in the Natomas Basin can be found in the Economic Appendix for the Natomas Post-Authorization Change & Interim GRR.)
- That the hydrologic, hydraulic, and geotechnical conditions within the study area would remain the same between the without-project and the most likely future without-project conditions. Most likely future (without-project) hydrologic, hydraulics, and geotechnical engineering data for input into the economic modeling were assumed to be the same as the base without-project condition
- That damages resulting from out flanking from the non-leveed portions of the American River upstream of existing levees would not be reduced even with a project in place; this assumption was factored into the estimation of benefits for the ARS and ARN basins.

2.4 METHODOLOGIES, TECHNIQUES, & ANALYTICAL TOOLS

Various methodologies, analytical techniques, and tools were used to perform the economic analysis. The majority of those used for this analysis is standard to many Corps of Engineers studies and are described in the appropriate sections throughout this document. Several of the main ones used in this analysis are described below.

2.4.1 Economic Analytical Tool: HEC-FDA Software

The main analytical tool used to perform the economic analysis was the Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) software, version 1.2.5a. This program stores the engineering data (hydrologic, hydraulic, and geotechnical) and the economic data (structure/content inventory and depth-percent damage curves), and is used to model the flooding problem and potential alternative solutions in the study area.

By relating the economic inventory data to the floodplain data, the HEC-FDA software computes economic stage-damage curves. Through integration of the main engineering relationships (exceedance probability-discharge curves, rating curves, and geotechnical levee fragility curves) and the main economic relationship (stage-damage curves), the HEC-FDA software computes project performance statistics and expected annual damages/benefits.

The results of the economic modeling are then used as input into the net benefit and benefit-to-cost analyses and may also aid in plan formulation, all of which are performed external to the HEC-FDA software.

2.4.2 Floodplain Data in HEC-FDA Using FLO-2D Model Output

The SPK Hydraulic Design Section developed floodplains using the FLO-2D model, which produces interior water surface elevations by grid cell. The model generates suites of FLO-2D floodplains {0.5 (1/2), 0.1 (1/10), 0.04 (1/25), 0.02 (1/50), 0.01 (1/100), 0.005 (1/200), and 0.002 (1/500) annual chance exceedance events}; suites were developed for each index point. (See Section 2.6 for discussion of representative index points).

Importing the FLO-2D data into the HEC-FDA models required file formatting. The FLO-2D files were formatted so that the HEC-FDA program would import them as a HEC-RAS water surface profile (WSP) output file. Instead of using river station numbers like in a typical HEC-RAS WSP, assignment of water surface elevations by frequency event were completed using grid cell numbers (output of FLO-2D); the grid cell assignments represent actual floodplain water surface elevations by frequency event rather than in-channel water surface elevations.

2.4.3 Computing Stage-Damage Curves in HEC-FDA

The formatted WSPs included every grid cell that contained a structure and the water surface elevations in each grid cell for each frequency event. The suite of floodplains along with the imported structure inventory was used in HEC-FDA to compute stage-damage curves.

Once the formatted floodplain data were imported into HEC-FDA, a row was inserted at the top of the WSP which included the in-channel stages associated with the index point (for a particular impact area). This step allowed for the linkage between the two-dimensional floodplain data and the in-channel stages. Importing formatted floodplain data and assigning water surface elevations to grid cells eliminated the need for creating interior-exterior relationships, which is another way to link exterior (river) stages to interior (floodplain) stages within HEC-FDA.

2.4.4 Multiple-Source Flooding into Single Consequence Area

Multiple sources of flooding within a single consequence area complicate the economic risk analysis in terms of estimating the chance of flooding and the consequences of flooding in that consequence area. Additional analytical complexity is introduced if one considers that the probability of flooding along a particular flooding source also varies (i.e., not only is the probability of flooding between various water sources not uniform but the probability of flooding along a specific water source is also not uniform), and that the same area is flooded from levee breaches at different locations but at varying magnitudes (i.e., different floodplains) depending on the location of the breach.

The risk analysis was performed using eight representative index points, with each point tied to a specific source of flooding within the study area. The same index points were used for both the without-project and with-project analysis. Section 2.6 below describes in more detail the index points used and their locations.

2.5 ECONOMIC IMPACT AREAS (EIA)

Economic impact areas (EIA) were delineated in order to facilitate the economic risk analysis. These areas enable the direct computation and reporting of consequences that result from flooding from a specific source under both the without-project and with-project conditions. Three main EIAs within the study area were identified:

- American River North Basin (ARN)
- American River South Basin (ARS)
- Natomas Basin (NAT)

During the 2007 PAC/2008 ERR, sub-EIAs within two of the main EIAs (ARN and ARS) were identified in order to more precisely (by neighborhood within a basin) analyze residual risk. These impact areas are presented below but were not carried forward to this analysis. Figures 5 and 6 display the three main EIAs (NAT, ARN, ARS) and the sub-EIAs within the ARN and ARS Basins. It should also be noted that the boundaries of the EIAs presented in Figure 6 do not correspond to any particular ACE event flood plain used in the current analysis.

ARS:

- ARS 1 Pocket/Greenhaven
- ARS 2 Fruitridge/Meadowview
- ARS 3 Land Park
- ARS 4 Downtown Sacramento
- ARS 5 East Sacramento
- ARS 6 Rancho Cordova
- ARS 7 Gold River
- ARS 8 South I-50/Florin/Watt
- ARS 9 Florin South
- ARS 10 Mather North
- ARS 11 Rosemont
- ARS 17 South of Morrison Creek

ARN:

- ARN 13 American River Drive
- ARN 14 Arden/Expo
- ARN 15 North Sacramento
- ARN 16 Dry Creek

The smaller sub-economic impact areas (neighborhoods) were not used for the current analysis but instead aggregated into two larger impact areas (ARS and ARN Basins); this aggregation is unlikely to affect the accuracy of the results in terms of damages, benefits, or plan selection. Aggregating the sub-impact areas allowed for a more streamlined approach to the analysis that required fewer models, which then translated into fewer model runs, fewer sets of output results, less documentation, and ultimately time savings.

It should also be noted that there is a trade-off in terms of detail/precision by aggregating the sub-EIAs into one FDA model/inventory/impact area. Since models are run by basin and results are also reported by basin rather than sub-impact area, seeing how a neighborhood within the basin is affected by a project is not as apparent. However, since each structure is still identified by sub-impact area (e.g., 1-17) within the aggregated inventory, this information is not lost and could be ascertained if necessary.

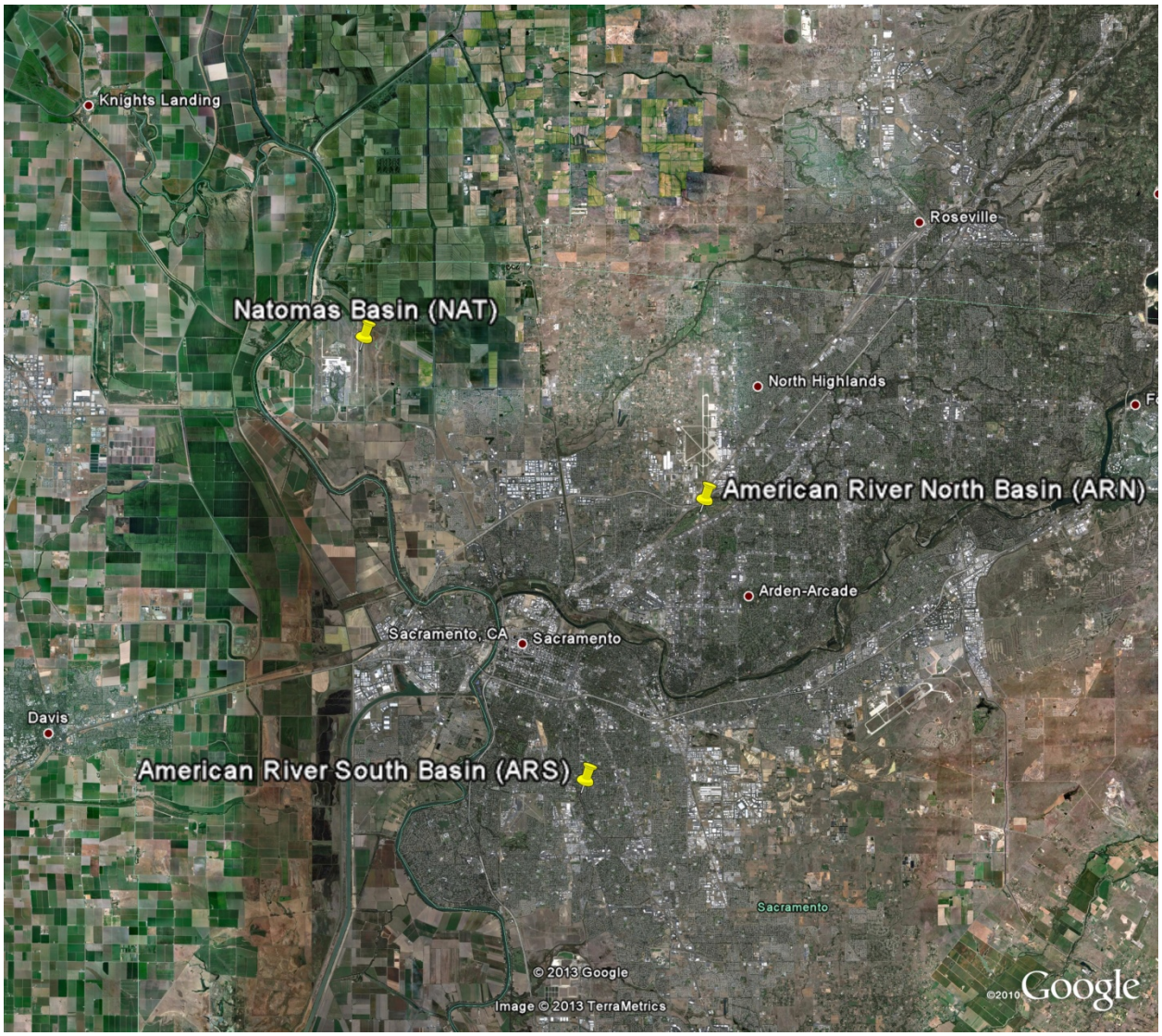


Figure 5: Main Economic Impact Areas (Basins)

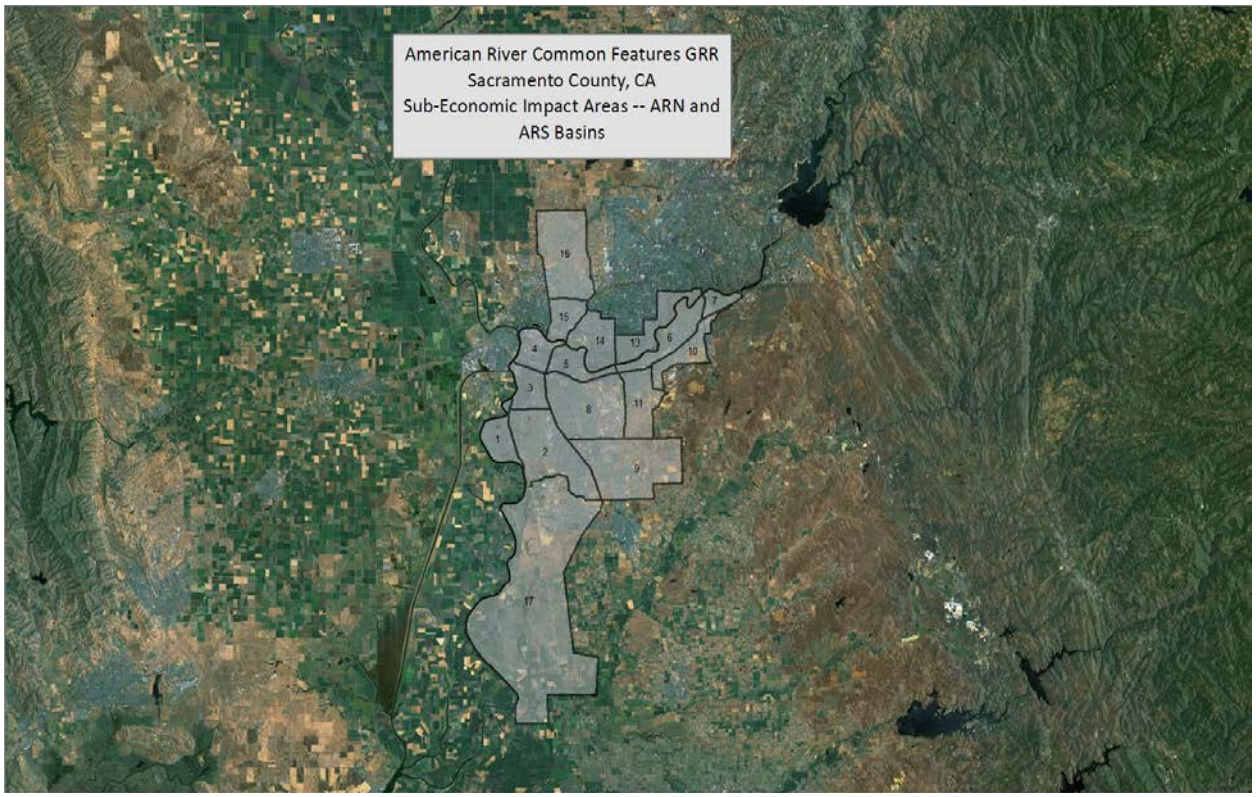


Figure 6: Sub-EIAs in the ARS and ARN Basins

2.6 HYDRAULIC REACHES & REPRESENTATIVE INDEX POINTS

Chapter 1 (Section 1.3) explained that each basin/EIA may be at risk of flooding from multiple sources. For example, the ARS Basin could be flooded from either the American or Sacramento Rivers. Additionally, along each source of flooding, the condition of the levee could vary from one location (hydraulic reach) to the next, with the probability of flooding from a particular reach varying correspondingly.

In terms of economic analysis, levee reaches are used to focus-in on those areas deemed most pertinent for developing engineering data, which feed into the economic modeling. Data are generated at representative index points within each reach and are used to estimate project performance statistics under both without-project and with-project conditions. The engineering data is also used in conjunction with economic data to estimate expected damages and benefits. Both sets of results are then used together to describe the flood risk in the study area.

Twenty-five hydraulic reaches were originally identified based on extensive geotechnical analyses of the levee conditions along each source of flooding within the study area. From these 25 reaches, the project delivery team (PDT) selected five of them, each containing one index point, for which to generate engineering data for use in the economic modeling and the associated without-project damage and with-project benefit analyses. The PDT also selected three additional index points -- two located on the right and left banks of the American River and one located on the NEMDC/PGCC (also known as the Sankey Gap) at locations where there are no levees. These index points were not part of the original 25, but were included in order to aid in a more accurate description of residual flood risk in the study area. The representative index points used in economic analysis were selected based on preliminary estimates

of the chance of flooding and consequences of flooding using flood plain extents and depths, levee fragility (geotechnical fragility curves), and estimates of ACE event damages. The index points, by basin, are shown in Figure 7 and listed below.

ARS:

- ARS A, American River, RM 9.0, left bank
- Flanking location on American River, RM 14.5, left bank
- ARS F, Sacramento River, RM 50.25, left bank

ARN:

- ARN A, American River, RM 7.82, right bank
- Flanking location on American River, RM 13.21, right bank
- ARN E, Arcade Creek, RM .88, right bank

NAT:

- NAT D, Natomas Cross Canal, RM 4.3, left bank
- Sankey Gap on the NEMDC/PGCC

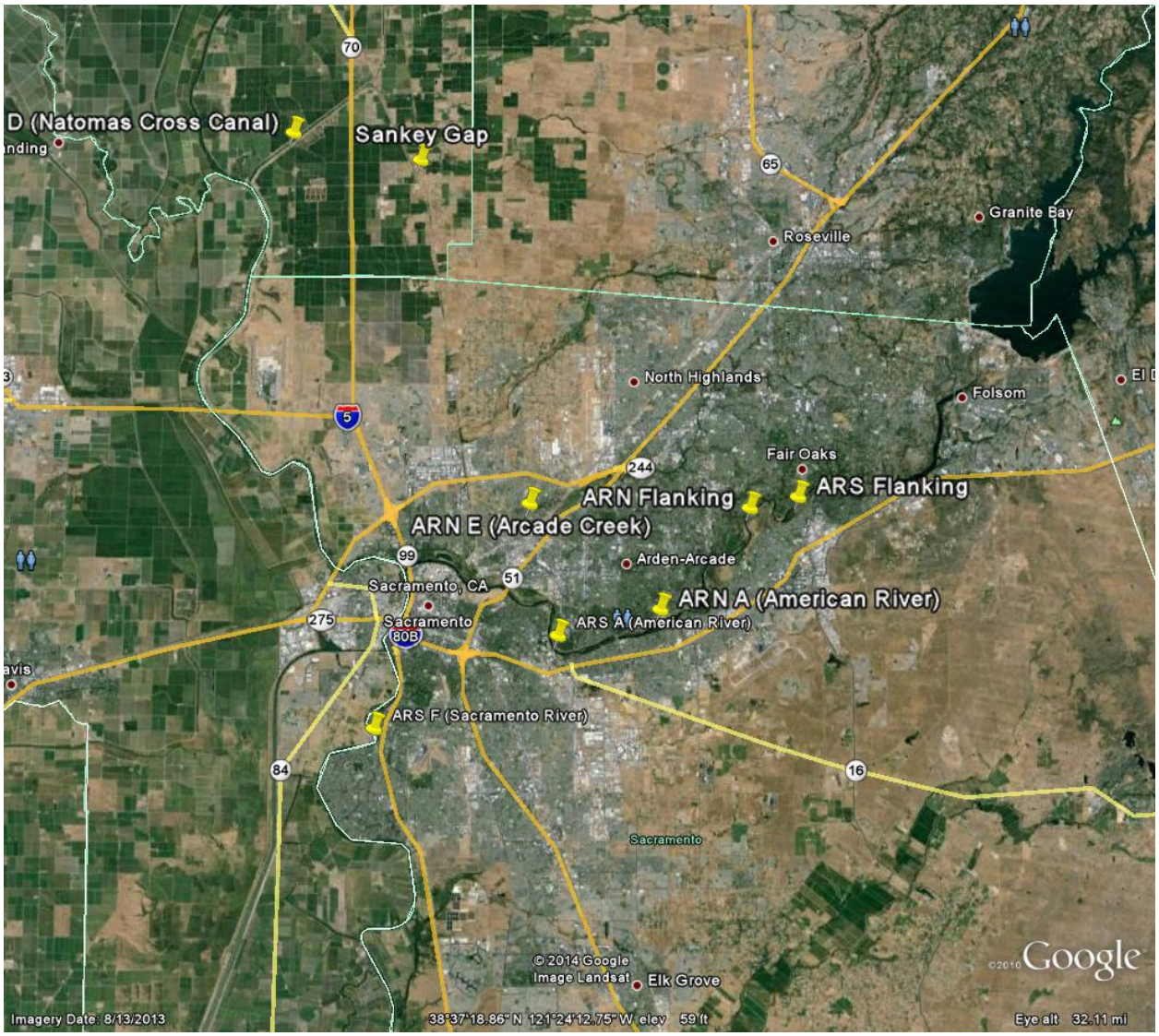


Figure 7: General Location of Eight Index Points Used in the Economic Analysis

In this analysis "representative index points" refers to those locations whereby the without-project condition (damages and performance) of the study area is best characterized. The PDT's intent was to balance rigor with practicality in choosing the number of index points to use in the analysis. Once the number of index points was determined for this GRR – essentially one index point to represent a major source of flooding (per bank side) plus several others to be able to check for residual damages (e.g., outflanking locations on the American River), the PDT then made a preliminary comparison of the chance of flooding and the consequences of flooding – in other words the overall flood risk associated with a levee breach at various locations – in selecting the representative index points. During the course of the study, two of the index points (ARS B and ARS E) that were originally selected were replaced by alternate index points (ARS A and ARS E).

As Table 5 below indicates, there's a relatively high chance of a levee performing poorly in the majority of the smaller reaches that make up the larger increments used in the final analysis. Furthermore, a breach in any of the reaches would result in deep and extensive flooding by filling up the respective basin. Taking into account the chance of flooding and consequences of flooding specific to this study

area, an incremental analysis based on a delineation of one reach/increment equal to an entire stretch of river (e.g., the Sacramento River from the confluence with the American River downstream to the boundary of the study area) or an incremental analysis based on a delineation of multiple reaches/increments along a stretch of river (e.g., ARS D, E , F, and G on the Sacramento River from the confluence with the American River downstream to the boundary of the study area) would ultimately arrive at the same conclusion: that benefits/net benefits are maximized once the entire system is improved. Residual risk would remain relatively high until the entire system is improved since flooding from various locations (reaches) affects the same consequence area.

Table 5: Probability of Poor Performance for Various ACE Events

Basin/Reach	Probability of Poor Performance (P(f))		
	2% ACE	1% ACE	Top of Levee (TOL)
ARS Basin – American River Index Points			
ARS A	~13%	~13%	~65%
ARS B	~20%	~23%	~65%
ARS C	~12%	~16%	~30%
ARS Basin – Sacramento River Index Points			
ARS D	~12%	~16%	~61%
ARS E	~25%	~25%	~45%
ARS F	~30%	~30%	~45%
ARS G	~22%	~28%	~36%
ARN Basin – American River Index Points			
ARN A	~12%	~15%	~56%
ARN B	~6%	~7%	~15%
ARN C	~28%	~45%	~60%

2.7 DESCRIPTION OF ECONOMIC DATA & UNCERTAINTIES

The economic data used in the analysis are described in the following sub-sections. These data lay the groundwork for the without-project damage and with-project benefit analyses that are described in Chapters 3 and 4, respectively.

2.7.1 Structure Inventory

An extensive, comprehensive structure inventory of the study area was performed for the 2008 American River Watershed Folsom Dam Modification and Folsom Dam Raise Economic Reevaluation Report (ERR). The 2008 ERR inventory was carried forward to this analysis with limited updating for price level (all basins) and foundation heights (Natomas Basin).

Structure data was collected using standard USACE practices. For the ERR, a base geographic information system (GIS) inventory with parcel attribute data for both Sacramento and Sutter counties was provided by the non-federal partner. Numerous field visits were taken to collect the base inventory data, including number of stories, foundation heights, building use (residential, commercial, industrial, public), occupancy types (more specific building use, such as commercial restaurant or single-family residential), class (per Marshall & Swift Valuation Service's grades of construction), construction rating (per Marshall & Swift's categories of "low cost" to "excellent" construction), and condition ("poor" to "new" condition), which was used to estimate depreciation.

The data collected for the ERR produced a structure inventory encompassing an area larger than the current 0.2% (1/500) annual chance exceedance (ACE) floodplain for the ARS and ARN basins. Structure counts for the four main building categories are listed in Table 6 below, and represent only those structures falling within the 0.2% (1/500) ACE floodplain.

Table 6: Number of Structures by Category and Basin in Impact Areas Delineated in 2008 ERR

CATEGORY	STRUCTURE COUNT			
	ARS BASIN	ARN BASIN	NATOMAS BASIN	TOTAL
COMMERCIAL	3,210	754	292	**4,256**
INDUSTRIAL	1,064	224	149	**1,437**
PUBLIC	819	147	82	**1,048**
RESIDENTIAL	104,513	14,018	22,247	**140,778**
TOTAL	**109,627**	**15,143**	**22,770**	**147,540**

2.7.2 Structure and Content Values

Structure attribute data collected during field visits and obtained from the non-federal partner were used to determine valuation of structures and contents.

2.7.2.1 Structure Values

For all residential structures classified as single-family residential (SFR), Sacramento County provided detailed information regarding square footage of the buildings. This included total square footage, basement square footage, 2nd-floor square footage, and garage square footage; this same data was not available for the non-residential and multi-family residential (MFR) categories. For many of the larger buildings and in some of the commercially-dense areas, the county provided GIS data that included digitized building footprints. The GIS data was used to identify each structure's square footage. For those buildings not included in the GIS data, high-resolution aerial photographs were used in conjunction with GIS to measure the building footprint. In both cases, the measured first floor square footages were used along with the number of damageable floors (limited to no more than three floors) to estimate the maximum possible damageable square footage for structure valuation purposes.

Depreciated replacement value of structures were estimated based upon building square footage, estimated cost per square foot (from the Marshall & Swift Valuation Handbook), and estimated depreciation. Values per square foot were based on building use, class, and type as outlined in the Marshall and Swift Valuation Handbook.

2.7.2.2 Content Values

For SFR residential structures, depth-percent damage curves developed by the USACE Institute for Water Resources (IWR) and presented in Economic Guidance Memorandum (EGM) 01-03 and 04-01, were used. Since the percentage damages in these generic depth-percent damage curves were developed as a function of structure value, it was unnecessary to explicitly derive content values for input into the HEC-FDA model; the model computes content damages by applying the percentages in the content-percent damage curves to structure values. For report purposes and to estimate content value for residential structures, a content-to-structure value ratio of 50% was used, which is consistent

with the ratio used in prior American River Watershed studies. It should be note that the residential content-to-structure value ratio (CSVR) of 0.5 (50%) was used to derive an order of magnitude estimate of the value of damageable property (contents) for reporting purposes only and was not used to estimate actual residential content values for use in the calculation of expected annual damages (EAD) or annual benefits. While it is understood that the 0.5 CSVR cannot realistically be applied broadly to all homes in the study area, it has been used in past District studies as a simple but adequate way to help derive an estimate of the total value of property in the study area and as a way to gage the magnitude of content damages should a flood event occur.

For non-residential categories, an expert elicitation was performed to develop content values and content depth-percent damage curves for specific occupancy types for the 2008 ERR. The results of that expert elicitation were used for this analysis. The values and curves were developed specifically for structures in the American River Watershed study area. In total, there were 22 different occupancy types with values ranging from $22 to $235 per square foot with uncertainty. Content values for non-residential structures were generated as a function of building use, damageable square footage, and content value per square footage per occupancy type. Additional information regarding non-residential dollar-per-square foot values and depth-percent damage curves can be found in the 2008 ERR.

Tables 7, 8 and 9 show the value of damageable property, by basin, for structures, contents, and combined, respectively.

Table 7: Value of Damageable Property (Structures) by Category and Basin in 0.2% Floodplain

CATEGORY	VALUE OF DAMAGEABLE PROPERTY (IN $1,000S, OCTOBER 2015 PRICE LEVEL): STRUCTURES			
	ARS BASIN (ARS A)	ARN BASIN (ARN E)	NATOMAS BASIN (NAT D)	TOTAL
COMMERCIAL	5,758,255	2,181,880	665,735	8,605,870
INDUSTRIAL	2,123,101	433,933	439,682	2,996,716
PUBLIC	5,516,293	633,479	489,049	6,638,821
RESIDENTIAL	18,195,458	2,648,052	4,259,542	25,103,052
TOTAL	**31,593,107**	**5,897,343**	**5,854,008**	**43,344,459**

Table 8: Value of Damageable Property (Contents) by Category and Basin in 0.2% Floodplain

CATEGORY	VALUE OF DAMAGEABLE PROPERTY (IN $1,000S, OCTOBER 2015 PRICE LEVEL): CONTENTS			
	ARS BASIN (ARS A)	ARN BASIN (ARN E)	NATOMAS BASIN (NAT D)	TOTAL
COMMERCIAL	3,095,566	1,052,296	280,247	4,428,109
INDUSTRIAL	1,452,267	364,061	232,758	2,049,086
PUBLIC	1,503,087	201,622	282,486	1,987,195
RESIDENTIAL	9,097,730	1,324,026	2,134,367	12,556,123
TOTAL	**15,148,650**	**2,942,005**	**2,929,857**	**21,020,512**

Table 9: Value of Damageable Property (Structures & Contents) by Category and Basin in 0.2% Floodplain

CATEGORY	VALUE OF DAMAGEABLE PROPERTY (IN $1,000S, OCTOBER 2015 PRICE LEVEL): STRUCTURES & CONTENTS			
	ARS BASIN (ARS A)	ARN BASIN (ARN E)	NATOMAS BASIN (NAT D)	TOTAL
COMMERCIAL	8,853,821	3,234,176	945,982	13,033,979
INDUSTRIAL	3,575,368	797,994	672,440	5,045,802
PUBLIC	7,019,380	835,101	771,535	8,626,016
RESIDENTIAL	27,293,188	3,972,078	6,393,909	37,659,175
TOTAL	**46,741,757**	**8,839,349**	**8,783,865**	**64,364,972**

2.7.3 First-Floor Elevation of Structures

For structure and content damages, depth of flooding relative to the structure's first floor is the primary factor in determining the magnitude of damages. The current analysis uses HEC-FDA's internal processes for the determination of structural inundation. The process combined a geographic information system (GIS) database containing spatially-referenced polygons for each parcel in the study area with water surface elevations (per grid cell) from the FLO-2D modeling. Parcels/structures were then tied to a specific grid cell in which the parcel was located.

A representative ground elevation was assigned to each parcel/structure using GIS. Foundation heights for each structure were estimated during numerous field visits. First-floor elevations were computed in HEC-FDA using the foundation height and ground elevation data.

Using the ground elevation and foundation height data from the economic structure inventory in conjunction with the water surface elevation data from the WSP, depths of flooding above the first floor at each structure for each annual chance exceedance event were computed within HEC-FDA. As explained previously, water surface elevations (WSE) from the FLO-2D modeling were provided for each grid cell for the 0.5, 0.1, 0.04, 0.02, 0.01, 0.005, and 0.002 ACE events and were imported into the HEC-FDA model in the form of a water surface profile.

2.7.4 Emergency Cost Losses

Depreciated replacement values of structures are used to assess structure and content damages and to gage the cost of replacing damaged portions of structures and contents of similar use and condition. However, there are other costs/damages directly associated with structure and content damages that may result from a flood event but which are not captured in the estimate of structure and content damages. These additional damage categories were considered in the assessment of without-project damages and with-project benefits for the American River Common Features GRR, and include:

1. Clean-up costs
2. Temporary evacuation, relocation and housing assistance (TERHA)

The sub-sections below describe in greater detail these additional flood damage/benefit categories. The assessment method used for this report follows the one used in the Sutter Basin Feasibility Study. In the Sutter study, both clean-up and TERHA costs were included in the estimate of without-project damages

and with-project benefits. Further, the Sutter study has been approved by the USACE Civil Works Review Board (CWRB) as well as by the Office of the Assistant Secretary of the Army, which adds some legitimacy to both the damage/benefit categories and methodology.

The without-project damages and with-project benefits (alternatives in Final Array) associated with clean-up and TERHA costs are summarized in Table 17 in Section 3.3.2 (without-project condition) and Tables 45-46 in Section 4.10 (without-project and with-project conditions).

Clean-Up Costs: Flood waters leave debris, sediment, salts and the dangers of diseases throughout flooded structures, making the cleaning of these structures a necessary post-flood activity. Clean-up costs for the extraction of flood waters, dry-out, and decontamination vary significantly based upon various factors, including depth of flooding. Studies conducted by both Sacramento and New Orleans Districts indicate a maximum value of ten dollars per square foot ($10/ft^2) for such clean-up costs. This maximum per square foot cost covers clean-up costs associated with mold and mildew abatement, which entails having professional firms apply fans, chemicals, and other techniques to eliminate and prevent mold/mildew in inundated areas. The maximum clean-up cost of $10/ft^2 was used for the American River Common Features economic assessment and was applied for flood depths equal to and exceeding five feet, with damage percentages scaled down for depths between zero and five feet. Figure 8 below displays per square foot clean-up costs as a function of flood depths; Figure 9 displays the depth-percent damage curve used in the HEC-FDA analysis.

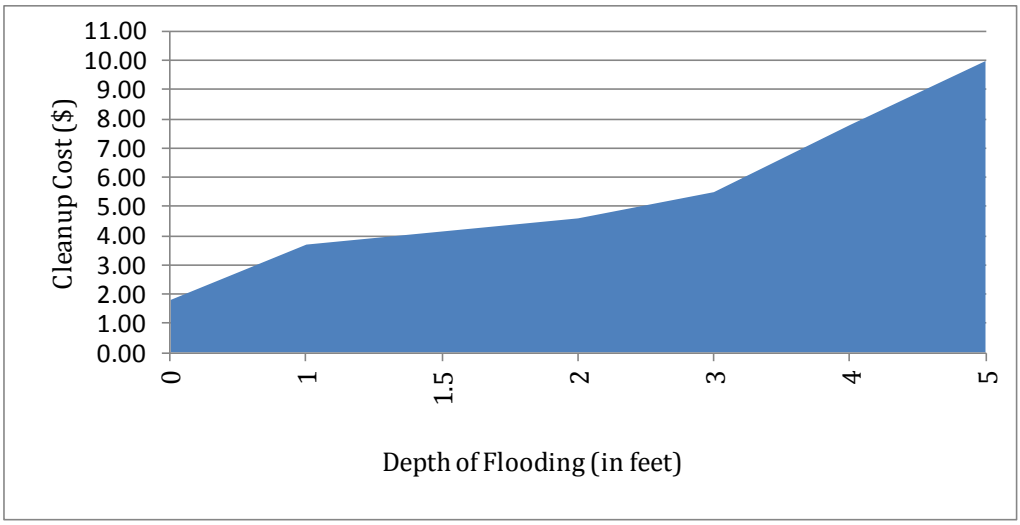


Figure 8: American River Common Features GRR, Dollar-Per-Square Foot Clean-Up Costs as a Function of Depth of Flooding

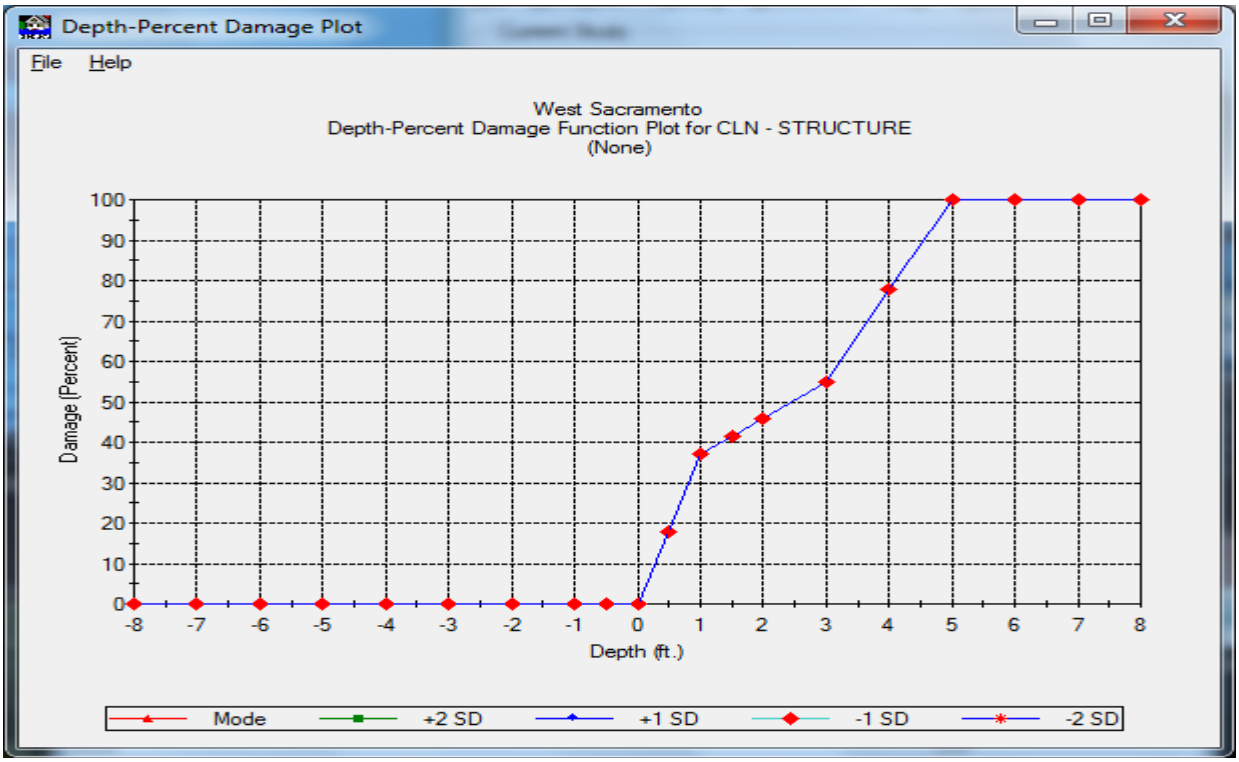


Figure 9: American River Common Features GRR, Depth-Percent Damage Curve for Clean-Up Costs Used in HEC-FDA Analysis

Temporary Evacuation, Relocation, and Housing Assistance (TERHA): ER 1105-2-100 states, "Flood damages are classified as physical damages or losses, income losses, and emergency costs." The ER then defines emergency costs as "those expenses resulting from a flood what would not otherwise be incurred…" The ER further requires that emergency costs should not be estimated by applying an arbitrary percentage to the physical damage estimates.

The Federal Emergency Management Agency (FEMA) provides grants to assist individuals and families to find suitable housing when they are displaced in cases of federally declared disasters. The program assures that people have a safe place to live until their homes can be repaired. This assistance is directly attributable to the disaster, since it is an expenditure that is only undertaken when a disaster occurs. Therefore, it falls under the emergency cost guidance of ER 1105-2-100, and the funds expended by FEMA for temporary evacuation, relocation, and housing assistance (TERHA) in the event of a flood are a legitimate flood damage category under the NED account.

Cost estimates for the relocation and emergency services provided to floodplain residents displaced during peak flood events and post-flood structural renovations were based on FEMA's methodology for evaluating TERHA costs. This methodology relates TERHA costs to relocation costs, structure damage percentages and the number of days residents spend displaced from their structures. The maximum TERHA costs of $11,244 correspond with one year of FEMA evacuation, relocation and/or housing assistance costs. These costs are based on the median rent of a two bedroom apartment, and were derived for this assessment using rent prices in the Sacramento area as posted on the website www.rent.com. The maximum cost of $11,244 was applied to structures sustaining at least 50 percent damage, with scaled down costs being computed for less damaging flood events. Figure 10 below shows percent of maximum TERHA damages as a function of the depth of flooding. The depth-percent damage

relationship for a one-story single family residential (SFR) structure is also shown as a point of reference; however, unique depth-percent damage relationships for one-story residential, two-story residential, and mobile homes were applied in HEC-FDA to derive damages and benefits for TERHA.

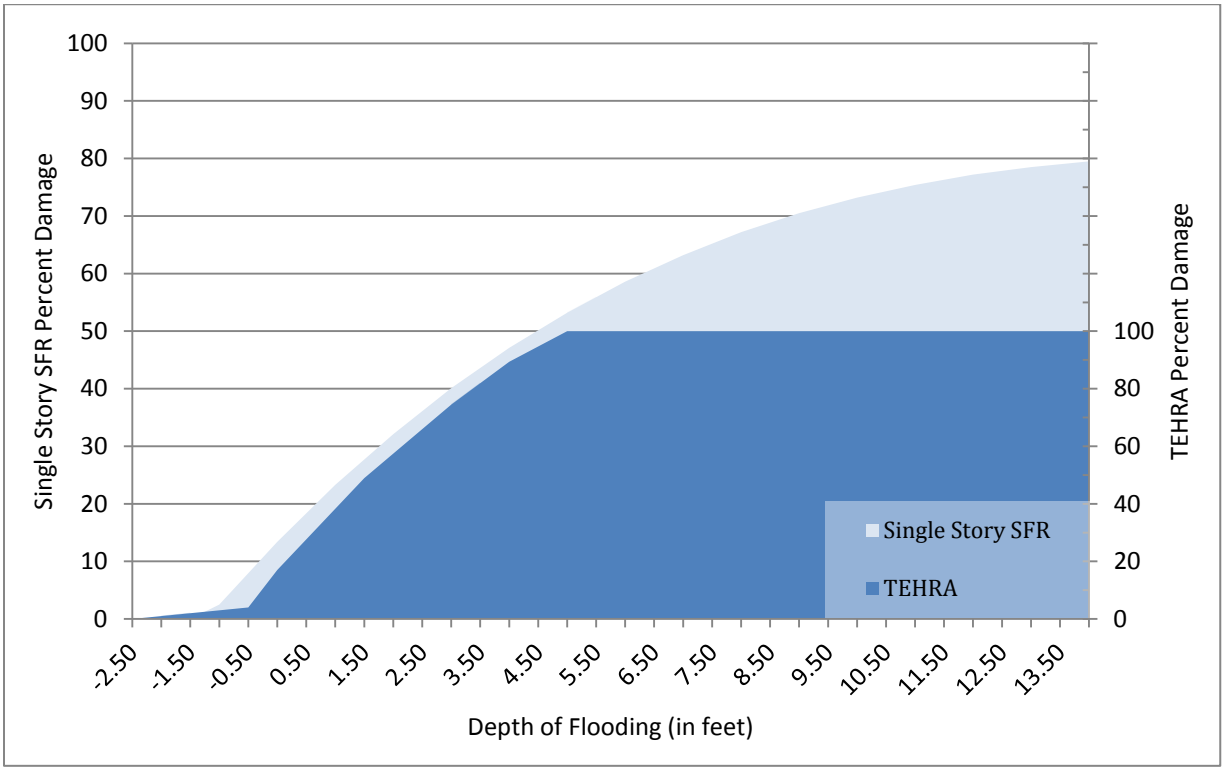


Figure 10: American River Common Features GRR, Depth-Percent Damage Curve for TERHA Overlaid onto Depth-Percent Damage Curve for One-Story Residential

2.7.5 Automobiles

In the 2010 Natomas Post-Authorized Change and Interim Reevaluation Report (NPACR) an average automobile value of $7,988 was obtained from the Bureau of Transportation Statistics. This value was updated for price level ($8,308) and used in this analysis.

The number of cars impacted was based on the number of cars per residential unit (1.93), which in turn was based on the total number of automobiles and trucks registered in the Sacramento Area (source: California Department of Finance) divided by the number of households. Automobile counts for car dealerships were based on discussions with local dealers and comparisons with spot inventories from aerial photos. The analysis assumed that, based on relatively short evacuation times, about 50% of residential-based vehicles would be removed from the flood area prior to the event and only 20% would be removed from dealerships. This is consistent with EGM 09-04, which recommends a removal rate of 50.6% for areas where the warning time is less than 6 hours.

Table 10 displays the estimated value of automobiles in the 0.2% annual chance exceedance (500-year) floodplain.

Table 10: Value of Damageable Property (Automobiles) by Category and Basin in 0.2% Floodplain

CATEGORY	VALUE OF DAMAGEABLE PROPERTY: AUTOMOBILES (IN $1,000S, OCTOBER 2015 PRICE LEVEL)			
	ARS BASIN (ARS A)	ARN BASIN (ARN E)	NATOMAS BASIN (NAT D)	TOTAL
AUTOMOBILES	1,408,337	274,254	186,905	**1,869,496**

2.7.6 Depth-Percent Damage Curves

The depth of flooding is the primary factor in determining potential damages to structures, contents, and automobiles. Depth-percent damage functions were used in the HEC-FDA models to estimate the percent of value lost for these categories. Residential depth-damage curves (structures and contents) were taken from Economic Guidance Memorandum (EGM) 01-03, *Generic Depth-Damage Relationships,* and 04-01, *Generic Depth-Damage Relationships for Residential Structure with Basements,* for use on both single-family and multi-family residential structures. Structures were identified as 1-story, 2-story, or split-level. Mobile home curves were taken from the May 1997 Final Report, *Depth Damage Relationships in Support of Morganza to the Gulf, Louisiana Feasibility Study*. Non-residential structure curves were based on revised Federal Emergency Management Agency (FEMA) Flood Insurance Administration (FIA) curves. Two sets were used: 1) standard FEMA FIA curves for impact areas with shorter-duration flooding and 2) adjusted curves for areas where inundation depths are deep and flooding durations are long (exceeding three days); these curves were based on the prior Natomas Basin studies and the 1997 Morganza Study. As previously described in Section 2.7.2.2, non-residential content depth-percent damage curves for 22 occupancy types were developed based on an expert elicitation; these curves were developed specifically for building types in the Sacramento area and for American River Watershed analyses.

Depth-percent damage functions for automobiles were based on averages from curves developed by the Institute for Water Resources (IWR) and provided in EGM 09-04, *Generic Depth-Damage Relationships for Vehicles*.

All of the depth-percent damage curves used in the analysis can be found in the American River Common Features GRR HEC-FDA models.

2.7.7 Economic Uncertainties

The valuation of residential and non-residential structures and contents along with automobile losses were estimated with uncertainty. In the estimation of structure value, three variables were considered to have a possible range of values: 1) dollar per square foot 2) building square footage and 3) percent of estimated depreciation. Using triangular distributions to describe the range of these three variables, a Monte Carlo simulation was run on typical structures by category and the mean and standard deviations were compared to derive coefficients of variation (COV) for structure values by category. Content value uncertainties for non-residential structures were based on data from the expert elicitation mentioned previously. The program Best Fit was used to determine what would be a reasonable distribution, and using the model data, it was determined that a normal distribution best described uncertainty in the structure and content valuation. These uncertainty parameters for valuation were imported into the HEC-FDA program.

Several factors contributed to the uncertainty associated with automobile damages. These factors include the average unit value, the number of vehicles per residence/dealership assumed, and the evacuation rate. It was assumed that the average number or automobiles per residential unit was about 2 and the evacuation rate was 50%. An average value of an automobile was determined to be $8,308. While uncertainty in these variables was not considered, uncertainty in the percent damage by depth (as reflected in the depth-percent damage curve) was taken into account.

Uncertainty in first floor elevation was also included in the model. During the field inventory, first floor (foundation height) estimates were made by visual inspection and assigned to structures in one half-foot increments. For example, the average SFR built on slab without any fill might be listed as ground elevation + 0.5 foot to 1.0 foot; raised foundations either 1.5, 2 or 2.5 feet. Based on this level of precision, it was assumed that 0.5 foot standard deviation would capture the potential uncertainty in this first floor elevation adjustment.

The uncertainty associated with the percent damages at specific depths of flooding for automobiles and structures/contents were entered into the HEC-FDA model. Residential structure and content depth-percent damage curves are normally distributed and include standard deviations of percent damages by depth of flooding. Non-residential content depth-percent damage curves are triangularly distributed and include a minimum, most likely, and maximum percent damage by depth of flooding.

All of the value and depth-percent damage uncertainty associated with structures, contents and automobiles can be found in the American River Common Features GRR HEC-FDA models.

2.8 DESCRIPTION OF ENGINEERING DATA & UNCERTAINTIES

The following sub-sections briefly describe the engineering data used in the economic analysis. More details about each discipline-specific engineering analysis can be found in the following appendices: Appendix B – Hydrology, Appendix C – Hydraulics, and Appendix F – Geotechnical.

2.8.1 Hydrologic Engineering Data Used in HEC-FDA

The Sacramento District's Water Management Section provided the hydrologic data used in the HEC-FDA modeling. This includes the equivalent record length at each index point, the exceedance probability-discharge curve or the statistics required to compute the exceedance probability-discharge curve in HEC-FDA (depending on the index point), and the transform flow curves for those index points on the American River, where outflow is regulated by operations at Folsom Dam. These data and curves can be found in the Hydrologic Engineering Attachment in the Main Engineering Report or in any of the American River Common Features GRR HEC-FDA models.

2.8.2 Hydraulic Engineering Data Used in HEC-FDA

The SPK Hydraulic Design Section used the HEC-RAS model to determine stages in the channel, to model levee breakout locations, and to develop breakout hydrographs; it used the FLO-2D model to determine water surface elevations in the floodplain (i.e., develop suites of floodplains). More details about the data and assumptions used by the Hydraulic Design Section for their HEC-RAS and FLO-2D modeling efforts can be found in the Hydraulic Design Attachment to the Main Engineering Report.

For this analysis, a suite of floodplains was generated for each of the eight index points. For each index point, the Hydraulic Design Section provided data for input into the HEC-FDA model. These include:

- Discharge-stage (rating) curves with uncertainty for the without-project and with-project conditions for four index points (those on the American River)
- Exceedance probability-stage curves with uncertainty for the without-project and with-project conditions for three index points (NAT D, ARS F, and ARN E)
- Suites of floodplains for each index point; these were formatted from FLO-2D water surface elevation data for direct import into HEC-FDA

2.8.3 Geotechnical Engineering Data Used in HEC-FDA

A geotechnical levee fragility curve shows the probabilities of failure at different water surface elevations against a levee. Fragility curves are a main component of the economic modeling and in determining the performance of a project, which is often described in terms of annual exceedance probability (AEP) or the chance of flooding in any given year.

For this analysis, five sets of geotechnical levee fragility curves were used in the economic analysis, one set for each index point located on a levee reach, with each set including a without-project and with-project curve. (Since there are no levees on the upper portion of the Lower American River or at the Sankey Gap, no fragility curves associated with these three index point locations were developed.) The levee fragility curves used in the economic analysis can be found in the American River Common Features GRR HEC-FDA models. The Geotechnical Engineering Attachment in the Main Engineering Report describes in detail the development of these curves.

2.8.4 Engineering Uncertainties in HEC-FDA

There were three main engineering uncertainties incorporated into the HEC-FDA modeling:

- Uncertainty in within-channel discharges was computed in HEC-FDA using data provided by the District's Water Management Section. This data was in the form of either an equivalent record length (for graphical curves) or Log Pearson Type III Statistics (for analytical curves). In both cases, the data is entered into HEC-FDA, which uses the data to compute uncertainty in discharge for a range of exceedance probability events.
- Uncertainty in discharges from Folsom Dam was accounted for in HEC-FDA by using transform flow (regulated versus unregulated) curves containing minimum values and maximum values around the regulated discharges for a range of exceedance probability events.
- Uncertainty in stages (in-channel) was captured in the hydraulic rating curves, which were entered into HEC-FDA. Stage uncertainty was provided by the District's Hydraulic Design Section.

All of the data used to describe the uncertainty in the main engineering relationships can also be found in the Common Features GRR HEC-FDA models or in the respective engineering attachments to the Main Engineering Report.

CHAPTER 3
WITHOUT-PROJECT ANALYSIS & RESULTS:
AUTHORIZED COMMON FEATURES + JOINT FEDERAL PROJECT + DAM RAISE

3.1 FUTURE WITHOUT-PROJECT CONDITION

Expected annual damages (EAD) and engineering project performance results for the without-project condition, which assumes that the WRDA 1996/1999 Authorized Common Features Project, the Joint Federal Project (JFP), and the Folsom Dam Raise Project are in place and operational, are summarized in this chapter. The without-project condition serves as the baseline for which all with-project alternatives are measured against. The with-project alternatives analysis is presented in Chapter 4.

3.2 FLOODING CHARACTERISTICS

The without-project analysis and results are based predominantly on estimates of the flooding extent, the depth of flooding, and the property that may be damaged from flooding within a particular area. Tables 11 to 13 display key characteristics of flooding associated with specific annual chance exceedance events for the three basins within the study area. The flooding characteristics of a basin may differ depending on the assumed levee breach location (reach/index point). For example, structures in the Natomas Basin (NAT D breach location) would experience significant flooding above the first floor elevation; the average depth of flooding above the first floor exceeds 10 feet, even for relatively higher frequency events such as the 25-year. In the ARS basin, average depth of flooding above the first floor exceeds 6 feet (ARS F breach location) for the 25-year event. In all basins, flooding would be deep and potentially catastrophic.

It is important to note that it would be incorrect to sum the number of structures inundated per index point within a basin to derive a total number of structures at risk (Tables 11 to 13 below); this would result in double counting. The same structures may in fact be at risk from flooding from more than one location (index point). For example, in the Natomas Basin and the ARS Basin, flooding from one location (ARS A and NAT D) will result in essentially the entire inventory extent for the respective basin (i.e., flooding from ARS A essentially includes all structures in the south basin and flooding from NAT D includes all structures in the Natomas Basin); on the other hand, in the ARN Basin there is substantial overlap between flooding that occurs from ARN A and from ARN E, but flooding from either does not totally encompass the full structure inventory for the ARN Basin. Estimates of the total number of structures at risk from flooding in each basin were presented in Chapter 2.

Plates displaying the full suite of floodplains for each of the index points are located in the Hydraulic Design Attachment of the Main Engineering Report.

Table 11: Flooding Characteristics by Index Point and Annual Chance Exceedance (ACE) Event Floodplains Under Levee Breach Scenario: ARS Basin

REACH/INDEX POINT	AVERAGE DEPTH OF FLOODING ABOVE 1ST FLOOR BY INDICATED ANNUAL CHANCE EXCEEDANCE (ACE) EVENT (IN FEET)			NUMBER OF STRUCTURES INUNDATED BY INDICATED ANNUAL CHANCE EXCEEDANCE (ACE) EVENT		
	0.04	0.01	0.002	0.04	0.01	0.002
A	1.6	4.1	6.7	11,405	23,888	109,627
FLANKING	0	0	5.8	0	0	95,560
F	6.7	7.0	7.6	37,759	49,374	96,019

Table 12: Flooding Characteristics by Index Point and ACE Event Floodplains Under Levee Breach Scenario: ARN Basin

REACH/INDEX POINT	AVERAGE DEPTH OF FLOODING ABOVE 1ST FLOOR BY INDICATED ANNUAL CHANCE EXCEEDANCE (ACE) EVENT (IN FEET)			NUMBER OF STRUCTURES INUNDATED BY INDICATED ANNUAL CHANCE EXCEEDANCE (ACE) EVENT		
	0.04	0.01	0.002	0.04	0.01	0.002
A	4.4	7.1	7.7	8,009	13,437	14,837
FLANKING	0	0	6.4	0	0	13,758
E	4.1	3.9	8.1	2,247	3,346	15,143

Table 13: Floodplain Characteristics by Index Point and ACE Event Floodplains Under Levee Breach Scenario: Natomas Basin

REACH/INDEX POINT	AVERAGE DEPTH OF FLOODING ABOVE 1ST FLOOR BY INDICATED ANNUAL CHANCE EXCEEDANCE (ACE) EVENT (IN FEET)			NUMBER OF STRUCTURES INUNDATED BY INDICATED ANNUAL CHANCE EXCEEDANCE (ACE) EVENT		
	0.04	0.01	0.002	0.04	0.01	0.002
D	10.0	12.2	17.6	22,547	22,677	22,770
SANKEY GAP	0	0	1.8	0	0	2,821

A full set of floodplain plates can be found in the Hydraulic Design Appendix. These include floodplains for a range of events (2yr to 500yr) and for each index point.

3.3 FLOOD RISK: PROBABILITY & CONSEQUENCES

Risk can be described in terms of the chance of some undesirable event occurring and the potential consequences should that undesirable event occur. In FRM National Economic Development (NED) analysis, risk is described in terms of the chance of flooding (the undesirable event) and the potential damages (consequences) from flooding. The following sections describe the flood risk associated with the without-project condition.

3.3.1 Annual Chance Exceedance (ACE) Event Damages

Annual chance exceedance (ACE) event damages, sometimes referred to as single-event damages, were computed in HEC-FDA. Single-event damages assume that a breach from a specific probability event

occurs; it does not take into account the likelihood of this event actually happening. Single-event damages are useful in that they show the magnitude of consequences, within a particular consequence area, *should* a specific flood event occur in that area. Table 14 below shows the damages that may occur for a range of events within the three main basins. These damage values include automobiles, structures, and contents, and represent damages based on flooding from one index point per basin – ARN A in the north basin, ARS F in the south basin, and NAT D in the Natomas Basin. While damages reported in the table for the ARS basin are based on flooding from the ARS F location, it should be noted that flooding from a 0.2% ACE event (500-year) from the ARS A location on the American River would result in greater damages to the ARS basin – about $24.6 billion in damages – than sustained at the ARS F location ($21.6 billion).

Table 14: Damages by Annual Chance Exceedance Event

BASIN	ACE EVENT DAMAGES (IN $1,000s, OCTOBER 2015 PRICE LEVEL)						
	50%	10%	4%	2%	1%	.5%	.2%
ARS (F)	6,660,369	8,427,409	8,427,409	9,197,846	13,302,749	14,288,782	21,612,855
ARN (A)	0	0	2,824,045	2,908,650	4,654,995	4,970,941	5,456,034
NATOMAS	4,404,922	5,579,812	5,784,706	6,109,155	6,271,056	6,403,807	6,896,591
TOTAL	**11,065,291**	**14,007,221**	**17,036,160**	**18,215,651**	**24,228,800**	**25,663,530**	**33,965,480**

3.3.2 Expected Annual Damages (EAD)

Expected annual damage (EAD) is the metric used to describe the consequences of flooding on an annual basis considering a full range of flood events – from high frequency/small events to low frequency/large events over a long time horizon (years). It is the main economic statistic used to describe the flooding problem in the study area; it is also used as the baseline to measure potential benefits from proposed FRM alternatives.

Table 15 displays the EAD results for each index point and by major damage category. Table 16 condenses the information from Table 15 and displays the EAD results by basin. Since the economic incremental analysis is being performed from a system perspective, the basin EAD results in Table 15 were used as the baseline without-project damages (per each basin) for which to measure with-project outputs.

For the ARS basin, the without-project EAD used as the starting point for the economic analysis is the EAD associated with the index point (per basin) that produced the highest without-project EAD. This is index point ARS F on the Sacramento River.

For the ARN basin, the without-project EAD used as the starting point for the economic analysis is the sum of the EADs associated with the ARN A (American River) and the ARN E (Arcade Creek) index points. Based on information from the SPK Hydraulic Design Section, the American River and Arcade Creek are uncorrelated from both a hydrologic and hydraulic perspective.

For the Natomas Basin, the without-project EAD used as the starting point for the economic analysis is the EAD associated with the NAT D index point. In the prior 2010 NPACR analysis, EAD for Natomas was computed using the HEC-FDA model as well as a supplemental model (N@RM) that accounted for flood plain occupant behavior. The N@RM model was used to adjust EAD results obtained from HEC-FDA by taking into account reduced inventory, reduced value of damageable property, and a decrease in the

number of flood plain occupants as floods occurred over time. The adjustment factor using the N@RM model turned out to be, on average, around 67% (i.e., 67% reduction in damages). This factor was carried forward to the current analysis; the EAD results for the Natomas Basin presented in the following tables reflect adjusted values.

Table 15: Without-Project EAD by Index Point

INDEX POINT	WITHOUT-PROJECT EXPECTED ANNUAL DAMAGES (EAD) (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS)						
	AUTOS	COMMERCIAL	FARM	INDUSTRIAL	PUBLIC	RESIDENTIAL	TOTAL
ARS A	4,171	15,338	30	3,704	11,760	56,327	**91,330**
FLANKING	806	2,898	3	1,121	2,051	9,858	**16,737**
ARS F	15,080	42,514	395	11,197	35,644	227,555	**332,383**
ARN A	2,171	18,967	0	5,257	4,937	19,796	**51,128**
FLANKING	206	1,702	0	476	535	2,077	**4,995**
ARN E	1,050	8,416	0	4,044	2,023	10,642	**26,175**
NAT D	863	3,294	36	2,328	2,774	19,300	**28,595**
S. GAP	87	0	0	0	36	913	**1,036**

Table 16: Without-Project EAD by Basin

BASIN	WITHOUT-PROJECT EXPECTED ANNUAL DAMAGES (EAD) (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS)						
	AUTOS	COMMERCIAL	FARM	INDUSTRIAL	PUBLIC	RESIDENTIAL	TOTAL
ARS	15,080	42,514	395	11,197	35,644	227,555	**332,383**
ARN	3,221	27,383	0	9,301	6,960	30,438	**77,303**
NATOMAS	863	3,294	36	2,328	2,774	19,300	**28,595**
TOTAL	**19,164**	**73,191**	**431**	**22,826**	**45,378**	**277,293**	**438,281**

Emergency cost losses: Expected annual damages (EAD) under the without-project condition were computed using HEC-FDA. For the ARS Basin, damages were computed using the engineering data from Index Point ARS F (Sacramento River), since this location serves as both the starting point for measuring without-project damages and the ending point for measuring with-project residual damages in the incremental analysis presented in Chapter 4. For the ARN Basin, damages were computed using the engineering data from Index Points ARN A (American River) and ARN E (Arcade Creek). The Emergency Cost analysis was performed after the determination of the Final Array of Alternatives. Since none of the alternatives include the Natomas Basin, the emergency cost analysis did not include the Natomas Basin. More information about the Final Array of Alternatives is presented in Chapter 4.

Table 17 below display the results of the HEC-FDA analysis. Expected annual damages associated with clean-up activities are estimated to be approximately $44 million; EAD associated with TERHA is estimated to be approximately $21.5 million. Total EAD for both emergency cost categories combined is estimated to be around $65 million.

Table 17: Without-Project EAD -- Emergency Cost Losses (Values in $1,000s, October 2015 Price Level, 50-Year Period of Analysis)

Emergency Loss Category	Without-Project Expected Annual Damages (EAD)		
	ARS Basin	ARN Basin	Total
Clean-UP	36,860	6,893	43,753
TERHA	17,933	3,566	21,499
Total	**54,792**	**10,459**	**65,251**

Table 18 below summarizes the total without-project EAD by basin and category. It includes all damage categories (structures and contents, automobiles, and emergency cost losses) but does not include the Natomas Basin, which was ultimately removed from the analysis (see Chapter 4). An EAD of approximately $475 million was used as the basis to measure benefits of the proposed alternatives.

Table 18: Total Without-Project EAD by Basin and Category (Values in $1,000s, October 2015 Price Level, 50-Year Period of Analysis)

Total Without-Project EAD by Basin and Category			
Category	ARS Basin	ARN Basin	Total
Structures and Contents	317,303	74,082	391,385
Automobiles	15,080	3,221	18,301
Emergency Costs	54,792	10,459	65,251
Total	387,175	87,762	474,937

3.3.3 Annual Exceedance Probability (AEP) by Index Point and Basin

Annual exceedance probability (AEP) is a statistic used to describe the chance of flooding in any given year within a designated area. It is often used to describe one aspect of flood risk, with the other being the consequences (e.g., damages and loss of life) of flooding. Annual exceedance probability is computed in HEC-FDA using engineering data at an index point; these input data include exceedance probability-discharge, stage-discharge, and geotechnical levee failure relationships, and in some cases transform flow (inflow-outflow discharges associated with dams/reservoirs) curves.

Table 19 below displays the AEP values associated with each index point. Annual exceedance probability values differ depending on the location along the levee due primarily to the differing geotechnical conditions of the levees protecting the basin. Each basin is considered to be protected by a system of levees, and flooding to the basin could potentially occur from various sources. For example, in the ARS Basin, flooding can occur from the American River or the Sacramento River; further, the risk of flooding along either river varies depending on the location along the river. In this respect, the AEP values listed in Table 19 for each index point represent the probability of a flood event occurring when considering only one failure location (one failure mechanism). Generally, evaluating AEP information at multiple points at which flooding into an area could occur typically provides a more complete characterization of the chance of flooding for that particular area.

Table 19: Annual Exceedance Probability (AEP) by Index Point -- Without-Project Condition

BASIN	INDEX POINT	AEP	1/AEP
ARS	ARS A	0.0103	1 in 97
	ARS Outflanking	0.0034	1 in 294
	ARS F	0.0310	1 in 32
ARN	ARN A	0.0104	1 in 96
	ARN Outflanking	0.0010	1 in 1000
	ARN E	0.0165	1 in 61
NATOMAS	NAT D	0.0150	1 in 67
	Sankey Gap	0.2070	1 in 5

3.3.4 Long-Term Risk by Index Point and Basin

Another statistic that the HEC-FDA program computes is long-term risk. Long-term risk describes the chance of flooding over a given time period, such as 30 years; HEC-FDA computes long-term risk statistics for 10-, 30-, and 50-year periods. Table 20 displays the without-project long-term risk results for each index point/basin. For each basin, the long-term risk over a 30-year period is relatively high and exceeds 25%.

Table 20: Long-Term Risk by Index Point/Basin -- Without-Project Condition

BASIN	INDEX POINT	LONG-TERM RISK		
		10 YEARS	30 YEARS	50 YEARS
ARS	ARS A	10%	27%	41%
	Outflanking	4%	11%	18%
	ARS F	27%	61%	79%
ARN	ARN A	10%	27%	41%
	Outflanking	1%	3%	4%
	ARN E	15%	39%	57%
NATOMAS	NAT D	9%	36%	52%
	Sankey Gap	90%	99%	99%

3.3.5 Assurance

Assurance, formerly known as conditional non-exceedance probability (CNP), describes the likelihood of a stream/river being able to pass a specific flow event, for example the 100-year flow. The assurance statistics provide relevant information to decision makers in that it helps describe both how well the flood system currently performs and how well the system could potentially perform under various with-project scenarios.

The assurance statistics for each index point/basin under the without-project condition are listed in Table 21 below. Taking ARS B index point as an example, the information indicates that there is an 84% assurance of passing the 4% flow event, but a lower 75% assurance of passing the 1% flow event.

Table 21: Assurance by Index Point -- Without-Project Condition

BASIN	INDEX POINT	ASSURANCE		
		4%	1%	0.2%
ARS	ARS A	93%	77%	18%
	Outflanking	99%	80%	9%
	ARS F	75%	69%	24%
ARN	ARN A	92%	75%	22%
	Outflanking	99%	98%	40%
	ARN E	90%	68%	7%
NATOMAS	NAT D	93%	84%	37%
	Sankey Gap	3%	1%	1%

CHAPTER 4
WITH-PROJECT ALTERNATIVES ANALYSES

4.1 WITH-PROJECT ANALYSIS: BASIN AS BASIC ANALYTICAL UNIT

Without-project expected annual damages were computed at eight representative index points throughout the study area. As was explained in Chapter 2, the project delivery team (PDT) selected these index points, which are located on the main flood sources, in order to be able to reasonably characterize the flood risk associated with each of the three main basins by accounting for the multiple sources of flooding in each basin.

Similarly, with-project damages reduced (benefits) associated with various project alternatives were also computed at each representative index point for each basin. If the flood risk in a basin (or any other consequence area) could be attributed to one and only one flood source, then the total benefits computed at an index point along a particular flood source would represent the benefits of building a project on that flood source. This is not the case, however, for the Common Features study area as flood risk in each basin/consequence area can be attributed to multiple flood sources. Under this scenario, benefits were computed first at each index point (source), and then estimated for the whole basin using the appropriate calculation method as determined by assessments of the hydrologic/hydraulic correlation between the flood sources within a basin. Table 22 below summarizes the methods used to estimate benefits for each basin.

It should be pointed out that while the results for the Natomas Basin are presented in some of the following tables, the Natomas Basin is not part of any alternative in the Final Array. Therefore, any potential benefits associated with improvements to the Natomas Basin are not included in the final net benefit analysis. Section 4.7 discusses the rationale for leaving out the Natomas Basin from each of the alternatives as well as the implications of this decision on residual risk in the basin.

Table 22: Method of Benefit Calculation by Basin

BASIN	INDEX POINT	METHOD USED TO ESTIMATE BENEFITS
ARS	A	Compare risk at multiple index points and use highest EAD/residual EAD to estimate benefits (A and F)
	Flanking	
	F	
ARN	A	Compute risk at multiple index points and add EADs using joint probabilities (A and E)
	Flanking	
	E	
NAT	D	Estimate benefits using single index point (D) and information from prior analysis (NPACR)
	Sankey Gap	

4.2 DESCRIPTION OF FINAL ARRAY OF ALTERNATIVES

At the start of the plan formulation process, the project delivery team (PDT) assessed an Initial Array of alternatives. This array was then narrowed down to a Focused Array of alternatives (Table 23), which

was evaluated in more detail. The alternatives in the Focused Array are described in the following paragraphs below, with the decision whether or not to carry forward each alternative into the Final Array. More detail about the Initial and Focused Arrays of Alternatives is presented in the GRR (Chapter 3).

- **Alternative 0.5** – Improve levees within the existing geometry (Minimum Plan): This alternative would incorporate levee improvements for seepage, stability and erosion but not include any levee raises or other conveyance improvements. This is considered to be the minimum amount of levee improvements needed to substantially reduce the flood risk.

- **Alternative 1** – Improve levees: Focused Alternative 1 adds levee raising to the previous alternative. Focused Alternative 1 involves the construction of in-place levee improvement measures to address seepage, slope stability, erosion, and overtopping concerns identified for the American and Sacramento River levees, NEMDC, Arcade, Dry/Robla, and Magpie Creeks.

- **Alternative 2** – Improve levees and widen Sacramento Weir and Bypass: Focused Alternative 2 adds widening of the Sacramento Weir and Bypass which negated the need to include most of the levee raising in Focused Alternative 1. It accomplished this by rerouting flow that would have gone down the Sacramento River instead to the widened Sacramento Weir and Bypass. The levees along the American River, NEMDC, Arcade, Dry/Robla, and Magpie Creeks would be improved to address identified seepage, stability, erosion, and height concerns through the methods described under Alternative 1. The levees along the Sacramento River would be improved to address identified seepage, stability, erosion, and overtopping concerns through the measures described under Alternative 1.

- **Alternative 3** – Improve levees and construct I-Street diversion structure: Focused Alternative 3 would include the construction of a diversion structure just upstream of the existing I-Street Bridge on the Sacramento River. This diversion structure would restrict flows going down the Sacramento River past the cities of Sacramento and West Sacramento, and would cause a large portion of the flows from the Sacramento and American Rivers to be forced upstream through the Sacramento Bypass out to the Yolo Bypass. The Sacramento Bypass and Weir would be widened to accommodate the increased flows to the bypass system. The effect of this diversion structure would be to reduce the water surface elevation of the Sacramento River downstream of the structure to the point at which seepage, stability, height, and erosion improvements would not be needed.

- **Alternative 4** – Upstream storage on the American River: This alternative involves construction of a flood control dam near the town of Auburn on the north fork American River for the purpose of attenuating flows continuing downstream into Folsom Reservoir and the lower American River. Additionally, levee improvements to address seepage, stability, erosion, and overtopping concerns are included where they exist in various stretches of levee protecting the city of Sacramento.

- **Alternative 5** – Maximum Plan: This alternative would reduce flood risk to the city of Sacramento and the surrounding area and would include most of the measures previously discussed, including levee improvements from Alternative 1, the Sacramento Weir and Bypass

widening of Alternative 2, the I-Street Diversion Structure from Alternative 3, and the Auburn Dam from Alternative 4.

- **Alternative 6** – Non-structural: The non-structural alternative would consist of measures such as raising or relocating structures where practical and economically feasible. Also, flood proofing critical infrastructure features and individual structures where inundation depths are lower may be an efficient means of reducing flood risk.

Table 23: Summary of Focused Array of Alternatives

Focused Alternative	Evaluation Summary	Carried Forward?
0.5. Improve Levees within Existing Geometry (Minimum Plan)	This alternative does not maximize net benefits and is on the rising portion of the net benefits curve. It was therefore dropped from further consideration.	No
1. Improve Levees	Improving the existing levees to address seepage, stability, erosion and height issues is the first increment to reducing flood risk for the Sacramento area. Because this alternative increases system performance and appears to have the highest net benefits, it was carried forward for further consideration.	Yes
2. Improve Levees & Widen Sacramento Weir and Bypass	This alternative reduces the flood risk to the urbanized area and has high net benefits and is therefore carried forward for further evaluation. This is the sponsor supported plan.	Yes
3. Improve Levees and Construct I-Street Diversion Structure	This alternative is not efficient. Does not meet worst-first implementation strategy. The implementation sequencing would leave the densely populated areas of Sacramento at risk of flooding until the end of the construction timeframe. The Yolo and Sacramento Bypass levee work would be constructed first in order to accept the higher flows associated with this alternative. Once this was completed, then work on the diversion structure itself would begin. Since no levee work is recommended on the Sacramento river levees as part of this alternative, this high risk area would remain exposed throughout implementation of the project.	No
4. Upstream Storage on American River	Construction of an upstream storage facility does not address the high frequency flood risk associated with the poor performance of levees in the study area. It also does not reduce the risk for the highest risk area along the Sacramento River since this is dominated by Sacramento River flows. All downstream levee improvements contained in Alternatives 1 and 2 would need to be included to effectively reduce the high frequency flood risk for the study area. Other alternatives offer more efficient methods to reduce the flood risk.	No
5. Maximum Plan	Other plans offer more efficient ways to reduce risk.	No
6. Non-Structural	These measures reduce the consequences of flooding, but do not reduce the probability of flooding and therefore do not significantly reduce the overall risk of flooding.	No

From this Focused Array of alternatives, the most promising alternatives were carried forward into a Final Array of alternatives. Summary descriptions of each alternative in the Final Array are presented below:

- **Alternative 1 – Fix Levees**: Alternative 1 would include the construction of levee remediation measures to address seepage, stability, erosion, and height measures identified for the Sacramento River, Natomas East Main Drainage Canal (NEMDC), Arcade, Dry/Robla, and Magpie Creeks. Alternative 1 would also include erosion measures for specific locations along the American River. Alternative 1 does not include levee raises in the Natomas Basin. (Although the results of the benefits analysis are shown in this document.)

- **Alternative 2 – Sacramento Bypass and Fix Levees:** Alternative 2 would include widening the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass and reduce the need to raise levees along the Sacramento River downstream of the bypass. The levees along the American River, the Natomas East Main Drainage Canal (NEMDC), Arcade, Dry/Robla, and Magpie Creeks, would be improved to address identified seepage, stability, erosion and height concerns through some combination of repairing the levees in place (fix in place) or construction of an adjacent levee with measures to address the concerns. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns through some combination of repairing the levees in place (fix in place) or construction of an adjacent levee with measures to address the concerns. Alternative 2 would also include erosion measures for specific locations along the American River. Alternative 2 does not include any levee raises in the Natomas Basin. (Although the results of the benefits analysis are shown in this document.)

4.3 WITH-PROJECT RESULTS: RESIDUAL EAD AND BENEFITS BY INDEX POINT AND ALTERNATIVE

The following tables show the without-project EAD and with-project residual EAD results computed in HEC-FDA for each index point/breach/outflanking location. The benefits shown for each alternative in each table are the damages reduced at a respective index point/breach/over flanking location, and represent the benefits to the associated basin if improvements were to occur on the source of flooding where the index point is located and if there were no other sources of flood risk. It should be pointed out that damages and benefits associated with the prevention of emergency cost losses are described and reported in Section 4.6, separately from the other categories, which are reported in Sections 4.3-4.5.

For example, in Table 24, the benefits of Alternative 1 are approximately $25.5 million. All of these benefits could be claimed if improvements to the American River (left bank) were made, and if there were no other sources of flood risk. While the first condition (improvements to the levees) would be met under this scenario, the second condition under this scenario has not yet been met – there is still flood risk from the Sacramento River. Since there is still flood risk from the Sacramento River, the full $25.5 million in benefits cannot be claimed for the entire ARS Basin. (In the next section, the benefits for each basin are estimated by considering all of the sources of flood risk in that basin.)

Tables 24 to 28 show three sets of with-project data. The first set is associated with outputs derived from improvements only to the Sacramento River levees downstream of the confluence with the American River and not from any Sacramento levee raises (Alternative 1) or the Sacramento Bypass widening (Alternative 2). This scenario only applies to the ARS F index point (Table 25), but the columns were added to the other tables for consistency purposes.

Table 24: Without-Project EAD and With-Project Residual EAD (ARS A, left bank American River)

DAMAGE CATEGORY	ARS A INDEX POINT – AMERICAN RIVER SOUTH BASIN (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS)						
	WITHOUT EAD	FIX SAC RIVER LEVEES ONLY (BELOW CONFLUENCE WITH AMERICAN)		ALTERNATIVE 1 (FIP)		ALTERNATIVE 2 (SBW)	
		RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS
Autos	4,171	N/A	N/A	2,986	1,185	2,966	1,205
Commercial	15,338	N/A	N/A	11,258	4,080	11,136	4,202
Farm	30	N/A	N/A	27	3	27	3
Industrial	3,704	N/A	N/A	3,238	466	3,203	501
Public	11,760	N/A	N/A	8,402	3,358	8,338	3,422
Residential	56,327	N/A	N/A	39,900	16,427	39,664	16,663
TOTAL IP	**91,330**	N/A	N/A	**65,814**	**25,519**	**65,331**	**25,996**

Table 25: Without-Project EAD and With-Project Residual EAD (ARS F, left bank Sacramento River)

DAMAGE CATEGORY	ARS F INDEX POINT – AMERICAN RIVER SOUTH BASIN (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS)						
	WITHOUT EAD	FIX SAC RIVER LEVEES ONLY (BELOW CONFLUENCE WITH AMERICAN)		ALTERNATIVE 1 (FIP)		ALTERNATIVE 2 (SBW)	
		RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS
Autos	15,080	5,474	9,606	3,084	11,996	2,997	12,083
Commercial	42,514	16,303	26,211	8,403	34,111	8,295	34,219
Farm	395	142	253	79	316	75	320
Industrial	11,197	5,090	6,107	2,051	9,146	2,053	9,144
Public	35,644	13,372	22,272	7,207	28,437	7,091	28,553
Residential	227,555	80,268	147,287	47,213	180,342	45,566	181,989
TOTAL IP	**332,383**	**120,650**	**211,733**	**68,037**	**264,346**	**66,078**	**266,305**

Table 26: Without-Project EAD and With-Project Residual EAD (ARN A, right bank American River)

DAMAGE CATEGORY	ARN A INDEX POINT – AMERICAN RIVER NORTH BASIN (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS)						
	WITHOUT EAD	FIX SAC RIVER LEVEES ONLY (BELOW CONFLUENCE WITH AMERICAN)		ALTERNATIVE 1 (FIP)		ALTERNATIVE 2 (SBW)	
		RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS
Autos	2,171	N/A	N/A	1,177	994	1,260	911
Commercial	18,967	N/A	N/A	10,316	8,651	11,043	7,924
Farm	0	N/A	N/A	0	0	0	0
Industrial	5,257	N/A	N/A	2,781	2,476	2,982	2,275
Public	4,937	N/A	N/A	2,621	2,316	2,809	2,128
Residential	19,796	N/A	N/A	10,928	8,868	11,699	8,097
TOTAL IP	**51,128**	N/A	N/A	**27,823**	**23,305**	**29,793**	**21,335**

Table 27: Without-Project EAD and With-Project Residual EAD (ARN E, right bank Arcade Creek)

DAMAGE CATEGORY	ARN E INDEX POINT – AMERICAN RIVER NORTH BASIN (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS)						
	WITHOUT EAD	FIX SAC RIVER LEVEES ONLY (BELOW CONFLUENCE WITH AMERICAN)		ALTERNATIVE 1 (FIP)		ALTERNATIVE 2 (SBW)	
		RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS
Autos	1,050	N/A	N/A	724	326	666	384
Commercial	8,416	N/A	N/A	6,280	2,136	5,866	2,550
Farm	0	N/A	N/A	0	0	0	0
Industrial	4,044	N/A	N/A	2,079	1,965	1,777	2,267
Public	2,023	N/A	N/A	1,646	377	1,523	500
Residential	10,642	N/A	N/A	7,376	3,266	6,735	3,907
TOTAL IP	**26,175**	N/A	N/A	**18,105**	**8,070**	**16,567**	**9,608**

Table 28: Without-Project EAD and With-Project Residual EAD (NAT D, left bank Natomas Cross Canal)

DAMAGE CATEGORY	NAT D INDEX POINT – NATOMAS BASIN (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS)						
	WITHOUT EAD	FIX SAC RIVER LEVEES ONLY (BELOW CONFLUENCE WITH AMERICAN)		ALTERNATIVE 1 (FIP)		ALTERNATIVE 2 (SBW)	
		RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS	RESIDUAL EAD	BENEFITS
Autos	863	N/A	N/A	382	481	370	493
Commercial	3,294	N/A	N/A	1,511	1,783	1,469	1,825
Farm	36	N/A	N/A	19	17	18	18
Industrial	2,328	N/A	N/A	1,081	1,247	1,051	1,277
Public	2,774	N/A	N/A	1,274	1,500	1,238	1,536
Residential	19,300	N/A	N/A	8,845	10,455	8,595	10,705
TOTAL IP	**28,595**	N/A	N/A	**13,113**	**15,482**	**12,742**	**15,853**

4.4 RANGE OF BENEFITS BY INDEX POINT & ALTERNATIVE

The following tables present ranges of benefits for each alternative and at each index point. HEC-FDA computes damages reduced (benefits) at specific probabilities (25%, 50%, and 75%); the intersection of the probability and the dollar value in the table can be read as, “There is an X chance that damages reduced (benefits) exceeds Y.” The benefits in these tables provide a broader picture of the possible range in benefits that may be realized considering all of the hydrologic, hydraulic, geotechnical, and economic uncertainty.

Table 29: Range of Benefits at ARS A (In $1000s, October 2015 Price Level, 50-Year Period of Analysis)

PLAN	WITHOUT-PROJECT EAD	WITH-PROJECT EAD	EXPECTED BENEFITS	PROBABILITY BENEFITS EXCEED INDICATED VALUE		
				75%	50%	25%
No action	91,330	--	--	--	--	--
Alt. 1 FIP	91,330	65,814	25,519	17,001	21,266	30,223
Alt. 2 SB	91,330	65,331	25,996	16,944	21,166	30,816

Table 30: Range of Benefits at ARS F (In $1,000s, October 2015 Price Level, 50-Year Period of Analysis)

PLAN	WITHOUT-PROJECT EAD	WITH-PROJECT EAD	EXPECTED BENEFITS	PROBABILITY BENEFITS EXCEED INDICATED VALUE		
				75%	50%	25%
No action	332,383	--	--	--	--	--
Alt. 1 FIP	332,383	68,037	264,346	148,191	194,802	372,595
Alt. 2 SB	332,383	66,078	266,305	151,059	202,639	378,927

Table 31: Range of Benefits at ARN A (In $1,000s, October 2015 Price Level, 50-Year Period of Analysis)

PLAN	WITHOUT-PROJECT EAD	WITH-PROJECT EAD	EXPECTED BENEFITS	PROBABILITY BENEFITS EXCEED INDICATED VALUE		
				75%	50%	25%
No action	51,128	--	--	--	--	--
Alt. 1 FIP	51,128	27,823	23,305	8,459	17,492	34,125
Alt. 2 SB	51,128	29,793	21,335	7,281	15,667	31,414

Table 32: Range of Benefits at ARN E (In $1,000s, October 2015 Price Level, 50-Year Period of Analysis)

PLAN	WITHOUT-PROJECT EAD	WITH-PROJECT EAD	EXPECTED BENEFITS	PROBABILITY BENEFITS EXCEED INDICATED VALUE		
				75%	50%	25%
No action	26,175	--	--	--	--	--
Alt. 1 FIP	26,175	18,105	8,070	4,573	7,128	10,783
Alt. 2 SB	26,175	16,567	9,608	4,874	8,102	12,670

Table 33: Range of Benefits at NAT D (In $1,000s, October 2015 Price Level, 50-Year Period of Analysis)

PLAN	WITHOUT-PROJECT EAD	WITH-PROJECT EAD	EXPECTED BENEFITS	PROBABILITY BENEFITS EXCEED INDICATED VALUE		
				75%	50%	25%
No action	28,595	--	--	--	--	--
Alt. 1 FIP	28,595	13,113	15,482	10,847	14,297	19,378
Alt. 2 SB	28,595	12,742	15,853	11,106	14,652	19,784

4.5 WITH-PROJECT RESULTS: BENEFITS BY BASIN AND ALTERNATIVE

Tables 34 and 35 below display the benefits of each alternative by basin. The benefit values in these tables reflect improvements made to each source of flood risk within a particular basin. For example, in the ARS Basin, FRM improvements are made to reduce risk from both the American and Sacramento Rivers. These tables reflect benefits that would be realized in a basin (i.e., in a single consequence area)

by thinking of the flood problem from a broader system perspective rather than from just individual, discrete sources of flood risk.

Table 34: Average Annual Benefits for Alternative 1 (In $1,000s, October 2015 Price Level, 50-Year Period of Analysis)

BASIN	WITHOUT-PROJECT EAD	WITH-PROJECT EAD	AVERAGE ANNUAL BENEFITS
ARS	332,383 (ARS F)	68,037 (ARS F)	**264,346**
ARN	77,303 (ARN A + ARN E)	45,928 (ARN A + ARN E)	**31,375**
NATOMAS	28,595 (NAT D)	13,113 (NAT D)	**15,482**
TOTAL	438,281	127,078	**311,203**

Table 35: Average Annual Benefits for Alternative 2 (In $1,000s, October 2015 Price Level, 50-Year Period of Analysis)

BASIN	WITHOUT-PROJECT EAD	WITH-PROJECT EAD	AVERAGE ANNUAL BENEFITS
ARS	332,383 (ARS F)	66,078 (ARS F)	**266,305**
ARN	77,303 (ARN A + ARN E)	46,360 (ARN A + ARN E)	**30,943**
NATOMAS	28,595 (NAT D)	12,742 (NAT D)	**15,853**
TOTAL	438,281	125,180	**313,101**

As explained throughout the preceding sections, the benefits of FRM improvements in the study area have been computed using simplifying assumptions and simplified computations in order to make reasonable estimates using available resources, which include time, money, data, as well as software applications. Simplifications were necessary considering that the study area may flood from multiple water sources.

As an example, the method used to compute benefits for the ARS Basin was selected based on information that the American and Sacramento Rivers are moderately correlated in terms of hydrology and hydraulics. While it is believed that the method used (compute risk at multiple index points and use the highest EAD) accurately accounts for damages, residual damages, and benefits associated with the ARS Basin, it also should be noted that this may not be the most rigorous method to estimate benefits for this basin. The most rigorous method to compute benefits given the multiple-source flooding situation in the ARS Basin would be to use a model that fully represents the system and could account for various "what if" scenarios:

- What if there is a levee breach along the American River first? Would this affect the probabilities of flooding along the Sacramento River downstream of the confluence?
- What if there is a breach along the Sacramento River first? Would this affect the probabilities of flooding along the American River?
- What if there is a levee breach along both rivers at the same time?

While a true systems approach is ideal, it may not be practical until more sophisticated analytical tools are developed and tested by FRM practitioners. In the meantime, it is believed that the method used to estimate benefits for this current analysis balances rigor with practicality without sacrificing accuracy.

4.6 BENEFITS ASSOCIATED WITH THE PREVENTION OF EMERGENCY COSTS

Prevention of Emergency Cost Losses: Tables 36-39 display the without-project EAD (repeated from Section 3.3.2) and the with-project benefits achieved under each alternative and for each basin. Both Alternatives 1 and 2 reduce the frequency of flooding to Sacramento and therefore prevent a significant amount of emergency-related costs from being incurred. Under each alternative, EAD would be reduced by about 75%, or to about $16.7 million for Alternative 1 and $17.8 million for Alternative 2. Therefore the annual benefits of Alternative 1 are approximately $48.6 million and those of Alternative 2 are approximately $47.4 million. For either alternative, the prevention of clean-up and TERHA costs comprise about 13% of total benefits for the Sacramento study area.

Separately, the benefits from the prevention of emergency cost losses associated with the Tributaries increment in the ARN Basin are approximately $1.25 million (Alternative 1) and $1.45 million (Alternative 2); the benefits associated with the American River increment are approximately $3.2 million (Alternative 1) and $2.9 million (Alternative 2).

Table 36: Expected Annual Damages and Benefits – Alternative 1, ARCF Clean-Up and TERHA Costs (In $1,000s, October 2015 Price Level)

Category	Without-Project			With-Project (Alternative 1)			Average Annual Benefits
	ARS Basin	ARN Basin	Total	ARS Basin	ARN Basin	Total	
Clean-UP	36,860	7,653	44,513	7,161	4,418	11,579	32,934
TERHA	17,933	2,805	20,738	3,478	1,617	5,095	15,643
Total	**54,793**	**10,458**	**65,251**	**10,639**	**6,035**	**16,674**	**48,577**

Table 37: Expected Annual Damages and Benefits – Alternative 2, ARCF Clean-Up and TERHA Costs (In $1,000s, October 2015 Price Level)

Category	Without-Project			With-Project (Alternative 2)			Average Annual Benefits
	ARS Basin	ARN Basin	Total	ARS Basin	ARN Basin	Total	
Clean-UP	36,860	7,653	44,513	7,873	4,465	12,338	32,175
TERHA	17,933	2,805	20,738	3,839	1,627	5,466	15,272
Total	**54,793**	**10,458**	**65,251**	**11,712**	**6,092**	**17,804**	**47,447**

Table 38: Expected Annual Damages and Benefits – Alternative 1, ARCF Clean-Up and TERHA Costs (In $1,000s, October 2015 Price Level) Separated by American River and Tributaries Increments

Category	Without-Project			With-Project (Alternative 1)			Average Annual Benefits
	American River (ARN Basin)	Tributaries (ARN Basin)	Total	American River (ARN Basin)	Tributaries (ARN Basin)	Total	
Clean-UP	5,088	2,565	7,653	2,738	1,680	4,418	3,235
TERHA	1,805	1,000	2,805	978	639	1,617	1,188
Total	**6,892**	**3,565**	**10,458**	**3,717**	**2,319**	**6,035**	**4,423**

Table 39: Expected Annual Damages and Benefits – Alternative 2, ARCF Clean-Up and TERHA Costs (In $1,000s, October 2015 Price Level) Separated by American River and Tributaries Increments

Category	Without-Project			With-Project (Alternative 2)			Average Annual Benefits
	American River (ARN Basin)	Tributaries (ARN Basin)	Total	American River (ARN Basin)	Tributaries (ARN Basin)	Total	
Clean-UP	5,088	2,565	7,653	2,931	1,534	4,465	3,188
TERHA	1,805	1,000	2,805	1,048	579	1,627	1,178
Total	**6,892**	**3,565**	**10,458**	**3,980**	**2,113**	**6,092**	**4,366**

4.7 NATOMAS BASIN – NO ADDITIONAL IMPROVEMENTS (LEVEE RAISES) RECOMMENDED

The Natomas Basin had largely been an agricultural area until recent times. After having been given assurances that the levees provided adequate flood protection, residential and commercial development increased in this area in the late 1990s and mid 2000s. Subsequent investigations and signs of levee distress during high flows have shown that the area is still at significant risk of flooding. Further flood risk reduction is needed, not only to meet the FEMA regulatory requirements, but also to meet the State of California requirement for 200-year level of protection for urban areas. The Natomas 2010 PAC report includes recommendations for Federal involvement in flood risk reduction through levee improvements which would provide a 1 in 67 annual exceedence probability (a 1 in 67 chance of being exceeded in any given year). These recommendations were authorized by WRRDA 2014. State and local agencies implemented improvements to more than a third of the perimeter levee system in advance of the Federal authorization. Some of those improvements were previously approved for consideration for credit under Section 104 (WRDA 1986). This GRR considered further flood risk reduction features (levee raises) for the Natomas Basin.

Initially assessments of both of the final alternatives included additional flood risk reduction for the Natomas Basin in the form of levee raises. The final alternatives included measures that would attain FEMA level accreditation as well as meet the State of California's requirement for 200 year level of protection for urban areas. The Administration has concerns with USACE projects enabling growth in floodplains. This additional growth would increase the consequences of flooding within the Basin and therefore increase the future flood risk. In fact, a preliminary assessment completed for the 2010 Natomas PACR (2010 Natomas Post-Authorization Change and Interim GRR, Economic Appendix H, Attachment 8) indicated that by the year 2035 there could be an additional 40,000 people and 16,000 structures worth about $6 billion located in the Basin, which would translate into additional flood damages of approximately $3.3 billion from a 1% annual chance exceedance (ACE) event. Discussions with the project partners determined that, in light of ongoing locally-driven regional planning efforts that are investigating regional-scale flood risk reduction measures to deal with large flood events, this ARCF GRR would not make further recommendations for the Natomas Basin. This is because the other local regional planning efforts could recommend implementation of other measures that would render levee raises around the Natomas Basin unnecessary.

Raising levees around the Natomas Basin is a separate element common to both of the action alternatives in the final array. As such, removal of those features from both alternatives does not change the identification of the NED Plan. Therefore, as a final step following plan comparison, the final array of alternatives was reformulated to remove the Natomas levee raise features.

4.8 BENEFITS OUTSIDE THE IMMEDIATE STUDY AREA: CITY OF WEST SACRAMENTO

Widening the Sacramento Bypass (Alternative 2) provides benefits to the city of West Sacramento, which is located on the right bank (west side) of the Sacramento River adjacent to the confluence with the American River and directly across the river from the city of Sacramento. The benefits are achieved through lower flows and stages in the Sacramento River downstream of the Sacramento Bypass, effectively decreasing the computed frequency of flooding from the Sacramento River into the city of West Sacramento and thereby reducing expected annual damages from flooding along the Sacramento River. However, these potential benefits are not effectively realized because the highest damages within the West Sacramento study area are instead driven by flooding coming from the Yolo Bypass, which does not see any decrease in water surface elevation from widening of the Sacramento Bypass.

A General Reevaluation Report (GRR) is currently being completed for the West Sacramento area.

4.9 WITH-PROJECT PERFORMANCE RESULTS: AEP, LONG-TERM RISK, & ASSURANCE

Tables 40 to 42 present the performance statistics under both without-project and with-project conditions for each index point, basin, and alternative.

The AEP values under with-project conditions indicate that each alternative provides significant risk reduction in terms of the chance of flooding in any given year. For example, in the ARS Basin, without-project AEP is about 1 in 32 (1 in 97 for ARS A on American River and 1 in 32 for ARS F on Sacramento River). With improvements made to both risk sources, flood risk is reduced to about a 1 in 135 (Alternative 1) and 1 in 147 (Alternative 2).

The long-term risk statistics indicate that the chance of flooding over a certain time period is also reduced. In the ARS Basin, the chance of flooding over a 10-year and 30-year period improves significantly with a project in place, while in the ARN Basin this improvement isn't as great. Like the ARS Basin, the Natomas Basin would also experience a significant reduction in long-term risk with levee improvements.

Table 40: AEP -- Without-Project and With-Project Conditions

BASIN	INDEX POINT	ANNUAL EXCEEDANCE PROBABILITY (AEP)			
		WITHOUT	FIX SAC RIVER LEVEES ONLY (BELOW CONFLUENCE WITH AMERICAN)	ALT. 1 (WITH SAC RAISES)	ALT. 2 SBW
ARS	ARS A	0.0103	0.0051	0.0051	0.0051
	Flanking	0.0033	--	--	--
	ARS F	0.0310	0.0104	0.0074	0.0068
ARN	ARN A	0.0104	0.0055	0.0055	0.0058
	Flanking	0.0009	--	--	--
	ARN E	0.0165	0.0165	0.0050	0.0039

Table 41: Long-Term Risk -- Without-Project and With-Project Conditions

BASIN	INDEX POINT	LONG-TERM RISK							
		WITHOUT		FIX SAC RIVER LEVEES ONLY (BELOW CONFLUENCE WITH AMERICAN)		ALT. 1 (WITH SAC RAISES)		ALT. 2 SBW	
		10 YEARS	30 YEARS	10 YEARS	30 YEARS	10 YEARS	30 YEARS	10 YEARS	30 YEARS
ARS	ARS A	13%	27%	5%	14%	5%	14%	5%	13%
	Flank.	3%	10%	--	--	--	--	--	--
	ARS F	27%	61%	10%	27%	7%	20%	7%	18%
ARN	ARN A	10%	27%	5%	15%	5%	15%	5%	16%
	Flank.	1%	3%	--	--	--	--	--	--
	ARN E	15%	39%	5%	14%	5%	14%	4%	11%

Table 42: Assurance -- Without-Project and With-Project Conditions

BASIN	INDEX POINT	ASSURANCE BY EXCEEDANCE PROBABILITY EVENT											
		WITHOUT			FIX SAC RIVER LEVEES ONLY (BELOW CONFLUENCE WITH AMERICAN)			ALT. 1 (WITH SAC RAISES)			ALT. 2 SBW		
		4%	1%	.2%	4%	1%	.2%	4%	1%	.2%	4%	1%	.2%
ARS	ARS A	93%	77%	18%	98%	91%	31%	98%	91%	31%	98%	91%	32%
	Flank.	99%	84%	6%	--	--	--	--	--	--	--	--	--
	ARS F	75%	69%	24%	95%	94%	36%	95%	95%	89%	95%	95%	81%
ARN	ARN A	92%	75%	22%	99%	90%	24%	99%	90%	24%	98%	89%	22%
	Flank.	99%	98%	40%	--	--	--	--	--	--	--	--	--
	ARN E	90%	68%	7%	99%	94%	23%	99%	94%	23%	99%	95%	28%

4.10 SCREENING-LEVEL COST ESTIMATES: BY ALTERNATIVE, BASIN, & SOURCE OF FLOOD RISK

Preliminary, screening-level cost estimates were provided by the District's Cost Engineering Section. Detailed costs were provided in several formats; the costs broken out by stream/river were used for this economic analysis and are summarized in Tables 43 and 44 below. In addition to project first costs, interest during construction (IDC), which is an economic cost, was also factored into the net benefit/BCR analyses. Information regarding the construction period (number of years) and the construction schedule for each alternative was provided by the Civil Design and used to compute IDC on an annual basis. The construction period for both Alternatives 1 and 2 are estimated to be 10 years; the construction schedules for each alternative identifies the timing of the improvements by reach and by year. The Total Project Cost Summaries (TPCS) for Alternatives 1 and 2 are shown in Attachment 2 and more detailed reach-by-reach cost estimates and schedules can be found in the Cost Engineering Appendix.

Table 43: Alternative 1 -- Costs

BASIN	ALTERNATIVE 1: FIX IN PLACE (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS, 3.125% DISCOUNT RATE)						
	RISK SOURCE	FIRST COSTS[1]	IDC[2]	TOTAL COSTS	AVERAGE ANNUAL COSTS (AAC)	O&M	TOTAL AAC
ARS	American	260,439	68,565	329,004	13,092	N/A	13,092
	Sacramento	677,122	127,289	804,411	32,010	N/A	32,010
	Sac Raises	61,088	13,948	75,036	2,986	N/A	2,986
	Total Basin	**998,649**	**209,803**	**1,208,452**	**48,088**	N/A	**48,169**
ARN	American	139,076	22,540	161,616	6,431	N/A	6,431
	Tributaries[3]	198,030	22,379	220,409	8,771	N/A	8,771
	Total Basin	**337,106**	**44,919**	**382,025**	**15,202**	N/A	**15,202**
GRAND TOTAL	**All Basins**	**1,335,755**	**254,722**	**1,590,477**	**63,290**	**286**	**63,576**

[1] Costs associated with cultural resource preservation ($8.237M) excluded from economic analysis as per USACE policy
[2]Interest During Construction
[3]Includes Arcade, Dry, and Robla Creeks and the Natomas East Main Drainage Canal (NEMDC)

Table 44: Alternative 2 -- Costs

BASIN	ALTERNATIVE 2: SACRAMENTO BYPASS WIDENING (IN $1,000s, OCTOBER 2015 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS, 3.125% DISCOUNT RATE)						
	RISK SOURCE	FIRST COSTS[1]	IDC[2]	TOTAL COSTS	AVERAGE ANNUAL COSTS (AAC)	O&M	TOTAL AAC
ARS	American	262,447	69,096	331,543	13,193	N/A	13,193
	Sacramento	677,122	127,289	804,411	32,010	N/A	32,010
	Sac Bypass	278,527	67,601	346,128	13,773	N/A	13,773
	Total Basin	**1,218,096**	**263,986**	**1,482,082**	**58,976**	N/A	**58,976**
ARN	American	140,151	22,714	162,865	6,481	N/A	6,481
	Tributaries[3]	199,266	22,530	221,796	8,826	N/A	8,826
	Total Basin	**339,417**	**45,244**	**384,661**	**15,307**	N/A	**15,307**
GRAND TOTAL	**All Basins**	**1,557,513**	**309,230**	**1,866,743**	**74,283**	**494**	**74,777**

[1]Costs associated with cultural resource preservation ($8.237M) excluded from economic analysis as per UACE policy
[2]Interest During Construction
[3]Includes Arcade, Dry, and Robla Creeks and the Natomas East Main Drainage Canal (NEMDC)

4.11 NET BENEFIT AND BENENFIT-TO-COST ANALYSES: PERFORMED INCREMENTALLY BY SOURCE OF FLOOD RISK & BASIN

Incremental net benefit/benefit-to-cost analyses were performed for each basin using the major sources of flood risk within a basin as the incremental unit. The cost information presented in Tables 43 and 44 was used to perform the analyses, which are presented in Tables 45 and 46 for the ARS and ARN Basins, respectively. The incremental analysis includes damages and benefits associated with structures, contents, automobiles, and emergency cost losses.

In the ARS Basin, addressing both sources of risk (in tandem) as part of an overall system is necessary in order to significantly reduce risk to the basin as a whole. Without addressing improvements to both the Sacramento and American Rivers, the ARS Basin, which includes downtown Sacramento and the state government buildings, still faces a significant level of risk in terms of the chance of flooding and consequences of flooding. O&M Costs are not included in the incremental analysis because they are negligible and will not affect the result.

Table 45: Incremental Net Benefit and Benefit-to-Cost Analyses for Alternatives 1 and 2 in ARS Basin (Values in $1,000s, October 2015 Price Level, 50-Year Period of Analysis, 3.125% Discount Rate)

Increment	Without-Project EAD/Resid EAD	Increm. Average Annual Benefits (AAB)	Cumulat. AAB	Increm. Average Annual Costs (AAC)	Cumulat. AAC	Increm. Net Benefits	Cumulat. Net Benefits	Increm. Benefit-to-Cost Ratio (BCR)	Cumalat. BCR
Alternative 1: Fix in Place (FIP)									
0 -- No Action	387,175	0	0	0	0	0	0	N/A	N/A
1 -- Fix Sac River	140,076	247,099	247,099	32,010	32,010	215,089	215,089	7.7	7.7
2a – Raise Sac River	105,859	34,217	281,316	2,986	34,996	31,231	246,320	11.5	8.0
2b – Fix American River	78,675	27,184	308,500	13,092	48,088	14,092	260,412	2.1	6.4
Total	N/A	308,500	308,500	48,088	48,088	260,412	260,412	6.4	6.4
Alternative 2: Sacramento Bypass Widening (SBW)									
0 -- No Action	387,175	0	0	0	0	0	0	N/A	N/A
1 -- Fix Sac River	140,076	247,099	247,099	32,010	32,010	215,089	215,089	7.7	7.7
2a – Widen Sac Bypass	105,859	34,217	281,316	13,773	45,783	20,444	235,533	2.5	6.1
2b – Fix American River	77,790	28,070	309,386	13,193	58,976	14,877	250,410	2.1	5.2
Total	N/A	309,386	309,386	58,976	58,976	250,410	250,410	5.2	5.2

Walking through the incremental analysis, Table 45 shows the first increment, under both alternatives, as being improving the Sacramento River levees (but no levee raises under Alternative 1 and no widening of the Sacramento Bypass under Alternative 2). Following improvements to the Sacramento River (fix levees under both Alternatives 1 and 2) the next logical step according to the results of the HEC-FDA analysis would be to address either the raise on the Sacramento River or the widening of the Sacramento Bypass, where AEP and residual damages are the next highest. Once these improvements are made, the American River levees would be improved.

It should be pointed out that this planning-level economic analysis indicates that improvements to the American River would be completed after (or in tandem with) either the Sacramento River levee raises (Alt 1) or Sacramento Bypass widening (Alt 2) in order for the ARS Basin to realize its full benefits from either the levee raises or bypass widening.

Table 46: Incremental Net Benefit and Benefit-to-Cost Analyses for Alternatives 1 and 2 in ARN Basin (Values in $1,000s, October 2015 Price Level, 50-Year Period of Analysis, 3.125% Discount Rate)

Increment	Without-Project EAD/Resid EAD	Increm. Average Annual Benefits (AAB)	Cumulat. AAB	Increm. Average Annual Costs (AAC)	Cumulat. AAC	Increm. Net Benefits	Cumulat. Net Benefits	Increm. Benefit-to-Cost Ratio (BCR)	Cumalat. BCR
Alternative 1: Fix in Place (FIP)									
0 -- No Action	87,762	0	0	0	0	0	0	N/A	N/A
1 -- Fix American	61,280	26,482	26,482	6,431	6,431	20,051	20,051	4.1	4.1
2 -- Fix Creeks	51,964	9,316	35,798	8,771	15,202	545	20,596	1.1	2.4
Total	N/A	35,798	35,798	15,202	15,202	20,596	20,596	2.4	2.4
Alternative 2: Sacramento Bypass Widening (SBW)									
0 -- No Action	87,762	0	0	0	0	0	0	N/A	N/A
1 -- Fix American	63,513	24,249	24,249	6,481	6,481	17,768	17,768	3.7	3.7
2 -- Fix Creeks	52,453	11,060	35,309	8,826	15,307	2,234	20,002	1.3	2.3
Total	N/A	35,309	35,309	15,307	15,307	20,002	20,002	2.3	2.3

One point of interest is the Creeks increment in the ARN Basin. While Table 46 indicates that this increment is only marginally justified (i.e., it has a BCR of 1.1 for Alt 1), the proposed improvements help to significantly reduce the residual risk to a basin where risk to human life is high.

Additionally, the increment is further justified in the Federal Interest with a social justice argument. The area receiving benefit from the Creeks increment represents one of the most impoverished locations in Sacramento County.[4] In fact, the median family income in Sacramento is more than 50 percent higher than the median family income of the affected area ($55,064 compared to $35,828); the poverty rate in the affected area is 64 percent higher that of the surrounding county (29.0% compared to 17.6%). Within some parts of the affected area more than one in three family's live below the poverty line (34.1% in zip code 95815). Furthermore, these high rates of poverty are strongly correlated with disabilities, lack of car ownership and other factors that increase life safety hazards. In the absence of this justified increment, the flood risks for this area would change very little, thereby putting this community at a further disadvantage relative to neighboring communities in the study area.

Net benefit/benefit-to-cost analyses for Alternative 1 and Alternative 2 are summarized in Tables 47 and 48 below. The calculations were performed using the information from the previous tables.

[4] The above analysis is based on the US Census Bureau 2009-2013 American Community Survey comparing Sacramento County to the zip codes most closely associated with the area affected by the increment (95815 and 95838).

Table 47: Final Net Benefits and Benefit-to-Cost Ratio – Alternative 1 (Dollar Values in $1,000s, October 2015 Price Level, 50-Year Period of Analysis, 3.125% Discount Rate)

Alternative 1	
Without-Project Damages and With-Project Benefits	
Without-Project Expected Annual Damages (EAD)	
ARS Basin – Structures/Contents/Autos	332,383
ARS Basin – Emergency Costs	54,793
ARN Basin – Structures/Contents/Autos	77,303
ARN Basin – Emergency Costs	10,458
Total	**474,937**
With-Project Residual EAD	
ARS Basin – Structures/Contents/Autos	68,037
ARS Basin – Emergency Costs	10,639
ARN Basin – Structures/Contents/Autos	45,928
ARN Basin – Emergency Costs	6,035
Total	**130,639**
Average Annual Benefits (AAB)	
ARS Basin – Structures/Contents/Autos	264,346
ARS Basin – Emergency Costs	44,154
ARN Basin – Structures/Contents/Autos	31,375
ARN Basin – Emergency Costs	4,423
Total AAB	**344,298**
Costs	
Total First Costs[1]	1,335,755
Interest During Construction (IDC)	254,722
Total Costs	1,590,477
Average Annual Costs (AAC)	63,290
O&M Costs	286
Total AAC	**63,576**
Net Benefit and BCR Analyses	
Net Benefits	**280,722**
Benefit-to-Cost Ratio (BCR)	**5.4**

[1] Costs associated with cultural resource preservation ($8.237M) excluded from economic analysis as per USACE policy

Table 48: Final Net Benefits and Benefit-to-Cost Ratio – Alternative 2 (Dollar Values in $1,000s, October 2015 Price Level, 50-Year Period of Analysis, 3.125% Discount Rate)

Alternative 2	
Without-Project Damages and With-Project Benefits	
Without-Project Expected Annual Damages (EAD)	
ARS Basin – Structures/Contents/Autos	332,383
ARS Basin – Emergency Costs	54,793
ARN Basin – Structures/Contents/Autos	77,303
ARN Basin – Emergency Costs	10,458
Total	**474,937**
With-Project Residual EAD	
ARS Basin – Structures/Contents/Autos	66,078
ARS Basin – Emergency Costs	11,712
ARN Basin – Structures/Contents/Autos	46,360
ARN Basin – Emergency Costs	6,092
Total	**130,242**
Average Annual Benefits (AAB)	
ARS Basin – Structures/Contents/Autos	266,305
ARS Basin – Emergency Costs	43,081
ARN Basin – Structures/Contents/Autos	30,943
ARN Basin – Emergency Costs	4,366
Total AAB	**344,695**
Costs	
Total First Costs[1]	1,557,513
Interest During Construction (IDC)	309,230
Total Costs	1,866,743
Average Annual Costs (AAC)	74,283
O&M Costs	494
Total AAC	**74,777**
Net Benefit and BCR Analyses	
Net Benefits	**269,918**
Benefit-to-Cost Ratio (BCR)	**4.6**

[1]Costs associated with cultural resource preservation ($8.237M) excluded from economic analysis as per USACE policy

4.12 NED OPTIMIZATION – LEVEE RAISES FOR ALTERNATIVE 1

Two alternative levee heights were evaluated to verify that the NED levee scale was properly identified.

The HEC-FDA model was used to assess a lower levee raise on the Sacramento River in the American River South (ARS) basin and to see how a lower raise would affect the benefits for Alternative 1. Currently, Alternative 1 includes raising levees in order to contain the 200-year water surface elevation (WSEL) plus 3 feet, which is equivalent to about a 1.8-foot levee height increase at the index point location (ARS F) used to model the levee raise. The analysis assessed a lower, 0.9-foot levee raise, or about one-half the height of Alternative 1's 1.8-foot raise (equivalent). The results of the analysis indicate that a lower levee raise would result in about a $21 million reduction in benefits, far outweighing the potential reduction in costs (which could not be more than about a $3.7 million

reduction, in average annual terms, since this is the estimate for the current levee raise), indicating that net benefits are lower for a 0.9-foot levee raise than for the current 1.8-foot levee raise (equivalent). Additionally, higher levee raises (i.e., higher than the 200-year plus 3 feet WSEL, at ARS F) on the Sacramento River in the ARS basin (e.g., raises to contain the 0.2% ACE event) would not make sense since any incremental benefit would likely be off-set by damages caused from flooding (outflanking) from the upstream, non-leveed reaches of the American River.

4.13 IDENTIFICATION OF NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

Based on the analysis presented above, both Alternative 1 and Alternative 2 provide positive net benefits. While the benefits for each alternative are very similar and are essentially equal from a risk and uncertainty perspective, it is clear that Alternative 1 would be considered the NED Plan given that it costs approximately $222 million less (first costs) than Alternative 2.

American River Common Features GRR
Attachments to Economic Appendix

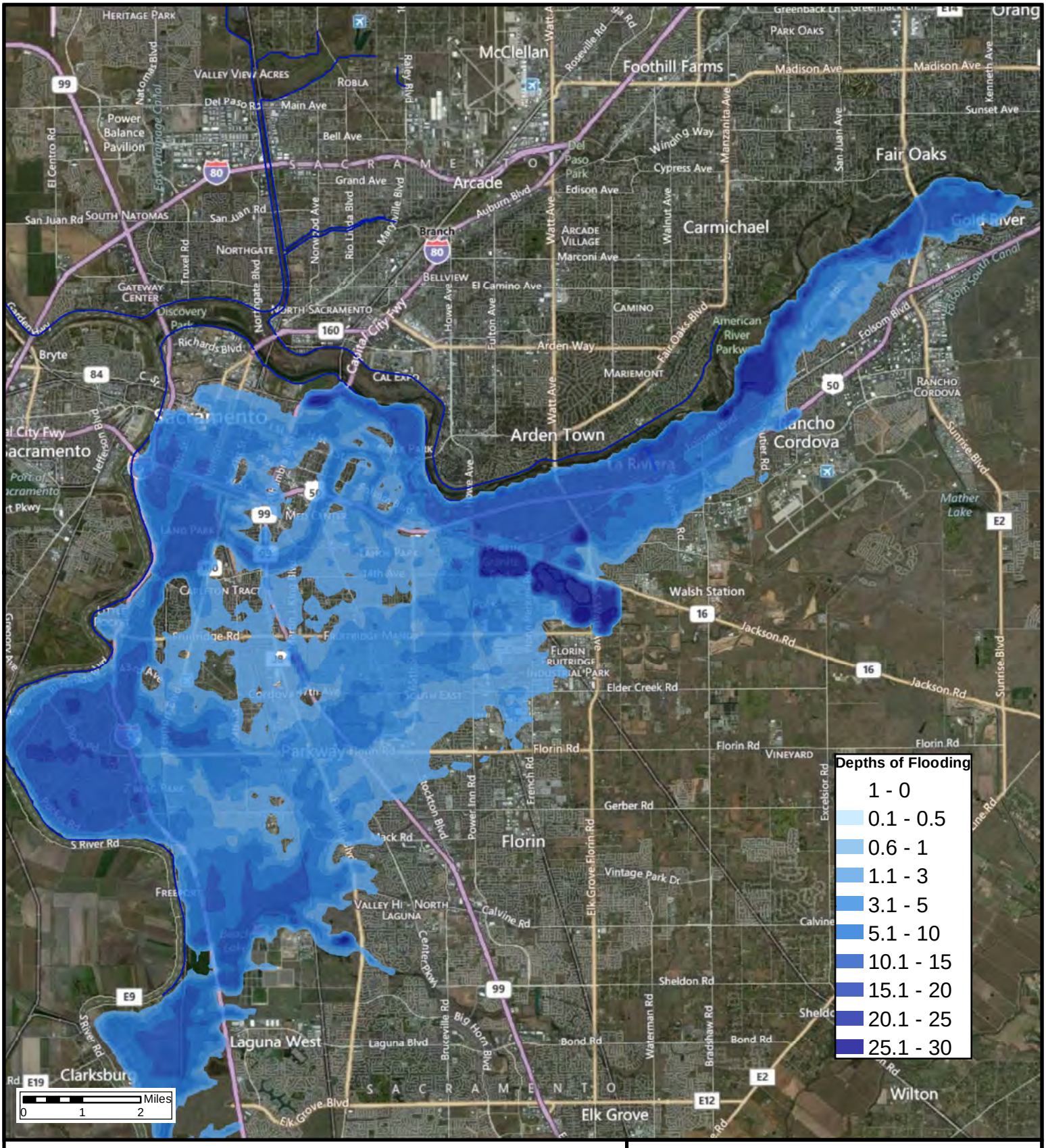
Attachment 1 - Supporting Data (Floodplain Plates, HEC-FDA Input Data)

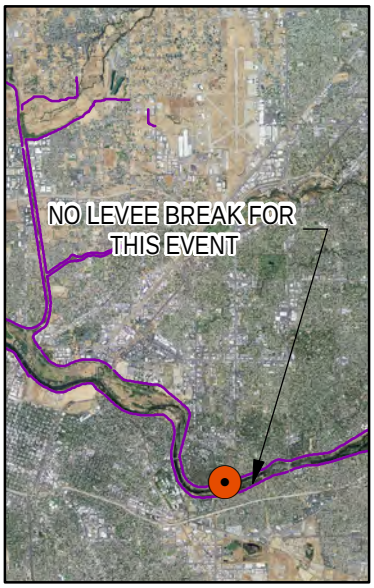
Attachment 2 – Certified Cost Estimates

Attachment 3 - Other Social Effects (OSE) & Regional Economic Development (RED) Analyses

American River Common Features GRR
Attachments to Economic Appendix

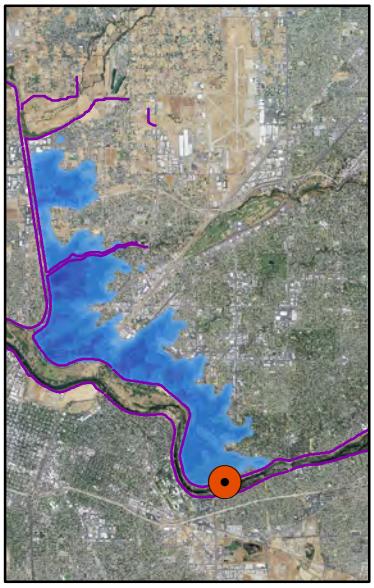
Attachment 1 - Supporting Data (Floodplain Plates, HEC-FDA Input Data)


Depths of Flooding
1 - 0
0.1 - 0.5
0.6 - 1
1.1 - 3
3.1 - 5
5.1 - 10
10.1 - 15
15.1 - 20
20.1 - 25
25.1 - 30
Miles
0 1 2
McClellan
Foothill Farms
Arcade
Carmichael
Fair Oaks
Arden Town
Cordova
Florin
Laguna West
Elk Grove
Wilton
Walsh Station
Mather Lake
Sacramento
Jackson Rd
Florin Rd
Elder Creek Rd
Gerber Rd
Vintage Park Dr
Calvine Rd
Sheldon Rd
Bond Rd
Laguna Blvd
Elk Grove Blvd
Folsom Blvd
Sunrise Blvd
Madison Ave
Fair Oaks Blvd
Watt Ave
Auburn Blvd
Power Balance Pavilion
Discovery Park
Gateway Center
Northgate
South Natomas
Valley View Acres
Robla
Del Paso Park
Arcade Village
Bellview
North Sacramento
Camino
Marconi Ave
Arden Way
Mariemont
Rancho Cordova
Florin Vineyard
Valley Hi - North Laguna
Clarksburg
Park Oaks
Sunset Ave
Cypress Ave
Edison Ave
Winding Way
El Camino Ave
Richards Blvd
Bryte
Port of Sacramento
Capitol City Fwy
American River Parkway
Folsom South Canal
Gold River
Greenback Ln
Orang
Heritage Park
Main Ave
Del Paso Rd
Bell Ave
San Juan Rd
Grand Ave
Marysville Blvd
Rio Linda Blvd
Norwood Ave
Truxel Rd
Northgate Blvd
Howe Ave
Fulton Ave
Walnut Ave
Manzanita Ave
San Juan Ave
Kenneth Ave
Roseville Rd
Natomas Blvd
El Centro Rd
Jefferson Blvd
Garden Hwy
Cal Expo
Florin Rd
Florin Perkins Rd
French Rd
Power Inn Rd
Rockton Blvd
Excelsior Rd
Elk Grove Florin Rd
Center Pkwy
Bruceville Rd
Big Horn Blvd
Waterman Rd
Bradshaw Rd
S River Rd
Freeport
Carleton Tract
Florin Ruitridge Industrial Park
Parkway Florin Rd
Cordova Hills
Mather Field Rd
Sacramento
Carson City
San Jose
San Francisco
SACRAMENTO
SAN JO
Legend
ARCF Levees
AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA
Residual Flooding
From Channel Outflanking
Into The American River South Basin
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
Jan 2013

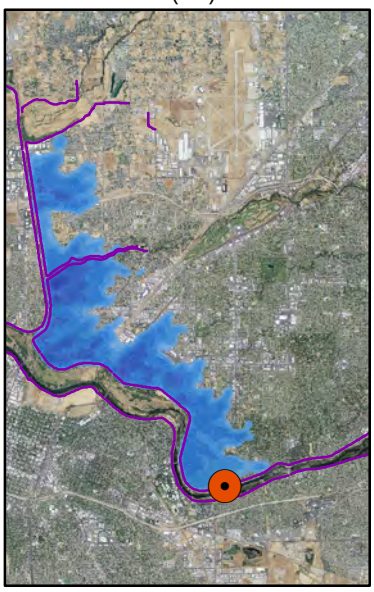


50% (1/2) ACE

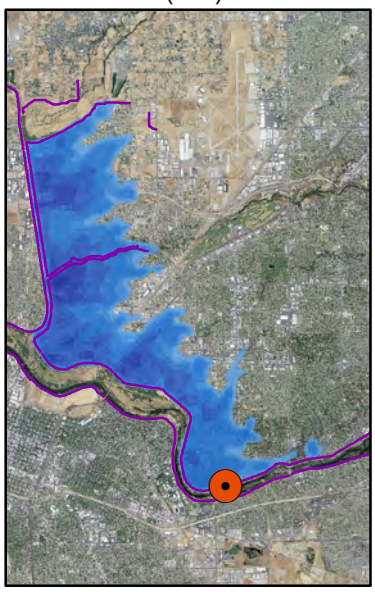
10% (1/10) ACE



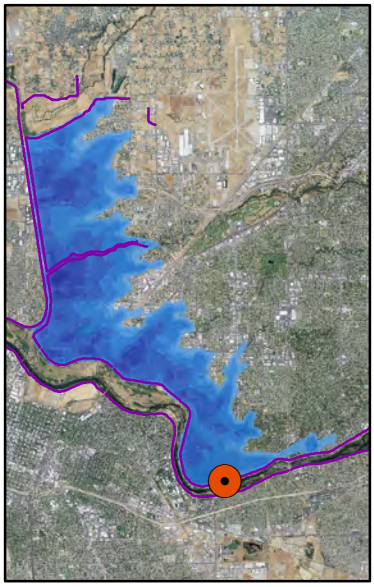
4% (1/25) ACE



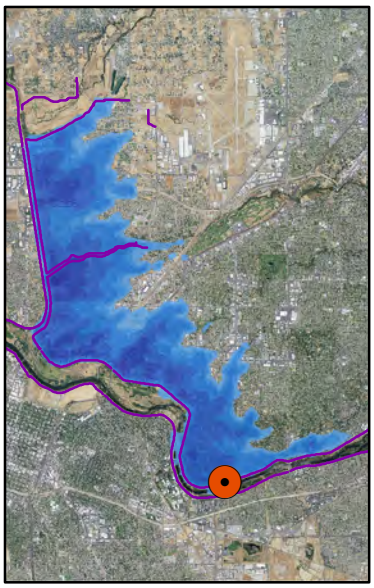
2% (1/50) ACE



1% (1/100) ACE



0.5% (1/200) ACE



0.2% (1/500) ACE

Legend

Depths of Flooding (Feet)

- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 3
- 3.1 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 - 30

N

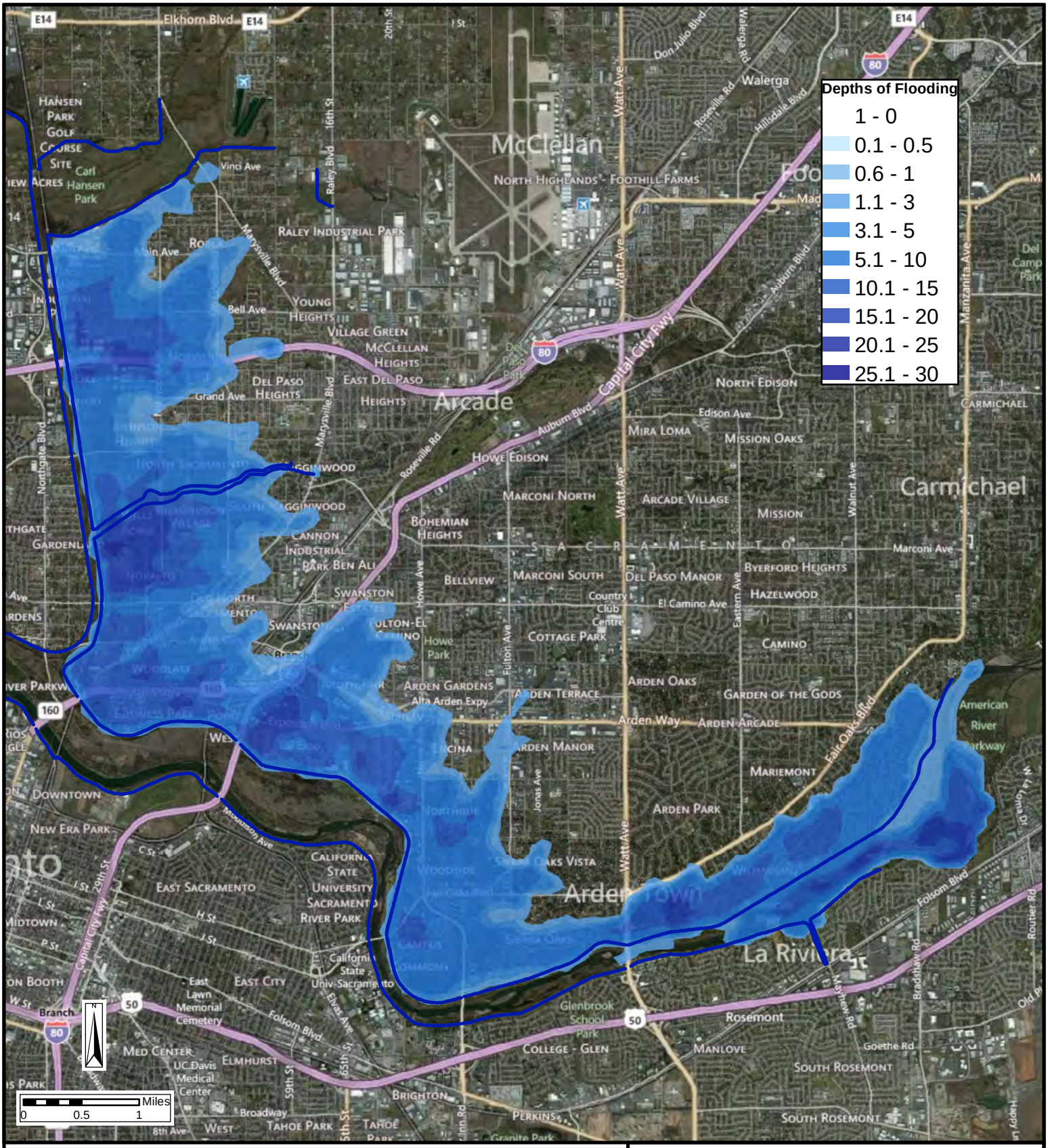
Miles
0 1.5 3

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

Economic Floodplains Based on a Levee Breach Simulation American River North Index Pt A.

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Jan 2013



Legend

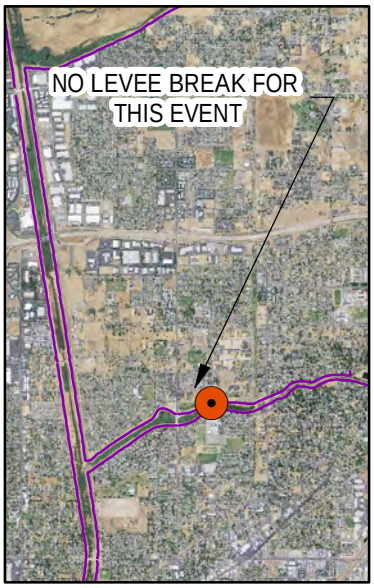
ARCF Levees

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

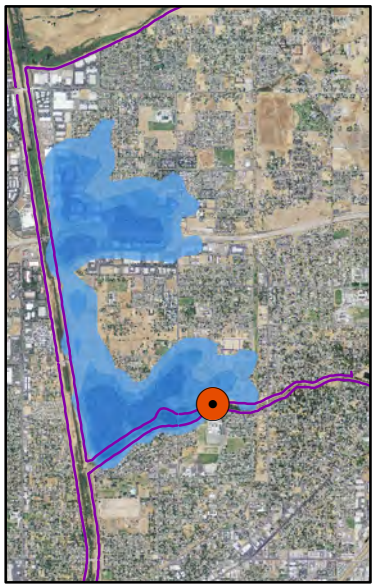
Residual Flooding From Upstream Channel Outflanking Into The American River Basin

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

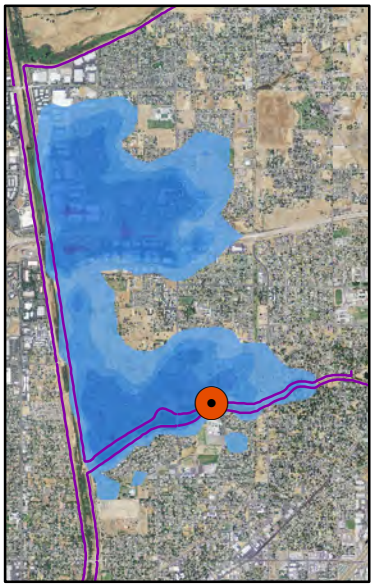
Jan 2013



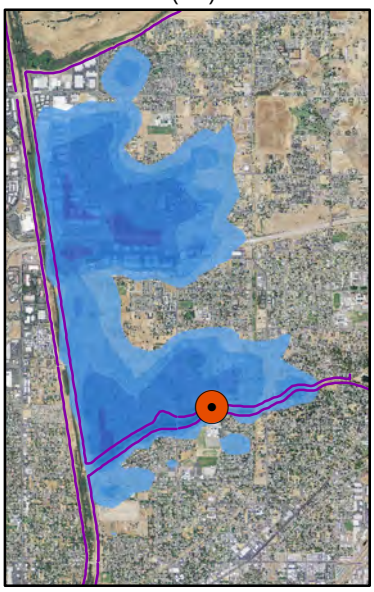
50% (1/2) ACE



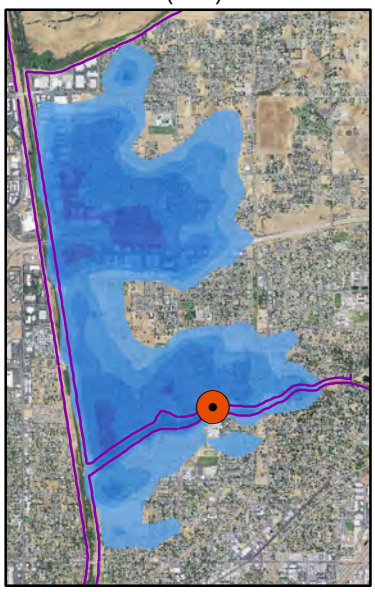
10% (1/10) ACE



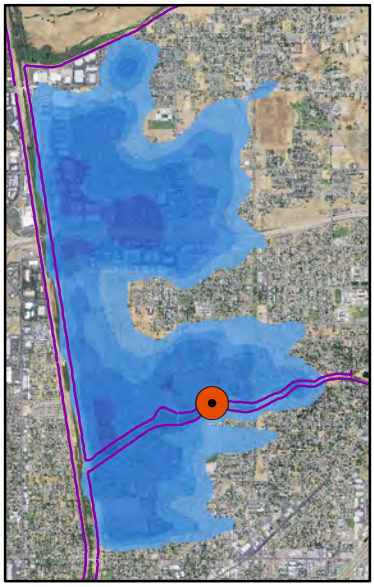
10% (1/25) ACE



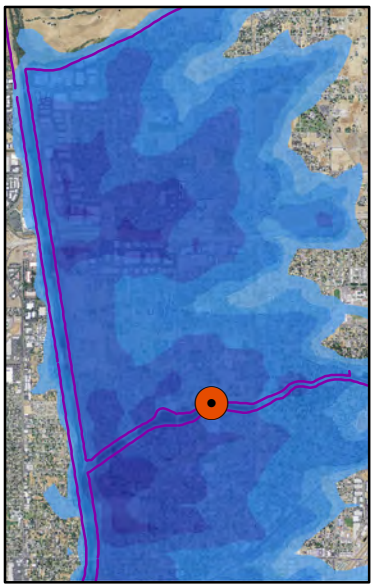
2% (1/50) ACE



1% (1/100) ACE



0.5% (1/200) ACE



0.2% (1/500) ACE

Legend

Depths of Flooding (Feet)

- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 3
- 3.1 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 - 30

STUDY AREA EXTENT

N

Miles

0 0.55 1.1

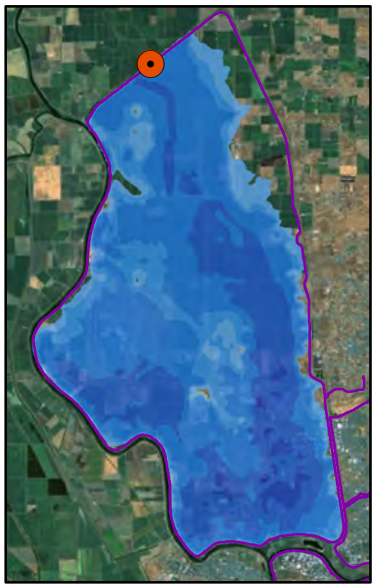
AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

Economic Floodplains Based on a Levee Breach Simulation American River North Index Pt E.

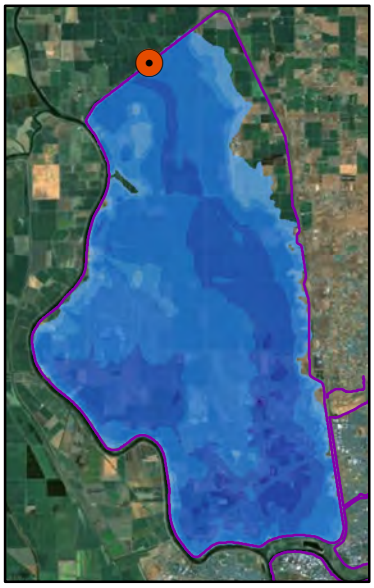
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Jan 2013

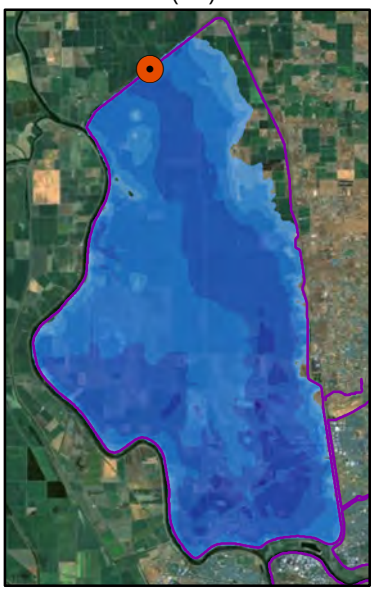
50% (1/2) ACE



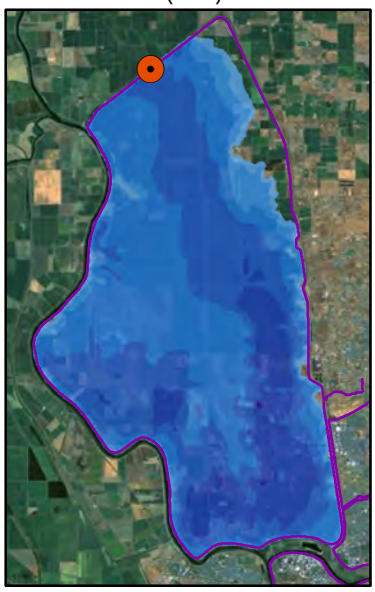
10% (1/10) ACE



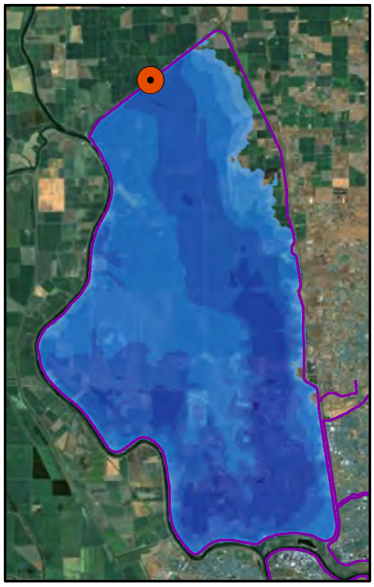
4% (1/25) ACE



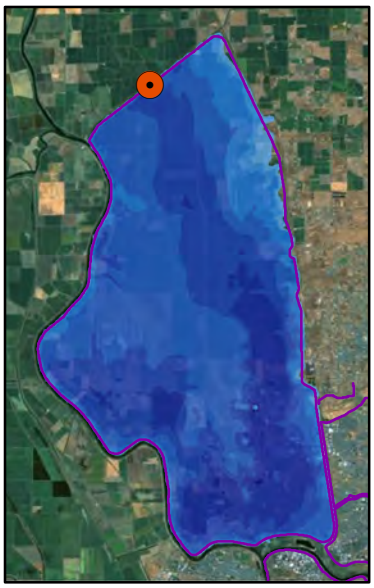
2% (1/50) ACE



1% (1/100) ACE



0.5% (1/200) ACE



0.2% (1/500) ACE

Legend

Depths of Flooding (Feet)

- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 3
- 3.1 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 - 30

N

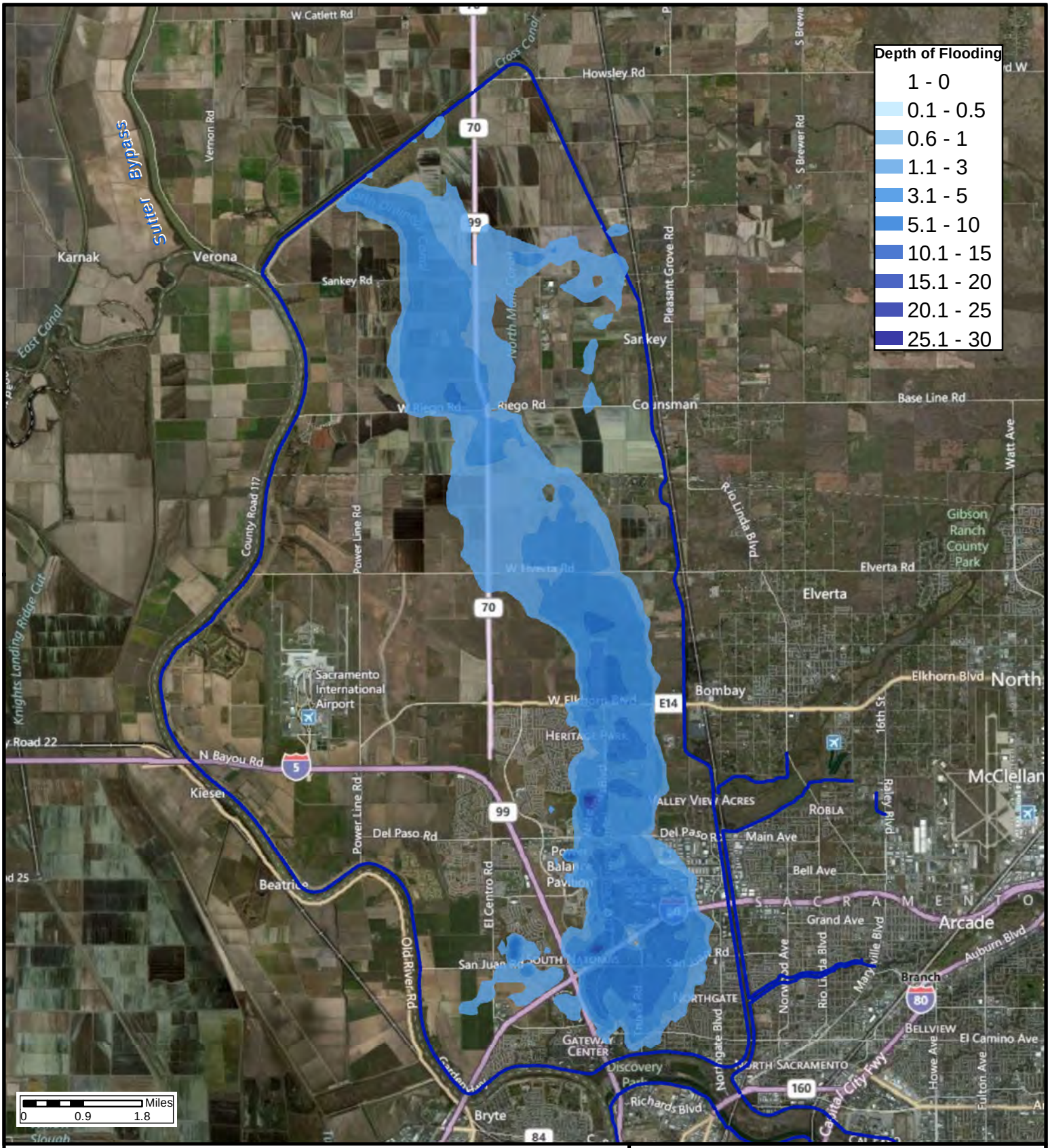
Miles

0 2.5 5

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

Economic Floodplains Based on a Levee Breach Simulation Natomas Basin Index Pt D.

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



Legend

ARCF Levees

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

Residual Flooding From Sankey Gap Into The Natomas Basin

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Jan 2013

ACF_JFP_RAISE

ARS

ARS_A

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	1423	24.05
2yr = .5	25977	31.85
10yr = .1	71654	41.98
25yr = .04	114993	48.01
50yr = .02	115000	48.07
100yr = .01	114999	48.15
200yr = .005	159995	53.22
500yr = .002	254357	58.1

ARS_F

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	52823	11.05
2yr = .5	94600	20.75
10yr = .1	100687	26.42
25yr = .04	115395	29.04
50yr = .02	118141	29.63
100yr = .01	121788	30.3
200yr = .005	133200	32.03
500yr = .002	152523	33.87

~~ARS~~

~~ARS_B~~

~~Frequency~~	~~Flow (cfs)~~	~~Stage (ft)~~
~~1yr = .999~~	~~1423~~	~~20.81~~
~~2yr = .5~~	~~25916~~	~~28.61~~
~~10yr = .1~~	~~71643~~	~~33.34~~
~~25yr = .04~~	~~114968~~	~~37.42~~
~~50yr = .02~~	~~114993~~	~~37.74~~
~~100yr = .01~~	~~114999~~	~~38.14~~
~~200yr = .005~~	~~144997~~	~~40.45~~
~~500yr = .002~~	~~195807~~	~~44.79~~

~~ARS_E~~

~~Frequency~~	~~Flow (cfs)~~	~~Stage (ft)~~
~~1yr = .999~~	~~52823~~	~~10.25~~
~~2yr = .5~~	~~94629~~	~~22.55~~
~~10yr = .1~~	~~100691~~	~~28.52~~
~~25yr = .04~~	~~115549~~	~~31.21~~
~~50yr = .02~~	~~118171~~	~~31.79~~
~~100yr = .01~~	~~121790~~	~~32.46~~
~~200yr = .005~~	~~130638~~	~~33.89~~
~~500yr = .002~~	~~148615~~	~~35.79~~

ARN

ARN_A

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	1690	23.25
2yr = .5	25968	31.05
10yr = .1	71653	40.47
25yr = .04	114992	46.57
50yr = .02	114999	46.65
100yr = .01	115000	46.74
200yr = .005	144996	49.96
500yr = .002	243028	56.28

ARN_E

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	-	26.92
2yr = .5	-	30.02
10yr = .1	-	33.02
25yr = .04	-	35.37
50yr = .02	-	37.77
100yr = .01	-	39.15
200yr = .005	-	41.46
500yr = .002	-	46.22

NAT

NAT_D

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	-	20.62
2yr = .5	-	33.62
10yr = .1	-	39
25yr = .04	-	41.53
50yr = .02	-	42.43
100yr = .01	-	43.49
200yr = .005	-	44.58
500yr = .002	-	45.2

Fix In Place Alternative

ARS

ARS_A

Frequency	Flow (cfs)	Stage (ft)	
1yr = .999	1423	24.05	
2yr = .5	25977	31.85	1.00
10yr = .1	71654	41.98	1.29
25yr = .04	114993	48.01	1.45
50yr = .02	115000	48.07	1.45
100yr = .01	114999	48.15	1.43
200yr = .005	159995	53.22	1.59
500yr = .002	254357	58.1	0.75

ARS_F

Frequency	Flow (cfs)	Stage (ft)	
1yr = .999	52823	11.05	
2yr = .5	94600	20.75	0.75
10yr = .1	100687	26.42	0.77
25yr = .04	115395	29.04	0.76
50yr = .02	118141	29.63	0.76
100yr = .01	121788	30.3	0.76
200yr = .005	133200	32.03	0.75
500yr = .002	152523	33.87	0.78

~~ARS~~

~~ARS_B~~

~~Frequency~~	~~Flow (cfs)~~	~~Stage (ft)~~
~~1yr = .999~~	~~1423~~	~~20.81~~
~~2yr = .5~~	~~25917~~	~~29.99~~
~~10yr = .1~~	~~71642~~	~~33.34~~
~~25yr = .04~~	~~114967~~	~~37.42~~
~~50yr = .02~~	~~114994~~	~~37.74~~
~~100yr = .01~~	~~114999~~	~~38.15~~
~~200yr = .005~~	~~159970~~	~~41.35~~
~~500yr = .002~~	~~177027~~	~~47.81~~

~~ARS_E~~

~~Frequency~~	~~Flow (cfs)~~	~~Stage (ft)~~
~~1yr = .999~~	~~52823~~	~~10.25~~
~~2yr = .5~~	~~94602~~	~~27.22~~
~~10yr = .1~~	~~100690~~	~~28.52~~
~~25yr = .04~~	~~115558~~	~~31.21~~
~~50yr = .02~~	~~118168~~	~~31.78~~
~~100yr = .01~~	~~121789~~	~~32.46~~
~~200yr = .005~~	~~133311~~	~~34.26~~
~~500yr = .002~~	~~161306~~	~~36.6~~

ARN

ARN_A

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	1690	23.25
2yr = .5	25969	32.43
10yr = .1	71653	40.47
25yr = .04	114991	46.16
50yr = .02	114999	46.24
100yr = .01	115000	46.34
200yr = .005	159998	51.2
500yr = .002	220684	55.91

ARN_E

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	-	26.98
2yr = .5	-	30.02
10yr = .1	-	33.1
25yr = .04	-	35.37
50yr = .02	-	37.73
100yr = .01	-	39.19
200yr = .005	-	41.41
500yr = .002	-	46.13

NAT

NAT_D

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	-	20.62
2yr = .5	-	33.62
10yr = .1	-	39
25yr = .04	-	41.53
50yr = .02	-	42.43
100yr = .01	-	43.49
200yr = .005	-	44.58
500yr = .002	-	45.52

Sacramento Bypass Widening (1500ft) Alternative

ARS

ARS_A

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	1439	24.05
2yr = .5	25998	31.85
10yr = .1	71655	41.78
25yr = .04	114990	47.88
50yr = .02	114999	47.94
100yr = .01	114999	48.02
200yr = .005	159982	53.04
500yr = .002	254410	58.1

ARS_F

Frequency	Flow (cfs)	Stage (ft)	
1yr = .999	47842	11.05	
2yr = .5	87375	20.75	0.75
10yr = .1	99631	25.97	0.77
25yr = .04	107204	27.86	0.76
50yr = .02	110188	28.52	0.76
100yr = .01	113973	29.33	0.76
200yr = .005	124750	30.93	0.75
500yr = .002	144263	33.36	0.78

ARN

ARN_A

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	1631	22.66
2yr = .5	25996	30.46
10yr = .1	71654	40.56
25yr = .04	114987	46.42
50yr = .02	114999	46.5
100yr = .01	114999	46.59
200yr = .005	159979	51.41
500yr = .002	215253	55.66

ARN_E

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	-	26.58
2yr = .5	-	29.35
10yr = .1	-	33.22
25yr = .04	-	34.75
50yr = .02	-	36.11
100yr = .01	-	38.63
200yr = .005	-	40.89
500yr = .002	-	45.22

NAT

NAT_D

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	-	20.46
2yr = .5	-	33.46
10yr = .1	-	38.86
25yr = .04	-	41.43
50yr = .02	-	42.34
100yr = .01	-	43.42
200yr = .005	-	44.55
500yr = .002	-	45.51

ARS

ARS_B

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	1439	19.55
2yr = .5	25992	27.35
10yr = .1	64302	32.7
25yr = .04	114928	36.72
50yr = .02	114992	37.07
100yr = .01	114995	37.5
200yr = .005	159901	40.71
500yr = .002	182206	46.79

ARS_E

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	47842	8.95
2yr = .5	87474	21.25
10yr = .1	100097	28.11
25yr = .04	107546	29.95
50yr = .02	110443	30.61
100yr = .01	114819	31.42
200yr = .005	124876	33.08
500yr = .002	146686	35.75

Basin ARS
Reach A
RM 9.08

Without Project

Crest Elev	56.05
L/S Toe Ele	46.75
W/S Toe El	45.93

WSE	Pr(f)
46.75	0
49.75	0.1531
51.4	0.2976
53.05	0.4562
56.05	0.6496

With Project
Alt 1

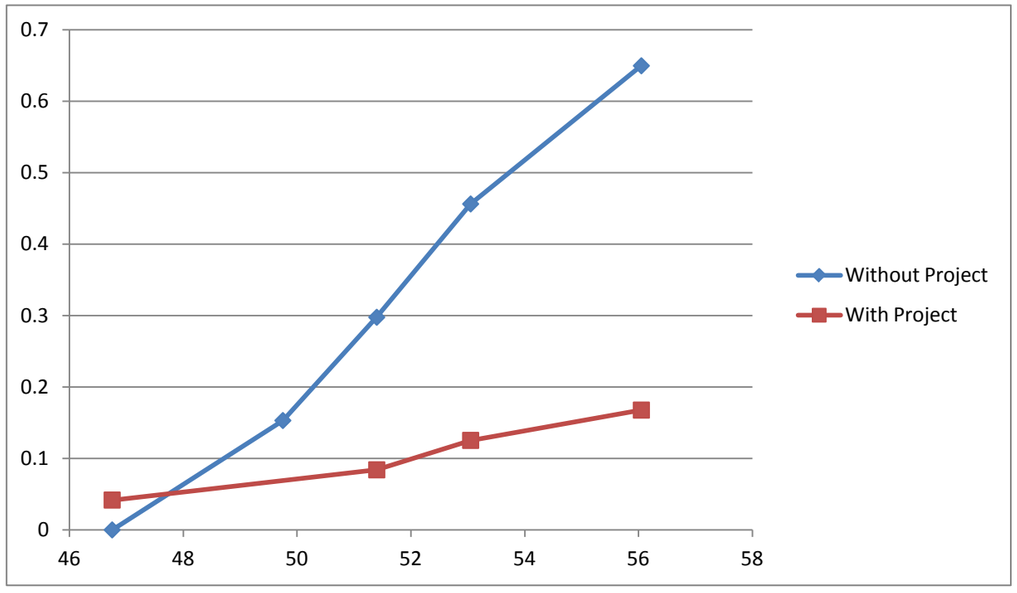
Crest Elev	56.05
L/S Toe Elev	46.75
W/S Toe Elev	45.93

	WSE	Pr(f)	
46.75			0
49.75	46.75	0.0418	0.0418
	51.4	0.0841	
	53.05	0.1253	
	56.05	0.1677	

With Project
Alt 2

Crest Elev	56.05
L/S Toe Elev	46.75
W/S Toe Elev	45.93

WSE	Pr(f)
46.75	0
49.75	0.0418
51.4	0.0841
53.05	0.1253
56.05	0.1677



1423	20.81	0
25977	33.23	0.83
71654	41.98	0.9
114967	48.01	1.01
114994	48.07	1
114999	48.15	0.95
159970	53.55	0.83
254357	58.1	0.75

Frequency	Flow (cfs)	Stage (ft)
1yr = .999	1423	24.05
2yr = .5	25977	31.85
10yr = .1	71654	41.98
25yr = .04	114993	48.01
50yr = .02	115000	48.07
100yr = .01	114999	48.15
200yr = .005	159995	53.22
500yr = .002	254357	58.1

Basin ARS
Reach F
RM 50.21

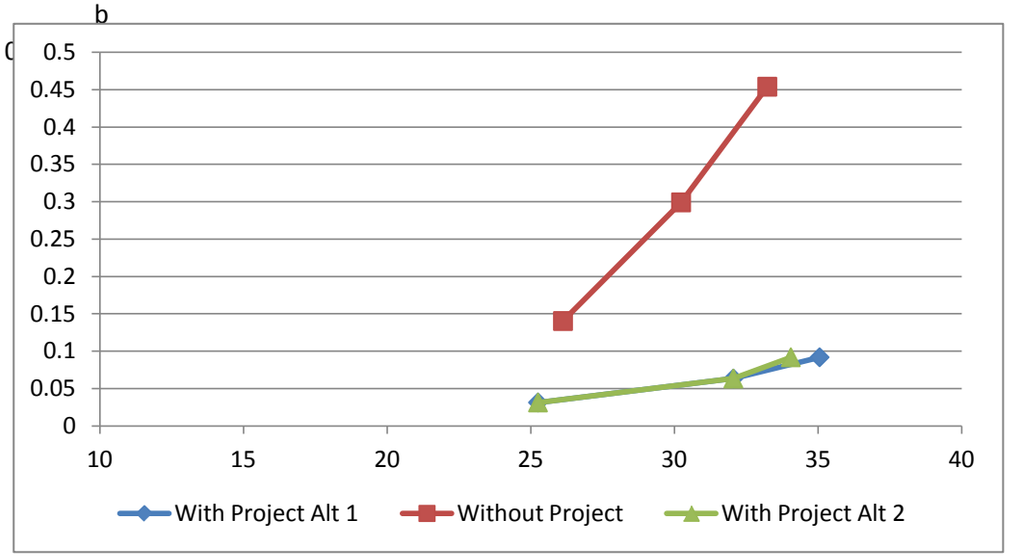
Without Project		With Project Alt 1		Testing Values	With Project Alt 2			
Crest Elev	33.23	Crest Elev	35.05		Crest Elev	34.05	1.82	0.82
L/S Toe Ele	19	L/S Toe Elev	15.45		L/S Toe Elev	15.45	Removes a 1 foot levee increase….	
W/S Toe El	22	W/S Toe Elev	21.05		W/S Toe Elev	21.05		

WSE	Pr(f)		WSE	Pr(f)			WSE	Pr(f)		
19		0	15.45		0	15.45			0	
22		0.0572	18.45	22	0.0107	18.45	22		0.0107	
26.12	0.1403		25.25	25.25	0.0313		25.25	0.0313		
30.23	0.2991		32.05	32.05	0.0633	0.1266	32.05	0.0633		
33.23	0.4539		35.05	35.05	0.0918	0.1836	34.05	0.0918	0.0823	Confirm Interpolation with Geotech!
							35.05	0.0918		

2SACNA3_RL	20.44	94600.12	22.55	94629.31		20.44
010SACN3_RL	26.41	100687.1	28.52	100690.5	2.11	25.41
025SACN3_RL	29.03	115394.1	31.21	115549	2.18	28.03
050SACN3_RL	29.62	118141.1	31.79	118171	2.17	28.62
100YR_SAC_RL	30.29	121788.3	32.46	121790	2.17	29.29
200YR_SAC_RL	32.02	133199.8	33.89	130637.5	1.87	31.02
500YR_SAC_RL	33.86	152522.8	35.79	148615.2	1.93	32.86

52823	11.05
94600	20.75
100687	26.42
115395	29.04
118141	29.63
121788	30.3
133200	32.03
152523	33.87

m b



Inflow-Outflow from Folsom

NA3 160

	1 in X chance	Inflow	Base Outflow	Min Outflow	Max Outflow
1	1.01569	5,000	2,000	2,000	4,242
2	1.2977	20,002	16,328	2,000	16,967
3	1.4393	25,004	20,411	2,000	21,210
4	1.5655	29,000	24,600	2,000	23,588
5	1.8517	37,002	26,005	2,000	27,464
6	2	40,722	25,215	8,916	30,225
7	5	90,369	44,261	50,000	54,221
8	10	136,522	71,655	65,753	81,913
9	15	167,533	115,000	84,559	115,000
10	20	191,482	115,000	115,000	115,000
11	25	211,227	115,000	115,000	115,000
12	35	243,016	115,000	115,000	115,000
13	50	279,485	115,000	115,000	115,000
14	65	308,218	115,000	115,000	115,000
15	80	332,148	115,000	115,000	115,000
16	100	359,078	115,000	115,000	115,000
17	130	392,399	160,000	115,000	160,000
18	150	411,351	160,000	160,000	160,000
19	175	432,395	160,000	160,000	160,000
20	200	451,163	160,000	160,000	160,000
21	225	468,139	160,000	160,000	172,840
22	250	483,665	193,667	160,000	202,925
23	325	523,757	297,943	214,967	320,734
24	400	556,967	405,477	310,772	430,723
25	500	594,159	534,386	420,080	558,062

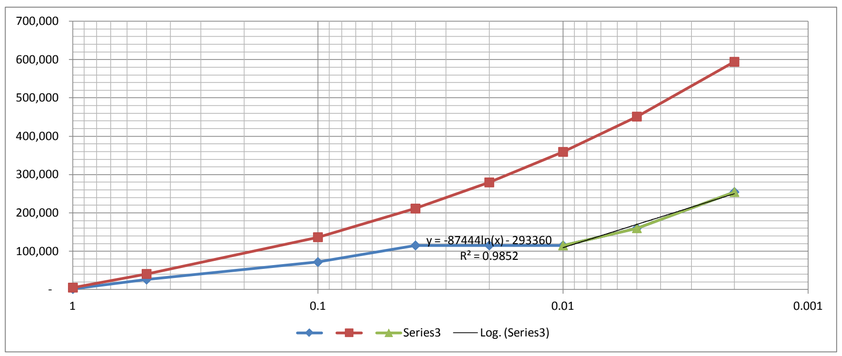
Converted Outflow to indexpoint location.

Frequency	1 in X chance per year	Inflow (cfs)	Outflow (cfs)	Min Outflow (cfs)	Max Outflow (cfs)
1yr = .999	1.01569	5,000	1,423	1,000	4,242
	1.2977	20,002	16,328	2,000	16,967
	1.4393	25,004	20,411	2,000	21,210
	1.5655	29,000	23,588	2,000	24,600
	1.8517	37,002	26,005	2,000	27,464
2yr = .5	2	40,722	25,977	8,916	30,225
	5	90,369	44,261	40,000	54,221
10yr = .1	10	136,522	71,654	65,753	81,913
	15	167,533	115,000	84,559	115,000
	20	191,482	115,000	115,000	115,000
25yr = .04	25	211,227	114,993	115,000	115,000
	35	243,016	115,000	115,000	115,000
50yr = .02	50	279,485	115,000	115,000	115,000
	65	308,218	115,000	115,000	115,000
	80	332,148	115,000	115,000	115,000
100yr = .01	100	359,078	115,000	115,000	115,000
	130	392,399	159,990	115,000	160,000
	150	411,351	160,000	160,000	160,000
	175	432,395	160,000	160,000	160,000
200yr = .005	200	451,163	160,000	152,705	167,295
	225	468,139	160,000	160,000	172,840
	250	483,665	189,459	160,000	202,925
	325	523,757	212,401	193,667	223,666
	400	556,967	230,558	193,667	244,407
500yr = .002	500	594,159	254,357	193,667	265,148

0.999	1yr = .999	5000	1,423
0.5	2yr = .5	40722	25,977
0.1	10yr = .1	136522	71,654
0.04	25yr = .04	211227	114,993
0	50yr = .02	279485	115,000
0.01	100yr = .01	359078	115,000
0.005	200yr = .005	451163	160,000
0.002	500yr = .002	594159	254,357

m b

-31452333 (84,634,547.23)



62,223

20,741.07

160,000
180,000
215,000
235,000

0.01	115,000		
0.005	160,000		
0.002	254,357		

200	0.005	169,946	
225	0.004444	180,245	
250	0.004	189,459	180,000
325	0.003077	212,401	
400	0.0025	230,558	
500	0.002	250,070	

= -87444ln(x) - 293360

-87444 293360

F3 (Without-Project) Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

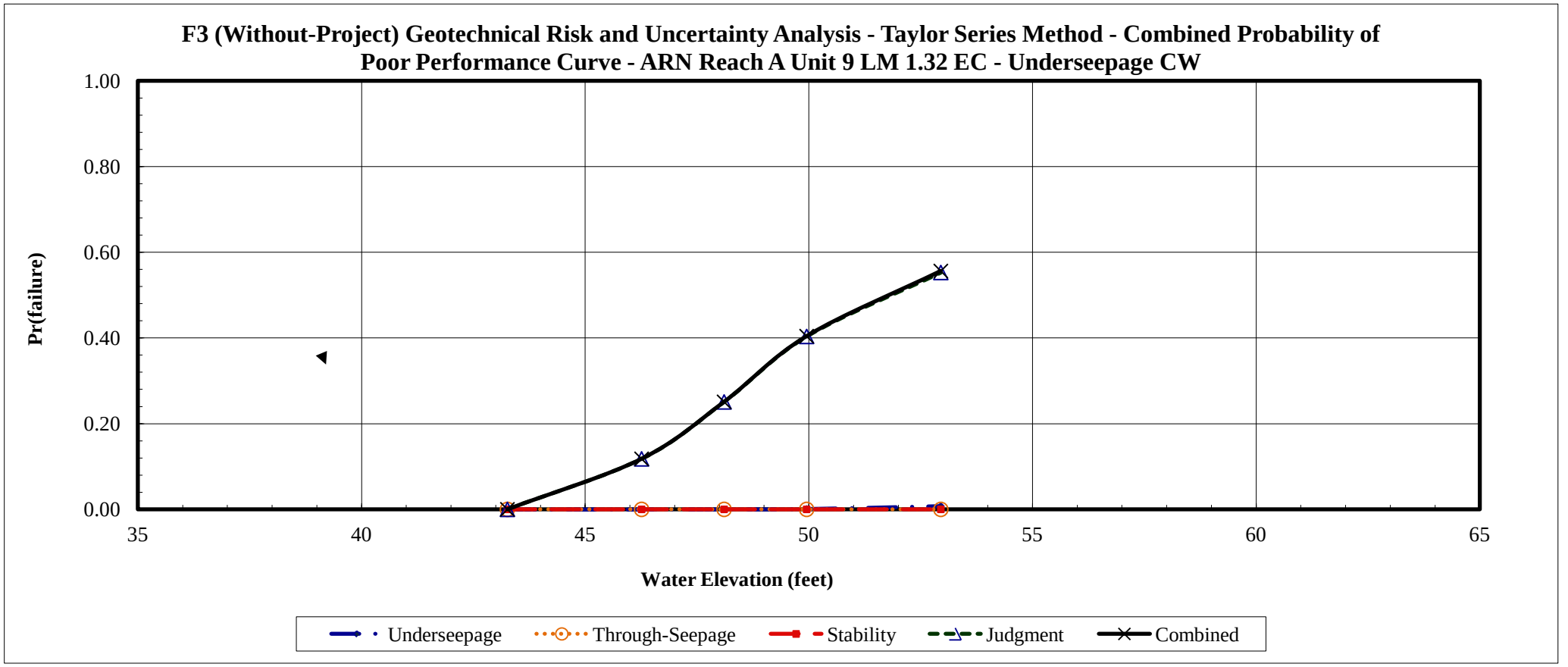
Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

Levee Mile: 1.32
River Mile: 7.82
Analysis Case: EC - Underseepage CW

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
43.26	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
46.26	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.1179	0.8821	0.1179	0.8821
48.11	0.0002	0.9998	0.0000	1.0000	0.0000	1.0000	0.2507	0.7493	0.2509	0.7491
49.95	0.0010	0.9990	0.0000	1.0000	0.0000	1.0000	0.4036	0.5964	0.4042	0.5958
52.95	0.0076	0.9924	0.0000	1.0000	0.0000	1.0000	0.5528	0.4472	0.5562	0.4438



F3 (Without-Project) Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

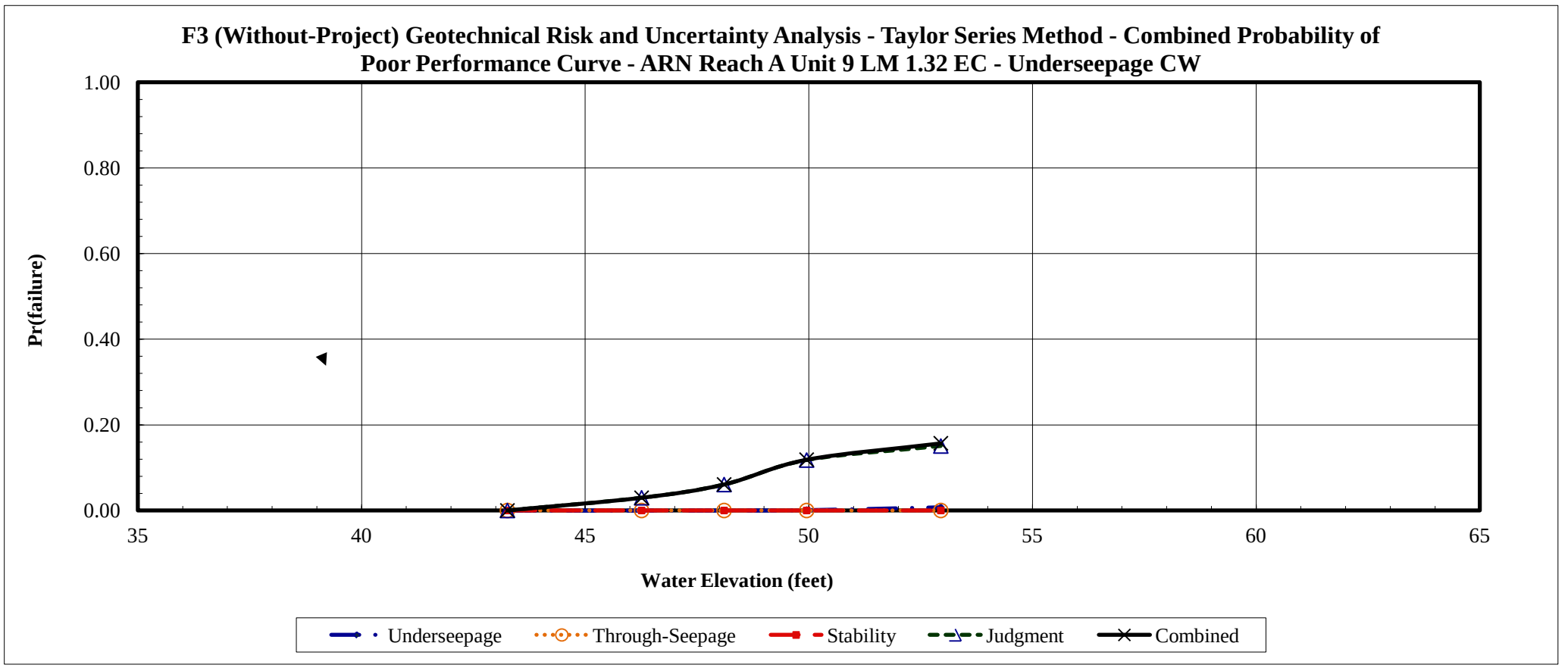
Project: American River Common Features GRR
Study Area: American River
River Section: ARN Reach A Unit 9

Levee Mile: 1.32
River Mile: 7.82
Analysis Case: EC - Underseepage CW

Crest Elev.: 52.95
L/S Toe Elev.: 43.26
W/S Toe Elev.: 40.62

Analysis By: A. Deus
Checked By: H. Mulder
Date: 7/5/2012

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
43.26	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
46.26	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0297	0.9703	0.0297	0.9703
48.11	0.0002	0.9998	0.0000	1.0000	0.0000	1.0000	0.0606	0.9394	0.0607	0.9393
49.95	0.0010	0.9990	0.0000	1.0000	0.0000	1.0000	0.1178	0.8822	0.1186	0.8814
52.95	0.0076	0.9924	0.0000	1.0000	0.0000	1.0000	0.1506	0.8494	0.1570	0.8430



F3 (Without-Project) Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

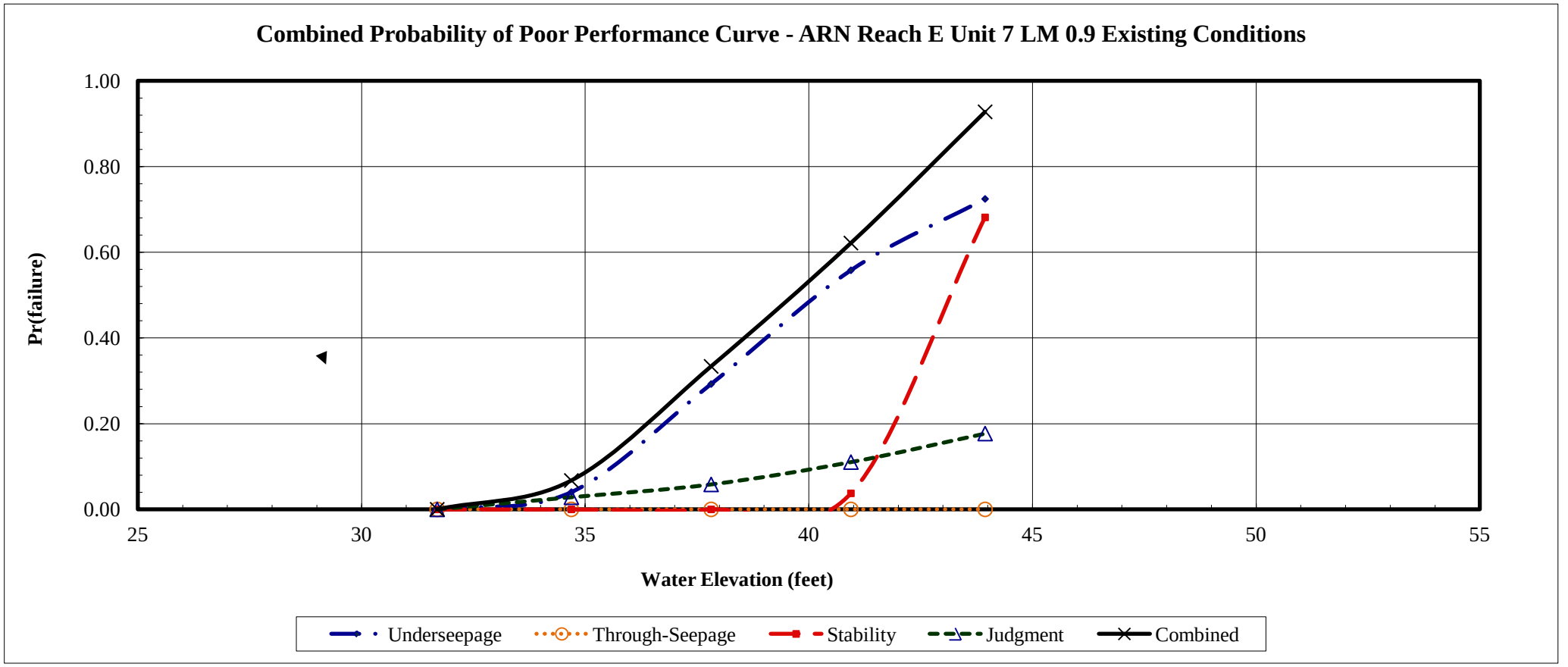
Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

Levee Mile: 0.90
River Mile: 0.88
Analysis Case: Existing Conditions

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
31.69	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
34.69	0.0403	0.9597	0.0000	1.0000	0.0000	1.0000	0.0282	0.9718	0.0674	0.9326
37.82	0.2925	0.7075	0.0000	1.0000	0.0000	1.0000	0.0582	0.9418	0.3337	0.6663
40.94	0.5580	0.4420	0.0000	1.0000	0.0374	0.9626	0.1103	0.8897	0.6215	0.3785
43.94	0.7245	0.2755	0.0000	1.0000	0.6814	0.3186	0.1769	0.8231	0.9278	0.0722



F3 (Without-Project) Geotechnical Risk and Uncertainty Analysis - Taylor Series Method
Combined Probability of Poor Performance Curve

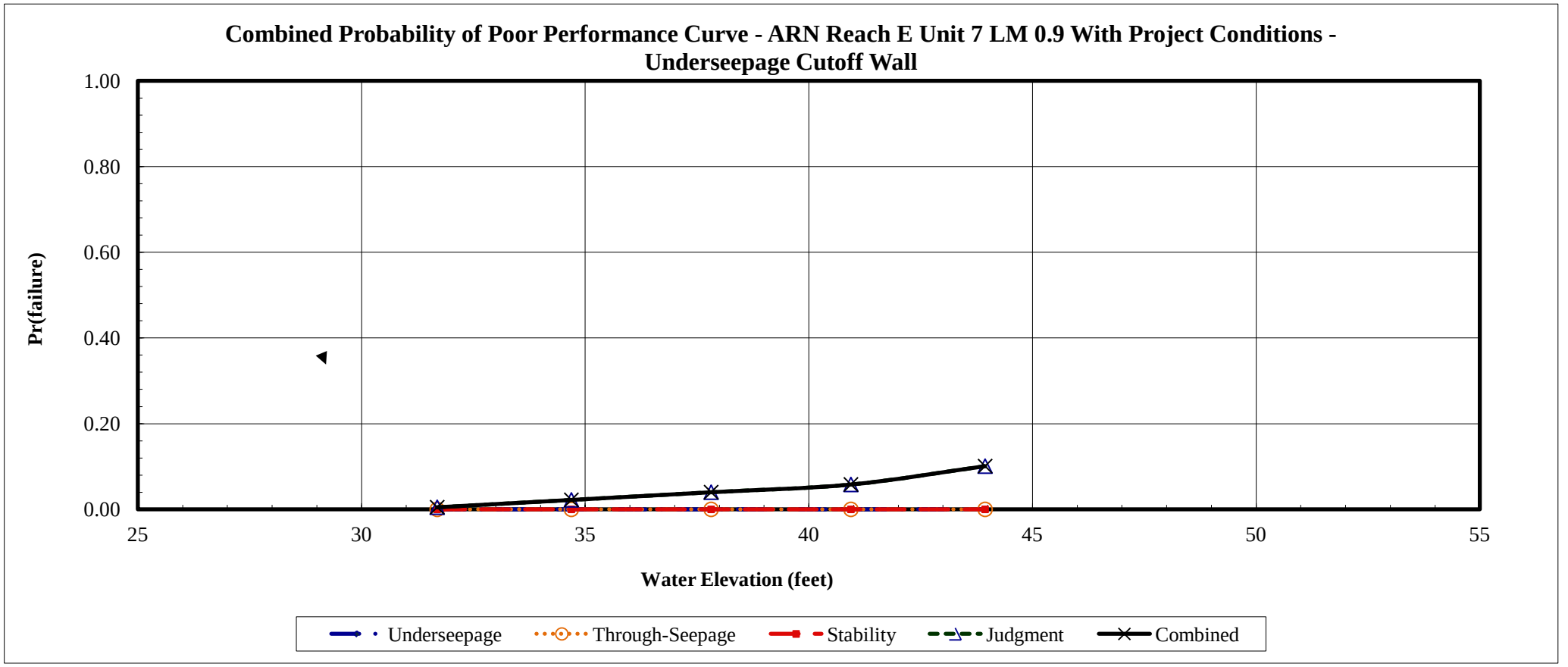
Project: American River Common Features GRR
Study Area: Arcade Creek North
River Section: ARN Reach E Unit 7

Levee Mile: 0.90
River Mile: 0.88
Analysis Case: With Project Conditions - Underse

Crest Elev.: 43.94
L/S Toe Elev.: 31.69
W/S Toe Elev.: 26.77

Analysis By: M. Kynett
Checked By: H. Mulder
Date: 4/29/2011

Water Surface Elevation	Underseepage		Through-Seepage		Stability		Judgment		Combined	
	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R	Pr(f)	R
31.69	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0050	0.9950	0.0050	0.9950
34.69	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0222	0.9778	0.0222	0.9778
37.82	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0401	0.9599	0.0401	0.9599
40.94	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0581	0.9419	0.0581	0.9419
43.94	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.1009	0.8991	0.1009	0.8991



American River Common Features GRR
Attachments to Economic Appendix

Attachment 2 – Certified Construction Cost Estimates for Alternatives 1 & 2.

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

SPK - PN 149827
American River Common Features GRR
Sacramento, CA

The American River Common Features GRR, as presented by the Sacramento District, has undergone a successful Cost Agency Technical Review (Cost ATR) of remaining costs, performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the cost products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of December 3, 2015, the Cost MCX certifies the estimated total project costs:

Alternative 1 - NED Plan:

Total First Costs:	$1,343,992,000 (Cost ATR Certified) *****
Fully Funded Costs:	$1,597,400,000 *

Alternative 2 - LPP Plan:

Total First Costs:	$1,565,750,000 (Cost ATR Certified) *****
Fully Funded Costs:	$1,851,993,000 *

***** Spent Costs Not Included. "Per direction from HQUSACE, the proposed elements of the American River Common Features GRR should be considered separate from the previously authorized portions including the work constructed using the WRDA 1996 and 1999 authorities as well as the Natomas levee improvements authorized by WRDDA 2014. Both cost sharing and the Section 902 limit would be established individually for the WRDA 96/99 features, for the WRRDA 2014 features, and for the GRR recommended plan."

Note: Cost ATR was devoted to remaining work. It did not review spent costs, which requires an audit process. It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.

JACOBS.MICHAEL.PIERRE.1160569537

Digitally signed by JACOBS.MICHAEL.PIERRE.1160569537
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=JACOBS.MICHAEL.PIERRE.1160569537
Date: 2015.12.03 09:29:54 -08'00'

Kim C. Callan, PE, CCE, PM
Chief, Cost Engineering MCX
Walla Walla District

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: American River Common Features GRR - Alt 1 - NED
PROJECT NO: P2 # 149827
LOCATION: Sacramento, CA

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

This Estimate reflects the scope and schedule in report; Feasibility Report

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)							TOTAL PROJECT COST (FULLY FUNDED)			
							Program Year (Budget EC): 2016										
							Effective Price Level Date: 1 OCT 15				Spent Thru:	TOTAL FIRST					
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	10/1/2014 ($K)	COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)	
A	B		C	D	E	F	G	H	I	J				M	N	O	
02	RELOCATIONS *		$101,612	$27,435	27%	$129,048	0.8%	$102,411	$27,651	$130,062	$0	$130,062	22.8%	$125,718	$33,944	$159,661	
06	FISH & WILDLIFE FACILITIES	Construction	$19,020	$5,135	27%	$24,156	0.4%	$19,103	$5,158	$24,261	$0	$24,261	20.5%	$23,017	$6,215	$29,232	
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$48,413	$13,071	27%	$61,484	0.4%	$48,624	$13,128	$61,752	$0	$61,752	15.1%	$55,972	$15,112	$71,084	
11	LEVEES & FLOODWALLS	Levees	$298,680	$80,643	27%	$379,323	0.4%	$299,871	$80,965	$380,836	$0	$380,836	17.3%	$351,674	$94,952	$446,626	
16	BANK STABILIZATION		$292,672	$79,021	27%	$371,694	1.8%	$297,828	$80,414	$378,242	$0	$378,242	14.7%	$341,678	$92,253	$433,931	
	CONSTRUCTION ESTIMATE TOTALS:		$760,397	$205,307		$965,705	1.0%	$767,837	$207,316	$975,153	$0	$975,153	17.0%	$898,059	$242,476	$1,140,535	
01	LANDS AND DAMAGES		$88,537	$38,715	44%	$127,253	0.6%	$89,028	$38,930	$127,958	$0	$127,958	12.8%	$100,492	$43,908	$144,399	
30	PLANNING, ENGINEERING & DESIGN *		$119,772	$32,338	27%	$152,110	2.3%	$122,529	$33,083	$155,611	$0	$155,611	27.6%	$156,388	$42,225	$198,613	
31	CONSTRUCTION MANAGEMENT *		$59,291	$16,009	27%	$75,300	2.3%	$60,656	$16,377	$77,033	$0	$77,033	35.8%	$82,356	$22,236	$104,592	
18	CULTURAL RESOURCE PRESERVATION		$6,550	$1,768	27%	$8,318	0.8%	$6,486	$1,751	$8,237	$0	$8,237	12.4%	$7,292	$1,969	$9,260	
	PROJECT COST TOTALS:		$1,034,548	$294,138	28%	$1,328,686		$1,046,535	$297,457	**$1,343,992**	$0	**$1,343,992**	18.9%	$1,244,586	$352,813	$1,597,400	

Mandatory by Regulation	CHIEF, COST ENGINEERING, Jeremiah Frost		
Mandatory by Regulation	PROJECT MANAGER, Dan Tibbitts	ESTIMATED FEDERAL COST:	**65% $1,038,310**
Mandatory by Regulation	CHIEF, REAL ESTATE, Stan Wallin	ESTIMATED NON-FEDERAL COST:	**35% $559,090**
	CHIEF, PLANNING, Alicia Kirchner	**ESTIMATED TOTAL PROJECT COST:**	**$1,597,400**
	CHIEF, ENGINEERING, Rick Poeppelman		
	CHIEF, OPERATIONS, Randy Olsen		
	CHIEF, CONSTRUCTION, Norbert Suter		
	CHIEF, CONTRACTING, Kim Ford		
	CHIEF, PM-PB, Mary Evans		
	CHIEF, DPM, Tambour Eller		

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account.

for

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: American River Common Features GRR - Alt 2 - LPP
PROJECT NO: P2 # 149827
LOCATION: Sacramento, CA

DISTRICT: SPK - Sacramento District PREPARED: 11/20/2015
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

This Estimate reflects the scope and schedule in report; Feasibility Report

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)							TOTAL PROJECT COST (FULLY FUNDED)			
							Program Year (Budget EC): 2016										
							Effective Price Level Date: 1 OCT 15				Spent Thru:	TOTAL FIRST					
WBS NUMBER	Civil Works Feature & Sub-Feature Description		COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	10/1/2014 ($K)	COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)	
A	B		C	D	E	F	G	H	I	J				M	N	O	
02	RELOCATIONS *		$122,813	$34,388	28%	$157,201	0.8%	$123,779	$34,658	$158,437	$0	$158,437	21.4%	$150,279	$42,078	$192,357	
06	FISH & WILDLIFE FACILITIES	Construction	$19,020	$5,326	28%	$24,346	0.4%	$19,103	$5,349	$24,452	$0	$24,452	20.5%	$23,017	$6,445	$29,462	
06	FISH & WILDLIFE FACILITIES	Mitigation and compensation	$55,826	$15,631	28%	$71,457	0.4%	$56,069	$15,699	$71,768	$0	$71,768	14.7%	$64,294	$18,002	$82,297	
08	ROADS, RAILROADS & BRIDGES		$20,073	$5,620	28%	$25,693	0.4%	$20,155	$5,643	$25,798	$0	$25,798	5.1%	$21,192	$5,934	$27,126	
11	LEVEES & FLOODWALLS	Levees	$362,348	$101,458	28%	$463,806	0.4%	$363,794	$101,862	$465,656	$0	$465,656	16.6%	$424,199	$118,776	$542,975	
16	BANK STABILIZATION		$292,672	$81,948	28%	$374,620	1.8%	$297,828	$83,392	$381,220	$0	$381,220	14.7%	$341,678	$95,670	$437,347	
15	FLOODWAY CONTROL & DIVERSION STRUCTURE		$42,316	$11,849	28%	$54,165	0.4%	$42,501	$11,900	$54,401	$0	$54,401	13.9%	$48,391	$13,549	$61,941	
	CONSTRUCTION ESTIMATE TOTALS:		$915,069	$256,219		$1,171,289	0.9%	$923,228	$258,504	$1,181,732	$0	$1,181,732	16.2%	$1,073,050	$300,454	$1,373,504	
01	LANDS AND DAMAGES		$71,078	$24,255	34%	$95,333	0.6%	$71,472	$24,389	$95,862	$0	$95,862	14.2%	$81,345	$28,148	$109,494	
30	PLANNING, ENGINEERING & DESIGN *		$142,464	$39,890	28%	$182,354	2.3%	$145,743	$40,808	$186,551	$0	$186,551	25.4%	$182,808	$51,186	$233,994	
31	CONSTRUCTION MANAGEMENT *		$71,303	$19,965	28%	$91,268	2.3%	$72,944	$20,424	$93,368	$0	$93,368	34.7%	$98,235	$27,506	$125,741	
18	CULTURAL RESOURCE PRESERVATION		$6,550	$1,768	27%	$8,318	0.8%	$6,486	$1,751	$8,237	$0	$8,237	12.4%	$7,292	$1,969	$9,260	
	PROJECT COST TOTALS:		$1,206,465	$342,097	28%	$1,548,562		$1,219,873	$345,877	**$1,565,750**	$0	**$1,565,750**	18.3%	$1,442,730	$409,263	$1,851,993	

Mandatory by Regulation	CHIEF, COST ENGINEERING, Jeremiah Frost		
		ESTIMATED FEDERAL COST:	**56%** **$1,038,310**
Mandatory by Regulation	PROJECT MANAGER, Dan Tibbitts	ESTIMATED NON-FEDERAL COST:	**44%** **$813,683**
Mandatory by Regulation	CHIEF, REAL ESTATE, Stan Wallin	**ESTIMATED TOTAL PROJECT COST:**	**$1,851,993**
	CHIEF, PLANNING, Alicia Kirchner		
	CHIEF, ENGINEERING, Rick Poeppelman		
	CHIEF, OPERATIONS, Randy Olsen		
	CHIEF, CONSTRUCTION, Norbert Suter		
	CHIEF, CONTRACTING, Kim Ford		
	CHIEF, PM-PB, Mary Evans		
	CHIEF, DPM, Tambour Eller		

* Non-Fed 30 and 31 Account Costs associated with Relocations are summarized in 02 - Relocations Account.

American River Common Features GRR
Attachments to Economic Appendix

Attachment 3 - Other Social Effects (OSE) & Regional Economic Development (RED) Analyses

ATTACHMENT 3
AMERICAN RIVER COMMON FEATURES GRR
ECONOMICS APPENDIX
OTHER SOCIAL EFFECTS (OSE) & REGIONAL ECONOMIC DEVELOPMENT (RED)
DECEMBER 2015

A. INTRODUCTION

In the past, planning studies at the Corps of Engineers have focused primarily on the National Economic Development (NED) account to formulate and evaluate water resource infrastructure projects. In recent years, however, there has been a renewed emphasis on considering the Other Social Effects (OSE), Regional Economic Development (RED), and Environmental Quality (EQ) accounts when making investment decisions, as can be seen in the publication of Engineering Circular (EC) 1105-2-409, "Planning in a Collaborative Environment." EC 1105-2-409 encourages the use of all four accounts in order to develop water resource solutions that are more holistic and acceptable, and which take into account both national and local stakeholder interests.

The following sections describe the OSE and RED assessments developed for the American River Common Features GRR. (The EQ assessment is described in the main planning document.)

B. OTHER SOCIAL EFFECTS (OSE)

Purpose and Methodology

The OSE assessment is intended to provide a portrait of the social landscape of the American River Common Features study area and offer a glimpse into the potential vulnerability of the people that live there. In essence, the questions the OSE account tries to answer are:

How are social connectedness, community social capital, and community resiliency likely to change in the absence of a solution to a water resource issue? How are vulnerable populations likely to be affected?

The metrics commonly used to answer these questions include:

- Social connectedness, which can be described using gender, race and ethnicity, age, rural versus urban communities, rental versus owner-occupied dwellings, and occupation
- Community social capital, which can be described using education, family structure, rural vs. urban communities, and population growth
- Community resilience, which can be described using income, political power, neighborhood prestige, employment loss, residential property characteristics, infrastructure and lifelines, family structure, and medical services

The assessment compares the other social effects associated with the without-project and with-project conditions. The 1% annual chance exceedance (ACE) floodplain serves as the baseline to assess effects.

References

- *Planning Guidance Notebook* (ER 1105-2-100)
- *Handbook on Applying "Other Social Effects" Factors in Corps of Engineers Water Resources Planning* (IWR 09-R4)
- *Planning in a Collaborative Environment*, (EC) 1105-2-409
- *Levee Screening Tool: Methodology and Application* (November 2011, RMC-CPD-1)
- *Social Vulnerability to Environmental Hazards (*Social Science Quarterly, Volume 84, Number 2, June 2003)
- *Economic Reevaluation Report, American River Watershed Project, CA, Folsom Dam Modification and Folsom Dam Raise Projects, Appendix D-Attachment V, Other Social Effects (May 2007)*

Early History of the Sacramento Area

The area that is now Sacramento was once inhabited, possibly for thousands of years, by the Nisenan (Southern Maidu) and Plains Miwok Native Americans. Sadly, there is little evidence of their existence in the area.

Gabriel Moraga, who was a Spanish explorer, is credited with naming the Sacramento Valley and the Sacramento River sometime near the turn on the 19th century. In 1839, pioneer John Sutter came from Liestal, Switzerland with other settlers and established a trading colony and stockade (Sutter's Fort) as New Helvetia (or "New Switzerland") soon after his arrival. In 1847, Sutter received 2,000 fruit trees, which marked the beginning of the Sacramento Valley's agricultural industry.

The town's population began to increase as more people came to the area in seek of gold, first discovered by James W. Marshall in 1848 at Sutter's Mill in the town of Coloma, which is about 50 miles northeast of Sutter's Fort (in what is now the mid-town area of Sacramento). John Sutter, Jr., along with Sam Brannan, planned the City of Sacramento and named it after the Sacramento River primarily for commercial reasons. They hired William H. Warner, who was a topographical engineer, to draft the official layout of the city. The boundary of the original city layout extended from C Street in the north to Broadway Avenue in the south and to Front Street in the west to Alhambra Boulevard in the east. Today, the city of Sacramento also includes many adjacent suburbs north (across the American River), east, and south of the original city boundary. In 1849, a city charter was adopted by the citizens, and in 1850 the charter was recognized by the State legislature. Sacramento became the first incorporated city in the state of California.

The capital of California under Spanish (and then Mexican) rule had been Monterey. The capital then moved several times – first to San Jose (1851), then to Vallejo (1852), then to Benicia (1853), and then finally to Sacramento (1854), which was named the permanent state capital in 1879. With a new status and a strategic location, the city of Sacramento quickly prospered. Most significantly, it became the western end of the Pony Express as well as the western terminus of the First Transcontinental Railroad.

The city of Sacramento has a long history of flooding. In 1850 and 1861 devastating floods crippled the city causing widespread disease such as cholera and the flu. Between 1862 and the mid-1870s, the City of Sacramento raised the level of its downtown to protect itself from flooding by building reinforced brick walls and filling the resulting street walls with dirt. What used to be the first floor of buildings had

now become its basements. (This perhaps may have been the first major non-structural flood risk management project in the city?)

Ironically, the same two rivers that devastated the city in the past would also prove to be key elements in the economic success of the city as commerce on both the Sacramento and American Rivers increased. The city effectively controlled the commerce on the rivers and benefitted from levying taxes on the goods unloaded from the boats. The tax income helped to fund many public works projects in the city.

The city has grown tremendously since the early days of the 1800s. In 1850, the population of the city was around 6,820. Today, the population in the city is over 475,000. The entire Sacramento metropolitan area is home to about 2.2 million people.

Current Social Landscape

Describing the social landscape of the area provides an understanding of who lives in the study area, who has a stake in the problem or issue, and why it is important to them. A demographic profile of the area is performed using social statistics, and the information is presented in a meaningful way through the use of comparisons and rankings. It is important to note that the profile itself is not an OSE analysis but rather a data collection step that provides a basic level of understanding about the social conditions in the area; the data provides input into a more in-depth analysis that targets areas of special concern or relevance to the water resources issue at hand. The basic social statistics discussed below and listed in Table 1 are indicators used to portray basic information about the social life and the processes of the study area.

The city of Sacramento, which lies within the American River Common Features study area, is home to nearly half a million people; the greater metropolitan statistical area (Sacramento/Arden/Arcade/Roseville), which includes Sacramento, Yolo, Placer, and El Dorado counties, is home to approximately 2.2 million people. The region has experienced tremendous growth over the last 10 to 15 years as an influx of people have moved to the area to take advantage of the relatively affordable home prices as well as the many amenities the region has to offer. Between 2000 and 2010, the city of Sacramento experienced a population increase of about 15%. The people that have moved here over the years represent many different races and ethnicities, bringing increased diversity to the area. For example, the city has seen an increase of about 15% and 25% in the Asian and Hispanic populations, respectively. This increase in the Asian and Hispanic populations may also explain the increase in the percentage of people who speak a language other than English at home; this percentage has increased approximately 13%, from about 33% of the population in 2000 to about 37% in 2010.

Additionally, based on the 2010 Census, the people that have settled in the area over the past decade have achieved greater levels of formal education, with about 29% having at least a bachelor's degree (compared to only about 24% in 2000); this is an increase of approximately 23%.

Finally, between the 2000 and 2010 Census, the data indicate that the city has experienced increased poverty and unemployment, more so than the state of California as a whole. In 2010, the unemployment rate in the city was nearly 14%, which is almost three times higher than in 2000 (4.7%). At the same time, the percentage of people living below the poverty level also increased from about 15.3% in 2000 to over 20% in 2010. Since the 2010 Census, however, the economy in the region has improved significantly and the unemployment rate has come down.

Key statistics are presented in Table 1 below.

Table 1: Basic Social Characteristic of the American River Common Features Study Area - 2000 and 2010 Census Data

Social Statistic	Sacramento			California		
	2000	2010	% Δ	2000	2010	% Δ
Population	407,018	466,488	+15%	33,871,648	37,253,956	+10%
Age						
Median	32.8	33	+1%	33.3	35.2	+5.7%
% >65	11.4%	10.6%	-7%	10.6%	11.4%	+7.5%
% <18	27.3%	24.9%	-8.8%	27.3%	25.0%	-8.4%
Race & Ethnicity						
Asian	16.6%	18.3%	+10%	10.9%	12.8%	+17.4%
Black	15.5%	14.6%	-7%	6.7%	5.8%	-13.4%
Hispanic	21.6%	26.9%	+24.5%	32.4%	37.6%	+16%
White	40.5%	34.5%	-15%	46.7%	40.1%	-14.1%
Other	5.8%	5.7%	-1.8%	4.3%	3.7%	+86%
Education						
% HS Graduates	77.3%	82.1%	+6.2%	81%	80.8%	-0.2%
% College Graduates	23.9%	29.4%	+23%	30.5%	30.2%	-0.9%
Income and Poverty						
% Unemployed	4.7%	13.9%	+296%	4.3%	7.1%	+65%
Median Household Income	37,049	50,661	+36.7%	$61,400	$61,632	0%
% Below Poverty	15.3%	20.2%	+32%	15.3%	14.4%	-5.9%
Housing						
% Own	50.1%	49.4%	-1.4%	56%	55.9%	0%
% Rent	49.9%	50.6%	+1.4%	44%	44.1%	0%
Quality of Life						
Avg. Household Size	2.65	2.68	+1%	2.98	3.45	+16%
Language Other than English Spoken at Home	32.6%	36.8%	+12.9%	43.5%	43.2%	-0.7%
Mean Travel Time to Work (in minutes)	23.4	23.7	+1.3%	27.1	27	-0.4%

Social Effects Assessment

A social effects assessment considers the social vulnerability and resiliency of a population. Social vulnerability refers to the sensitivity of a population to natural hazards, whereas social resiliency refers to the population's ability to respond to and recover from the impacts of a natural hazard. The characteristics that are recognized as having an influence on social vulnerability and resiliency generally include age, gender, race, and socioeconomic status as well as population segments with special needs or those without the normal social safety nets typically necessary to recover from a disaster. The quality of human settlements (e.g., housing type and construction, infrastructure, and lifelines) and the built environment also play an important role in assessing social vulnerability and resiliency, especially as these characteristics influence potential economic losses, injuries, and fatalities from natural hazards. Table 2 provides a discussion of factors that may influence social vulnerability and resiliency and also provides a qualitative assessment of the American River Common Features study area based on indicator statistics from the 2010 U.S. Census. The discussion column in Table 2 is from the article, *Social Vulnerability to Environmental Hazards*, which was published in the June 2003 edition of Social Science Quarterly.

Table 2: Social Vulnerability and Resiliency Indicators – Sacramento Study Area Assessment

Indicator	Discussion	Assessment
Income, political power, and prestige	This measure focuses on the ability to absorb losses and enhance resilience to hazard impacts. Wealth enables communities to absorb and recover from losses more quickly due to insurance, social safety nets, and entitlement programs.	The median household income of the area is below the median for the state of California; however, the city is the state's Capital and has access to significant amount of political resources.
Gender	Women can have a more difficult time during recovery than men, often due to sector-specific employment, lower wages, and family care responsibilities.	Women make up 49.4% of the work force while men make up 50.6%; the median income for women in the area is $42,824, which is 89% of the median income for men.
Race and Ethnicity	Race and ethnicity may impose language and cultural barriers that affect access to post-disaster funding	The area is highly diverse in terms of race and ethnicity. Over one-third of the residents speak a language other than English at home; this may contribute to the vulnerability and possibly the resiliency of the community.
Age	Extremes on the age spectrum inhibit the movement out of harm's way. Parents lose time and money caring for children when daycare facilities are affected; the elderly may have mobility constraints or mobility concerns increasing the burden of care and lack of resilience.	Those age 65 and over make up a slightly lower percentage of the community's population as compared to the percentage for the same age category for the state as a whole; the percentage of residents younger than 18 (24.9%) is about the same as the state statistic (25%).
Employment Loss	The potential loss of employment following a disaster exacerbates the number of unemployed workers in a	The latest Census indicates that the current unemployment rate in the area may be significantly higher

	community, contributing to a slower recovery from the disaster.	than the state's. A flood event which causes additional unemployment may exacerbate the current unemployment rate.
Rural/Urban	Rural residents may be more vulnerable due to lower incomes, and may be more dependent on locally-based resource extraction economies (farming and fishing). High-density areas (urban) complicate evacuation from harm's way.	The area is highly urbanized and close to many resources.
Residential Property	The value, quality, and density of residential construction affect potential losses and recovery. For example, expensive homes are costly to replace, while mobile homes are easily destroyed and less resilient to hazards.	The area is comprised of a full spectrum of homes – from average quality to excellent. Medium density neighborhoods are typical, with higher density neighborhoods in the downtown/midtown area.
Infrastructure and Lifelines	Loss of sewers, bridges, water, communications, and transportation infrastructure may place an insurmountable financial burden on the smaller communities that lack the financial resources to rebuild.	Most of the neighborhoods within the study area are well-established and would most likely have access to the many resources available within the city itself as well as within the greater metropolitan area, which includes, Davis, West Sacramento, Folsom, Elk Grove, Dixon, and many other cities.
Renters	People that rent typically do so because they are either transient or do not have the financial resources for home ownership. They often lack access to information about financial aid during recovery. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or too costly to afford.	The number of rentals in the area is significant (about 51%), and is higher than the state average of about 44%. The high rental population may contribute to communication cohesion issues; research indicates that renters do not have the same level of community pride as owners do, which may lead to more challenges in redeveloping a community after a flood event.
Occupation	Some occupations, especially those of resource extraction, may be severely impacted by a hazard event. Self-employed fishermen suffer when their means of production is lost and may not have the requisite capital to resume work in a timely fashion and thus will seek alternative employment. Migrant workers engaged in agriculture and low skilled service jobs (e.g., housekeeping, childcare,	The number of people that live in the area and work in resource extraction occupations is fairly low; the 2010 Census indicates that around 1,226 people (or 0.6% of the total work force) work in the farming, fishing, and forestry occupations.

	and gardening) may similarly suffer, as disposable income fades and the need for services decline. Immigration status also affects occupational recovery.	
Family Structure	Families with large numbers of dependents or single-parent households often have limited finances to outsource care for dependents, and thus must juggle work responsibilities and care for family members. All affect the resilience to recover from hazards.	The literature indicates that families having greater than four persons have more financial difficulty than smaller families. Accordingly, community planners need to be aware of issues that may arise.
Education	Education is strongly linked to socioeconomic status, with higher educational attainment resulting in greater lifetime earnings. Lower education constrains the ability to understand warning information and access to recovery information.	Over 80% of the population has graduated from high school and almost a third of the population hold a bachelor's degree.
Population Growth	Counties experiencing rapid growth lack available quality housing; its social services network may not have had time to adjust to increased populations. New migrants may not speak the language and not be familiar with bureaucracies for obtaining relief or recovery information, all of which increases vulnerability.	Sacramento has grown significantly over the past fifteen years, with a majority of the growth taking place between 2000 and 2010. The growth rate between 2000 and 2010 was about 15%. Overall, growth has been significant but not rapid; there are parts of the city that have experienced rapid growth (e.g., Natomas). Rapid growth is highly correlated with low community cohesion. The sense of belonging, cooperation, and community pride are dynamic factors which help with community resilience but which may not be as strong in cities that have experienced rapid growth.
Medical Services	Health care providers, including physicians, nursing homes, and hospitals are important post-event sources of relief. The lack of proximate medical services will lengthen immediate relief and result in longer recovery from disasters.	The residents of Sacramento would have access to nearby medical facilities in the cities of Davis, Woodland, West Sacramento, Elk Grove, Folsom, El Dorado Hills, Roseville, Rocklin, Dixon, and others

Life Safety Evaluation

The Sacramento District's Levee Safety Section uses the Levee Screening Tool (LST) to assess levees within the District's geographic boundary. The LST provides an initial quantitative risk estimate to assist local, state, and federal stakeholders in identifying and prioritizing the funding needs for levees of

concern. The information and data entered into the LST are collected from existing information/data. Life loss estimates are computed in the LST based on the information/data entered and for various scenario/conditions, including life loss during the day time, life loss during the night time, life loss assuming a levee breach prior to overtopping, and life loss assuming no breach until overtopping. Additional information about the levee screening tool and its computation processes can be found in, *Levee Screening Tool: Methodology and Application,* as listed in the reference section.

The results of the levee screenings performed for the American River Common Features study area were used in this OSE assessment to make preliminary estimates of life loss. The results of two scenarios modeled in the LST, levee breach prior to overtopping and no levee breach until overtopping, are presented here. For this assessment, the levee breach prior to overtopping scenario was assigned to the without-project condition and the no levee breach until overtopping was assigned to the with-project (Alternatives 1 and 2) conditions. A comparison of potential fatalities under each condition and for various levee segments within the system is displayed in Table 3 below.

Table 3: Statistical Life Loss Estimates

Levee Segment/Impact Area	Estimated Life Loss					
	Without-Project (Assumes Breach Prior to Overtopping)			Alternative 1/Alternative 2 (Assumes No Breach Until Overtopping)		
	Day	Night	Weighted	Day	Night	Weighted
Natomas Cross Canal – Left Bank (Natomas)	669	553	605	221	183	200
Arcade Creek – Left Bank (ARN)	166	151	158	95	86	90
NEMDC – Left Bank (ARN)	164	149	156	94	85	89
American River – Right Bank (ARN)	170	156	163	97	89	93
American River – Left Bank (ARS)	503	978	764	166	461	328
Sacramento River – Left Bank (ARS)	595	1,128	888	281	645	481

In addition to life loss estimates, other metrics were used to assess the vulnerability of individuals living in the study area, as listed in Table 4 below.

In any assessment that relies on assumptions, there is uncertainty. The life loss estimates under the with-project condition shown in Table 3 above assume no levee breach until overtopping. Importantly, while the Levee Screening Tool (LST) does not compute probabilities of a potential levee breach, the economic model (HEC-FDA) used in the National Economic Development (NED) Analysis does compute the annual exceedance probabilities (AEP) under without-project and with-project conditions using available engineering data. These probabilities can be tied to the life loss estimates computed in the LST in order to provide a more complete picture of the overall flood risk (consequence and chance). For example, the HEC-FDA results indicate that in the ARS Basin, there is about a 1 in 147 chance of flooding in any given year under the with-project condition, which can be tied to the estimated life loss of between 328 and 481 shown in Table 3. For the ARN Basin, the HEC-FDA results indicate that there is

about a 1 in 172 chance of flooding in any given year under the with-project condition, which can be tied to the estimated life loss of between 89 and 93 displayed in Table 3. In both basins, the chance of flooding and therefore life loss is significantly reduced with a project in place as compared to without a project in place. (Under without-project conditions, the chance of flooding in any given year in the ARS and ARN Basins are about a 1 in 32 and 1 in 61, respectively.)

Table 4: Description of Metrics Used to Evaluate Life Safety

Evaluation Metric	Description
Population at Risk (People)	Number of people within the 1% ACE floodplain based on the 2010 census block GIS data.
Critical Infrastructure (Facilities)	Number of fire stations, police stations, hospitals, senior living facilities, and jails that are of life safety significance; also includes substations, schools, power plants, chemical industry, colleges, intermodal shipping, heliports, petroleum bulk plants, and broadcast communication which may be of regional significance
Evacuation Routes (Number of Routes)	Assesses the vulnerability of populations with regard to the number of escape routes available during flood events.
Wise Use of Floodplains (Acres)	Potentially developable land within the 0.2% ACE floodplain. Acres of land with 1% ACE flood depths less than 3 feet.

Table 5 displays the comparison for the without-project and with-project (Alternatives 1 and 2) conditions as they relate specifically to the life safety metrics summarized in Table 4.

Table 5: Summary of Life Safety Metrics

Evaluation Metric	Alternative	
	Without-Project	Alternative 1/Alternative 2
Population at Risk (People)	250,000	0
Critical Infrastructure (Facilities)	523	0
Evacuation Routes (Number of Routes)	43	43
Wise Use of Floodplains (Acres)	0	TBD

[1]Values based on 1% ACE event floodplain

Population at Risk: The population at risk of flooding from a 1% ACE flood event is about 250,000 for the without-project condition. Most of this population would be removed from the 1% ACE floodplain under either Alternative 1 or 2. Of special concern is the population segment over the age of 65 living within the study area since these individuals have been shown to be at higher risk of life loss from flood events. The Sacramento community's senior population is slightly lower (10.6% of total population) than the senior population of the state of California (11.4%).

Additionally, the area in the American River North (ARN) Basin benefitting from the improvements to the creeks (Arcade, Dry, Robla, and the NMDEC) represents one of the most impoverished locations in

Sacramento County.[1] In fact, the median family income in Sacramento is more than 50 percent higher than the median family income of the affected area ($55,064 compared to $35,828); the poverty rate in the affected area is 64 percent higher that of the surrounding county (29.0% compared to 17.6%). Within some parts of the affected area more than one in three family's live below the poverty line (34.1% in zip code 95815). Furthermore, these high rates of poverty are strongly correlated with disabilities, lack of car ownership and other factors that increase life safety hazards. In the absence of these improvements, the flood risk for this area would change very little, thereby putting this community at a further disadvantage relative to neighboring communities in the study area.

Critical Infrastructure: A significant amount of critical infrastructure is located within the Common Features study area. Critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy from a national perspective. Most commonly associated with the term are fire stations, police stations, hospitals, senior living facilities, and prisons.

The numerous federal, state, county, and city offices located within the inundation area could be directly impacted. The massive loss of city and state offices would severely hamper a number of critical local government functions, at least temporarily. A significant number of records, both digital and hardcopy, have the potential to be lost. Floors of high-rise buildings above the effects of floodwaters would remain relatively untouched, but the bottom floors of large office buildings and their contents would most likely be destroyed.

The disruption of government work could have major indirect impacts to people living outside of the immediate flood zone. For state offices, the effects of flooding in the state's capitol could disrupt the lives of everyone living in California. County, city, and federal offices would also incur losses. While non-essential government workers would experience temporary unemployment, it is unlikely that government work would stop completely. Indeed, after an emergency of this scale, there would likely be a large need for more government action in the form of managing aid and organizing rebuilding efforts. Government offices outside of the flood footprint, either in West Sacramento or in the eastern part of Sacramento County, would likely increase their workloads and displaced employees could most likely find temporary workspace in these offices once security issues and logistical needs are assessed and provided.

Both Alternatives 1 and 2 significantly lowers the flood risk to critical infrastructure within the study area.

Evacuation Routes: The City of Sacramento's evacuation plan was updated as of September 2008. In their plan they have identified temporary shelters with their addresses and phone numbers within the city limits. They also have detailed maps for evacuation routes based on police beats, and they have a table for different triggers and the particular activation that needs to occur based on them and the roles and responsibilities of each agency for that trigger.

The County of Sacramento's evacuation plan was updated as of November 2008. In their plan they have identified temporary shelters with their addresses within the county limits. They also have detailed maps for evacuation routes, and they have identified different triggers and the particular activation that

[1] The above analysis is based on the US Census Bureau 2009-2013 American Community Survey comparing Sacramento County to the zip codes most closely associated with the area affected by the increment (95815 and 95838).

needs to occur based on them and the roles and responsibilities of each agency for that trigger.

Both the City and County have created detailed maps for various hypothetical levee breaks. These maps identify evacuation routes, and which evacuation routes would become inundated overtime and impassible. Depending on the location of the levee breach, up to 43 evacuation routes (all basins) have been identified which include highways and freeways, and main streets/roads.

Community awareness of the flood risk is good. Flood risk and levee safety have been covered extensively over the last few years by all the local TV stations and the Sacramento Bee newspaper. Additionally, Sacramento County has emergency sirens and a reverse-911 system. The Emergency Operations and Emergency Evacuation plans discuss communication with the local media to instruct the public during emergencies.

Wise Use of Floodplains: A determination must be made as to whether the increase in potentially developable floodplain area is acceptable under Corps policy, or can be avoided or mitigated to an acceptable level within a justified cost. It is important to remember that the floodplain metric used in this assessment is a simple index based on physical parameters. The metric does not attempt to forecast future population growth, economic conditions, or government decisions that will constrain future floodplain development. Those factors should be considered in conjunction with the metric.

Without-Project and With-Project Comparison

An assessment of the beneficial and adverse effects associated with the without-project condition and Alternatives 1 and 2 (with-project condition) was made. The social effects of the alternatives have both direct and indirect effects. Direct effects come from construction of the projects, whereas indirect effects come from the effects of the project on the existing social landscape. The alternatives are characterized using descriptors related to magnitude (number of individuals affected), location (concentration of effects), timing and duration (when the effects will start and how long they are expected to last), and associated risks. Table 6 provides a description of the effects of the without-project condition and Alternatives 1 and 2.

Table 6: Effects of Alternatives

	Without-Project	Alternative 1/Alternative 2
Alternative Description		
	No project is constructed by the Federal government	Improvements to the Sacramento River levees (left bank from confluence to south of Freeport), American River levees (right and left banks), East Side Tributaries, and Sacramento Bypass (Alternative 2 only) are made
Other Social Effects (OSE)		
Summary	Continued flood risk and high potential consequences in the West Sacramento study area	Life safety residual risk is significantly reduced
Population at Risk (PAR)	Approximately 250,000 people are at high risk from a 1% ACE flood	The risk from a 1% ACE flood is significantly reduced for all of the approximately 250,000 Sacramento residents
Loss of Life	Potential loss of life: 1,051	Potential loss of life: 574
Critical Infrastructure	523 critical infrastructure at risk	0 critical infrastructure at risk
Evacuation Routes	No evacuation routes available if flood event occurs	43 evacuation routes available in the event of a flood
Wise Use of Floodplains	0 available acres	About X acres of land would be available for future development
Social Vulnerability	The community may be characterized as having a medium level of social vulnerability based on the social vulnerability indicators presented in Table 2	Flood risk to the Sacramento community is reduced, and social vulnerability is minimized due to the decrease in chance of a flood occurring
Residual Risk and Consequences	Residual risk remains high throughout the study area.	Residual risk for life safety is significantly reduced.

It is important to realize that while either alternative would significantly reduce the overall flood risk to Sacramento, the risk will not be, and never will be, completely removed. In other words, while the alternatives would significantly reduce the chance of flooding, the tens of thousands of people and thousands of homes still remain susceptible to flood events which exceed the project design and the associated AEP.

C. REGIONAL ECONOMIC DEVELOPMENT (RED)

Purpose and Methodology

The U.S. Army Corps of Engineers (USACE) *Planning Guidance Notebook* (ER 1105-2-100) states that while the National Economic Development (NED) and Environmental Quality (EQ) accounts are required, display of the Regional Economic Development (RED) effects are discretionary. The Corps' NED procedures manual affirms that RED benefits are real and legitimate; however, the concern (from a Federal perspective) is that they are often offset by RED costs in other regions. Nevertheless, for the local community these benefits are important and can help them in making their preferred planning decisions.

Although the RED account is often examined in less detail than NED, it remains useful. For example, Hurricane Katrina caused a significant economic hardship to not just the immediate Gulf Coast but for entire counties, watersheds, and the state of Louisiana. Besides the devastating damage to homes (which are often captured by the NED account), hundreds of thousands of people lost their jobs, property values fell, and tourism and tax revenues declined significantly and were transferred to other parts of the U.S. In this example, the RED account can provide a better depiction of the overall impact to the region.

The distinction between NED and RED is a matter of perspective, not economics. A non-federal partner may consider the impacts at the state, regional, and local levels to be a true measure of a project's impact or benefit, whereas from the Corps' perspective, this may not constitute a national benefit. Gains in RED to one region may be partially or wholly offset by losses elsewhere in the nation. For example, if a Federal project enables a firm to leave one state to relocate to a newly-protected floodplain of another state, the increase in regional income for the project area may come at the expense of the former area's loss. In this case, there is no net increase in the value of the nation's output of goods and services and should be excluded from NED computations.

The following sections describe the impacts of Alternatives 1 and 2 from a regional perspective. The impacts were evaluated using the Corps' certified RECONS software.

Key RED Concepts

Econometric analysis allows for the evaluation of a full range of economic impacts related to specific economic activities by calculating effects of the activities in a specific geographic area. These effects are:

- Direct effects, which consist of economic activity contained exclusively within the designated sector. This includes all expenditures made by the companies or organizations in the industry and all employees who work directly for them.
- Indirect effects, which define the creation of additional economic activity that results from linked business, suppliers of goods and services, and provisions of operating inputs.
- Induce effects, which measure the consumption expenditures of direct and indirect sector employees.

Input-output (I/O) models are characterized by their ability to evaluate the effects of industries on each other. Unlike most typical measures of economic activity that examine only the total output of an industry or the final consumption demand provided by a given output, I/O models provide a much more

comprehensive view of the interrelated economic impacts. I/O analysis is based on the notion that there is a fundamental relationship between the volume of output of an industry and the volume of the various inputs used to produce that output. Industries are often grouped into production, distribution, transportation, and consumption categories. Additionally, the I/O model can be used to quantify the multiplier effect, which refers to the idea that an increase in spending can lead to an even greater increase in income and consumption, as monies circulate (or multiply) throughout the economy.

Flood Risk Management RED Considerations

There are particular effects for each type of project improvement as they relate to the RED account. The estimation of RED flood-related effects can be very complex. At a minimum, the RED analysis should include a qualitative description of the types of businesses at risk from flooding, particularly those that could have a significant adverse impact (output, employment, etc.) upon the community or regional economies if their operations should be disrupted by flooding and how this would be affected by the recommended project. The potential RED effects to flood risk management projects are summarized in Table 7 below.

Table 7: Potential RED Effects to Flood Risk Management

RED Factor	Potential RED Effects
Construction	Additional construction related activity and resulting spillovers to suppliers
Revenues	Increased local business revenues as a consequence of reduced flooding, particularly from catastrophic floods
Tax Revenues	Increased income and sales taxes from the direct project and spillover industries
Employment	Short-term increase in construction employment; with catastrophic floods, significant losses in local employment (apart from the debris and repair businesses, which may show temporary gains)
Population Distribution	Disadvantage groups may benefit from the creation of a flood-free zone
Increased Wealth	Potential increase in wealth for floodplain residents as less is spent on damaged property, repairs, etc.; potential increase in property values.

RECONS Software

A variety of software programs are available to measure the RED impacts of a project. The Corps of Engineers' Institute for Water Resources (IWR) along with the Louis Berger Group has developed a regional economic impact modeling tool called Regional Economic System (RECONS) that computes estimates of regional and national job creation, retention, and other economic measures. The expenditures made by the USACE for various services and products generate economic activity that can be measured in jobs, income, sales, and gross regional product. The software automates calculations and generates estimates of economic measures associated with USACE's annual civil works program spending. RECONS was built by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations by the Minnesota IMPLAN Group. These multipliers were then imported into a database. The software ties various spending profiles to the matching industry sectors by location to produce economic impact estimates. The RECONS program is used to document the performance of direct investment spending of the USACE, and allows users to evaluate project and program expenditures associated with annual expenditures.

RECONS Inputs and Outputs

The economic impacts presented below show the Common Features study area and the state of California's interrelated economic impacts resulting from an injection of flood risk management construction funds. For this assessment, the study area and the state of California were both used as the geographic designation to assess the overall impacts to the regional economy from constructing either Alternative 1 or Alternative 2. This places a frame around the economic impacts where the activity is internalized; leakages, which are payments made to imports or value added sectors that do not in turn re-spend the dollars within the area, are not included in the total impacts.

Table 8 summarizes the complex nature of the regional economy of the Sacramento/Arden/Arcade/Roseville, CA Metropolitan Statistical Area (MSA), which includes El Dorado, Placer, Sacramento, and Yolo counties and a population of approximately 2.2 million. There are approximately 1.2 million people employed in the MSA who provide an output to the nation worth over $158 billion annually.

Table 8: Regional Profile – Sacramento/Arden/Arcade/Roseville, CA MSA (Dollar Values in $Millions, October 2015 Price Level)

Industry	Output	Labor Income	GRP	Employment
Accommodations and Food Service	$4,522	$1,562	$2,384	75,155
Administrative and Waste Management Services	$4,072	$2,145	$2,665	67,557
Agriculture, Forestry, Fishing and Hunting	$1,526	$388	$671	11,783
Arts, Entertainment, and Recreation	$1,594	$489	$751	21,054
Construction	$12,733	$5,471	$5,999	82,970
Education	$4,254	$3,367	$3,811	66,272
Finance, Insurance, Real Estate, Rental and Leasing	$23,202	$5,878	$14,551	118,760
Government	$21,059	$17,612	$19,940	241,383
Health Care and Social Assistance	$10,710	$6,058	$7,029	103,062
Imputed Rents	$12,558	$2,011	$8,153	65,011
Information	$7,646	$1,442	$3,075	20,698
Management of Companies and Enterprises	$2,040	$876	$1,172	10,242
Manufacturing	$19,269	$3,263	$4,460	39,136
Mining	$562	$129	$344	1,087
Professional, Scientific, and Technical Services	$12,918	$6,688	$7,771	89,771
Retail Trade	$9,491	$4,062	$6,519	123,095

Transportation and Warehousing	$3,686	$1,470	$2,176	27,064
Utilities	$1,103	$243	$672	1,635
Wholesale Trade	$5,344	$2,022	$3,467	30,383
Total	**$158,286**	**$65,176**	**$95,610**	**1,196,119**

Input Costs: The total remaining costs of Alternatives 1 and 2 are $1,216,034,000 and $1,469,888,000, respectively (none of the costs have been expended). The RED analysis requires the adjustment of costs for two items: (1) interest during construction (IDC) and (2) purchase of land. Interest during construction is used in the NED analysis to estimate the opportunity cost of using money for one economic endeavor (e.g., building a FRM project) instead of another (e.g., building a bullet train); IDC is not actually expended within the region and therefore is not included in the RED analysis. Similarly, the purchase of land, not including administrative costs, is considered a transfer payment from one party to another and therefore is also not included in the RED analysis.

Tables 9 and 10 are based on the average annual regional expenditures that are expected over the construction period. The construction period for Alternative 1 is assumed to be 10 years; for Alternative 2 it is also assumed to be 10 years. Over that period, a total of about $1.22 billion is anticipated to be spent in the study area if Alternative 1 is built; a total of about $1.47 billion is anticipated to be spent if Alternative 2 is built. The average construction expenditure for Alternative 1 is about $122 million, which is the anticipated amount ($1.22 billion) divided by the number of years of construction (10); the average construction expenditure for Alternative 2 is about $147 million, which is the anticipated amount ($1.47 billion) divided by the number of years of construction (10).

Table 9: Alternative 1 Inputs Assumptions, Sacramento/Arden/Arcade/Roseville, CA MSA (October 2015 Price Level)

Category	Spending	Spending Amount	Local Percentage Capture		
		Alternative 1	Local	State	National
Aggregate Materials	10%	119,171,000	70	77	97
Other Materials	1%	14,572,000	99	100	100
Equipment	35%	425,612,000	69	99	100
Construction Labor	54%	656,658,000	100	100	100
Total	100%	1,216,034,000	NA	NA	NA

Table 10: Alternative 2 Inputs Assumptions, Sacramento/Arden/Arcade/Roseville, CA MSA (October 2015 Price Level)

Category	Spending	Spending Amount	Local Percentage Capture		
		Alternative 2	Local	State	National
Aggregate Materials	10%	144,049,000	70	77	97
Other Materials	1%	17,639,000	99	100	100
Equipment	35%	514,461,000	69	99	100
Construction Labor	54%	793,739,000	100	100	100
Total	100%	1,469,888,000	NA	NA	NA

RECONS Outputs: Direct expenditures expected for construction of earthen levees are spent primarily in two sectors of the economy, construction labor and equipment (both alternatives). Both accounts for 89% of the total project expenditures. Local capture rates are computed in RECONS to show where the output from expenditures is realized. As indicated in Tables 9 and 10, all of the construction labor is expected to occur within the Sacramento/Arden/Arcade/Roseville MSA (both alternatives); 69% of the equipment is expected to be provided from within the study area and 99% from within the state of California (both alternatives).

Tables 11 and 12 summarize the overall economic impacts of Alternatives 1 and 2. The USACE is planning to expend approximately $1.35 billion if Alternative 1 is built and approximately $1.57 billion if Alternative 2 is built. Of total project expenditures, approximately $1.05 billion will be captured within the regional impact area if Alternative 1 is built and approximately $1.27 billion will be captured within the regional impact area if Alternative 2 is built. For either alternative, the rest will be leaked out to the state of California or the nation. The expenditures made by the USACE for various services and products are expected to generate additional economic activity, which can be measured in jobs, income, sales, and GRP as summarized in Tables 13-18 (economic activity on regional, state, and national basis). It is important to note that the RED analysis indicates that construction of either alternative is anticipated to generate over 22,000 jobs and over one billion dollars in labor income during the construction period.

Table 11: Alternative 1, Summary of Economic Impacts, Sacramento/Arden/Arcade/Roseville, CA MSA (Dollar Values in October 2015 Price Level)

Total Spending		Alternative 1		
		Regional	State	National
		$1,216,034,000	$1,216,034,000	$1,216,034,000
Direct Impact	Output	$1,049,768,000	$1,184,467,000	$1,211,673,000
	Jobs	15,940	16,400	16,570
	Labor Income	$766,076,000	$802,542,000	$814,386,000
	GRP	$866,844,000	$941,704,000	$956,797,000
Total Impact	Output	$1,929,413,000	$2,382,499,000	$3,199,443,000
	Jobs	22,090	24,530	28,940
	Labor Income	$1,066,146,000	$1,214,895,000	$1,479,975,000
	GRP	$1,400,509,000	$1,656,427,000	$2,110,406,000

Table 12: Alternative 2, Summary of Economic Impacts, Sacramento/Arden/Arcade/Roseville, CA MSA (Dollar Values in October 2015 Price Level)

Total Spending		Alternative 2		
		Regional	State	National
		$1,469,888,000	$1,469,888,000	$1,469,888,000
Direct Impact	Output	$1,268,913,000	$1,431,730,000	$1,464,617,000
	Jobs	19,260	19,830	20,040
	Labor Income	$925,999,000	$970,077,000	$984,393,000
	GRP	$1,047,802,000	$1,138,290,000	$1,156,533,000
Total Impact	Output	$2,332,189,000	$2,879,859,000	$3,867,345,000
	Jobs	26,700	29,660	34,990
	Labor Income	$1,288,710,000	$1,468,511,000	$1,788,930,000
	GRP	$1,692,872,000	$2,002,215,000	$2,550,965,000

Table 13: Alternative 1, Economic Impacts – Regional Level, Sacramento/Arden/Arcade/Roseville, CA MSA (October 2015 Price Level)

Industry Sector		Alternative 1			
		Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$46,489,000	340	$17,220,000	$22,348,000
	Wholesale trade businesses	$1,292,000	1	$492,000	$976,000
	Transport by rail	$2,799,000	1	$951,000	$1,547,000
	Transport by water	$525,000	0	$106,000	$235,000
	Transport by truck	$32,908,000	250	$14,652,000	$17,718,000
	Construction of other new nonresidential structures	$14,464,000	80	$5,830,000	$7,363,000
	Commercial & industrial machinery & equipment rental/leasing	$294,635,000	940	$70,166,000	$159,998,000
	Labor	$656,658,000	14,310	$656,658,000	$656,658,000
Total Direct Effects		$1,049,768,000	15,940	$766,076,000	$866,844,000
Secondary Effects		$879,645,000	6,160	$300,069,000	$533,665,000
Total Effects		**$1,929,413,000**	**22,090**	**$1,066,146,000**	**$1,400,509,000**

Table 14: Alternative 2, Economic Impacts – Regional Level, Sacramento/Arden/Arcade/Roseville, CA MSA (October 2015 Price Level)

Industry Sector		Alternative 2			
		Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$56,195,000	400	$20,816,000	$27,013,000
	Wholesale trade businesses	$1,562,000	1	$595,000	$1,179,000
	Transport by rail	$3,383,000	1	$1,149,000	$1,869,000
	Transport by water	$633,000	0	$128,000	$285,000
	Transport by truck	$39,777,000	310	$17,710,000	$21,416,000
	Construction of other new nonresidential structures	$17,483,000	100	$7,048,000	$8,901,000
	Commercial & industrial machinery & equipment rental/leasing	$356,141,000	1,150	$84,814,000	$193,399,000
	Labor	$793,739,000	17,290	$793,739,000	$793,739,000
Total Direct Effects		$1,268,913,000	19,260	$925,999,000	$1,047,802,000
Secondary Effects		$1,063,276,000	7,440	$362,711,000	$645,070,000
Total Effects		**$2,332,189,000**	**26,700**	**$1,288,710,000**	**$1,692,872,000**

Table 15: Alternative 1, Economic Impacts – State Level, Sacramento/Arden/Arcade/Roseville, CA MSA (October 2015 Price Level)

Industry Sector		Alternative 1			
		Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$46,489,000	340	$17,220,000	$22,348,000
	Wholesale trade businesses	$1,787,000	10	$710,000	$1,362,000
	Transport by rail	$2,799,000	10	$951,000	$1,547,000
	Transport by water	$926,000	0	$188,000	$415,000
	Transport by truck	$40,223,000	310	$17,968,000	$21,706,000
	Construction of other new nonresidential structures	$14,592,000	80	$5,884,000	$7,430,000
	Commercial & industrial machinery & equipment rental/leasing	$420,991,000	1,350	$102,962,000	$230,237,000
	Labor	$656,658,000	14,310	$656,658,000	$656,658,000
Total Direct Effects		$1,184,467,000	16,400	$802,542,000	$941,704,000
Secondary Effects		$1,198,033,000	8,130	$412,354,000	$714,723,000
Total Effects		**$2,382,499,000**	**24,530**	**$1,214,895,000**	**$1,656,427,000**

Table 16: Alternative 2, Economic Impacts – State Level, Sacramento/Arden/Arcade/Roseville, CA MSA (October 2015 Price Level)

Industry Sector		Alternative 2			
		Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$56,195,000	400	$20,816,000	$27,013,000
	Wholesale trade businesses	$2,161,000	10	$858,000	$1,646,000
	Transport by rail	$3,383,000	10	$1,149,000	$1,869,000
	Transport by water	$1,119,000	0	$227,000	$503,000
	Transport by truck	$48,620,000	380	$21,719,000	$26,238,000
	Construction of other new nonresidential structures	$17,639,000	100	$7,112,000	$8,980,000
	Commercial & industrial machinery & equipment rental/leasing	$508,874,000	1,630	$124,455,000	$278,301,000
	Labor	$793,739,000	17,290	$793,739,000	$793,739,000
Total Direct Effects		$1,431,730,000	19,830	$970,077,000	$1,138,290,000
Secondary Effects		$1,448,128,000	9,830	$498,435,000	$863,926,000
Total Effects		**$2,879,859,000**	**29,660**	**$1,468,511,000**	**$2,002,215,000**

Table 17: Alternative 1, Economic Impacts – National Level, Sacramento/Arden/Arcade/Roseville, CA MSA (October 2015 Price Level)

Industry Sector		Alternative 1			
		Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$66,150,000	480	$26,276,000	$33,314,000
	Wholesale trade businesses	$1,812,000	10	$721,000	$1,381,000
	Transport by rail	$3,466,000	10	$1,176,000	$1,916,000
	Transport by water	$1,341,000	0	$273,000	$602,000
	Transport by truck	$42,662,000	330	$19,074,000	$23,036,000
	Construction of other new nonresidential structures	$14,592,000	80	$5,884,000	$7,428,000
	Commercial & industrial machinery & equipment rental/leasing	$424,990,000	1,360	$104,320,000	$232,461,000
	Labor	$656,658,000	14,310	$656,658,000	$656,658,000
Total Direct Effects		$1,211,673,000	16,570	$814,386,000	$956,797,000
Secondary Effects		$1,987,770,000	12,370	$665,591,000	$1,153,610,000
Total Effects		**$3,199,443,000**	**28,940**	**$1,479,975,000**	**$2,110,406,000**

Table 18: Alternative 2, Economic Impacts – National Level, Sacramento/Arden/Arcade/Roseville, CA MSA (October 2015 Price Level)

Industry Sector		Alternative 2			
		Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$79,939,000	570	$31,763,000	$40,269,000
	Wholesale trade businesses	$2,190,000	10	$871,000	$1,669,000
	Transport by rail	$4,190,000	10	$1,422,000	$2,315,000
	Transport by water	$1,621,000	0	$331,000	$728,000
	Transport by truck	$51,569,000	400	$23,057,000	$27,845,000
	Construction of other new nonresidential structures	$17,639,000	100	$7,112,000	$8,980,000
	Commercial & industrial machinery & equipment rental/leasing	$513,709,000	1,640	$126,097,000	$280,988,000
	Labor	$793,739,000	17,290	$793,739,000	$793,739,000
Total Direct Effects		$1,464,617,000	20,040	$984,393,000	$1,156,533,000
Secondary Effects		$2,402,728,000	14,950	$804,537,000	$1,394,432,000
Total Effects		**$3,867,345,000**	**34,990**	**$1,788,930,000**	**$2,550,965,000**

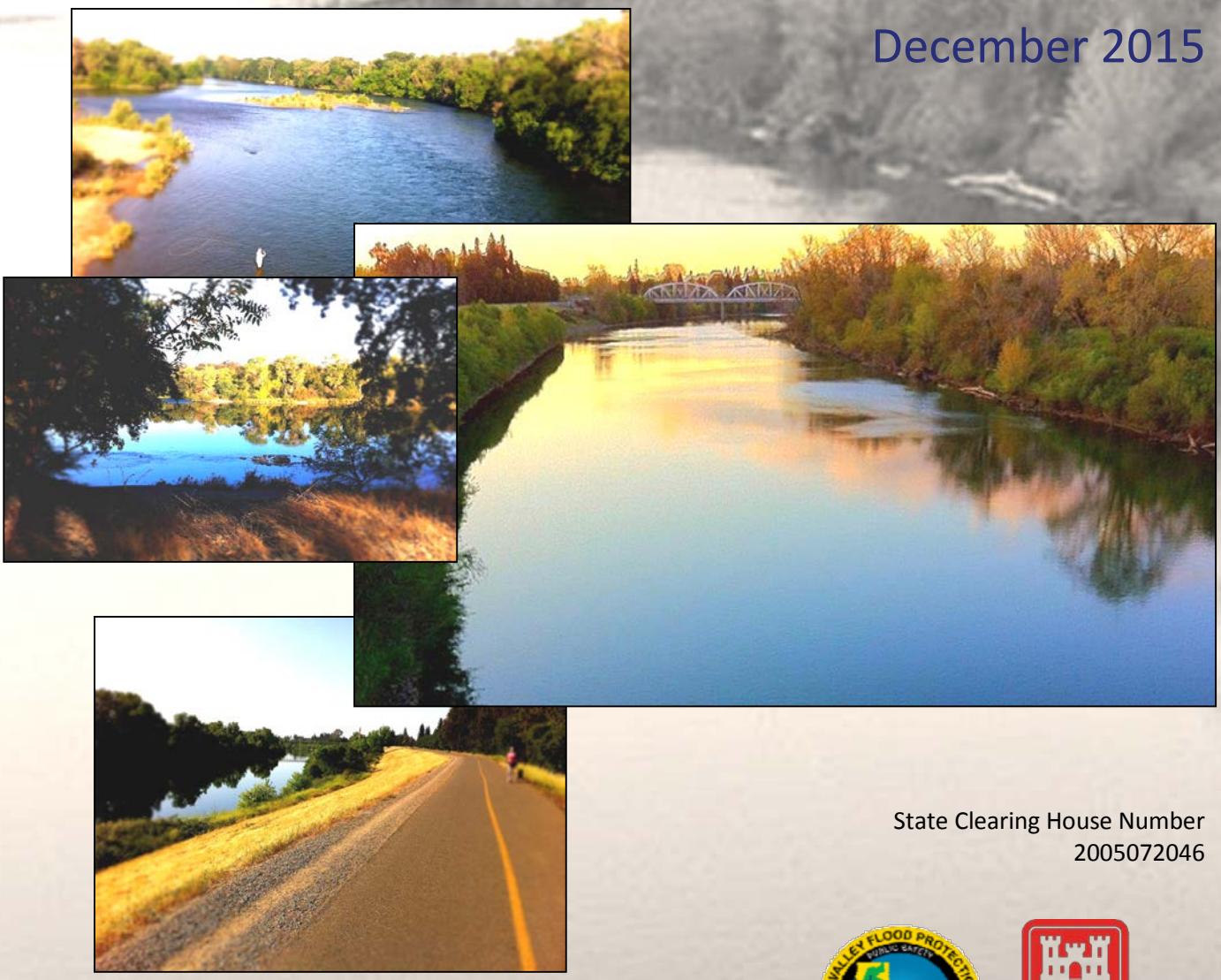
The creation of jobs in the study area is important to note. In 2010, the unemployment rate in the study area (13.9%) was higher than the state (7.1%) average; the number of jobs gained within the region demonstrates the multiplier effect of the infusion of construction funds for this project.

American River Watershed

Common Features
General Reevaluation Report

Final
Environmental Impact Statement
Environmental Impact Report

December 2015



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SAFCA
Sacramento Area Flood Control Agency

Central Valley Flood Protection Board

US Army Corps of Engineers ®
Sacramento District

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AMERICAN RIVER COMMON FEATURES GENERAL REEVALUATION REPORT

SACRAMENTO COUNTY, CALIFORNIA

FINAL ENVIRONMENTAL IMPACT STATEMENT/ ENVIRONMENTAL IMPACT REPORT

December 2015

Type of Statement: Final Environmental Impact Statement/Environmental Impact Report (EIS/EIR)

Lead NEPA Agency: U.S. Army Corps of Engineers, Sacramento District

Lead CEQA Agency: State of California, Central Valley Flood Protection Board

Cooperating Agency: Sacramento Area Flood Control Agency

Abstract: The U.S. Army Corps of Engineers and its non-Federal partners, the State of California Central Valley Flood Protection Board and the Sacramento Area Flood Control Agency, propose to enhance flood risk management for the city of Sacramento by improving the levees that surround the city. This EIS/EIR describes the environmental resources in the project area; evaluates the direct, indirect, and cumulative environmental effects of three alternatives, including the no action alternative; describes avoidance, minimization, and compensation measures. Most potential adverse effects would be either short term, or would be avoided or reduced using best management practices. However, there would be some significant and unavoidable impacts associated with this project. The beneficial effects of each alternative are also discussed.

Public Review and Comment: The public review period for the final EIS/EIR will begin on January 22, 2016 and close on February 22, 2016. Written comments or questions concerning this document should be directed to the following: U.S. Army Corps of Engineers, Sacramento District; Attn: Ms. Anne Baker; 1325 J Street; Sacramento, California 95814-2922, or by e-mail: Anne.E.Baker@usace.army.mil or California Department of Water Resources; Attn: Ms. Erin Brehmer; 3464 El Camino Avenue Suite 200; Sacramento, California 95821, or by e-mail: Erin.Brehmer@water.ca.gov.

EXECUTIVE SUMMARY

ES.1 Introduction

This environmental impact statement/environmental impact report (EIS/EIR) has been prepared by the U.S. Army Corps of Engineers (Corps), Sacramento District and the Central Valley Flood Protection Board (CVFPB) in accordance with the requirements of the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA), respectively. The Corps is the Federal lead agency for NEPA, and the CVFPB is the California lead agency for CEQA.

The purpose of the American River Common Features (ARCF) General Reevaluation Report (GRR) project is to reduce the overall flood risk within the study area. The study area includes the city of Sacramento and surrounding areas. An unacceptably high risk of flooding from levee failure threatens the public safety of approximately 530,000 people, as well as property and critical infrastructure throughout the study area. Additionally, the State Capitol and many state agencies reside within the study area. Historic flooding events have caused loss of life and extensive economic damages. Approximately 83,000 structures throughout the study area are at risk of flooding in a 100-year event (1% annual change of flooding). This EIS/EIR evaluates the potential significant environmental impacts of the alternatives discussed in the ARCF GRR. If the ARCF GRR is authorized by Congress, the Corps would begin construction to implement the project.

ES.2 Purpose and Intended Uses of this EIS/EIR

The purpose of this EIS/EIR is to evaluate the potential significant environmental impacts of the alternatives proposed in the GRR. This EIS/EIR will be used to support Congressional approval of the ARCF GRR. The CVFPB will consider whether or not to certify the EIR and approve the ARCF GRR in early 2016. This decision will be based on numerous factors, including the potential environmental impacts and mitigation measures addressed in this EIS/EIR, permitting requirements, Federal and state authorizations, funding and financing mechanisms, and implementation schedule.

This EIS/EIR will also be used by CEQA lead and responsible agencies, such as the CVFPB and Central Valley Regional Water Quality Control Board (RWQCB), Sacramento Area Flood Control Agency (SAFCA), and trustee agencies, such as the California Department of Fish and Wildlife (CDFW) and the California State Lands Commission (CSLC), to ensure that they have met the requirements of CEQA before deciding whether to issue discretionary permits or leases over which they have authority. It may also be used by other state, regional, and local agencies, which may have an interest in resources that could be affected by the project.

ES.3 Study Area

The proposed project is located in and around the city of Sacramento, California. Sacramento is the state capital of California, located at the confluence of the Sacramento and American Rivers in the northern portion of California's Central Valley. The Sacramento Metropolitan area, is the fourth largest in California, and includes seven counties and seven incorporated cities.

The ARFC Project area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Arcade Creek, and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento (Plate 2).

ES.4 Project Background

Following the 1986 flood, Congress directed the Corps to investigate additional means to reduce flood risk to the city of Sacramento. The Corps completed this investigation in 1991, recommending a concrete gravity flood detention dam at the Auburn Dam site and levee improvements downstream of Folsom Dam. Congress directed the Corps to conduct supplemental analysis of the flood management options considered in the 1991 study. The resulting *Supplemental Information Report, American River Watershed Project, California* (March 1996) recommended a similar combination of a gravity flood detention dam at the Auburn Dam site with downstream levee work. It considered, but did not advance, plans for Folsom Dam improvements and a stepped release plan for Folsom Dam accompanied by downstream levee improvements. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features". Thus, the ARCF Project was authorized in the Water Resources Development Act of 1996, Pub. L. No. 104-303, § 101(a)(1), 110 Stat. 3658, 3662-3663 (1996) (WRDA 1996), and the decision on Auburn Dam was deferred. Major construction components for the ARFC Project in the WRDA 1996 authorization included construction of seepage remediation along approximately 22 miles of American River levees, and levee strengthening and the raising of 12 miles of the Sacramento River levee in the Natomas Basin. Meanwhile, improvements to other levees adjacent to the Natomas Basin were authorized in the Department of Defense Appropriations Act of 1993, Pub. L. No. 102-396, § 9159, 106 Stat. 1876, 1944-46 (1992). SAFCA constructed these latter improvements between 1995 and 1998.

Under the Water Resources Development Act of 1999, Pub. L. No. 106-53, § 366, 113 Stat. 269, 319-320 (1999) (WRDA 1999), Congress authorized improvements to Folsom Dam to control a 200-year flood event with a peak release of 160,000 cfs. WRDA 1999 also authorized the Folsom Dam Modification Project to modify the existing outlets to allow for higher releases earlier in flood events. At the same time, Congress also directed the Corps to review additional modifications to the flood storage of Folsom Dam, indicating that Congress was

looking at maximizing the use of Folsom Dam to reduce flood risk prior to consideration of any additional upstream storage on the American River. The Folsom Dam Raise Project was subsequently authorized by Congress in 2004.

The ARCF Project was modified by WRDA 1999 to include improvements to safely convey an emergency release of 160,000 cubic feet per second (cfs) from Folsom Dam. These improvements included construction of seepage remediation and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of the Natomas Cross Canal levee in Natomas. Additional construction components for both WRDA 1996 and WRDA 1999 were authorized and have been constructed by the Corps. However, the Natomas Basin features authorized in WRDA 1996 and WRDA 1999 were deferred and later analyzed in the Natomas Post Authorization Change Report (PACR). The Natomas PACR was authorized in the Water Resources Reform and Development Act (WRRDA) of 2014, Pub. L. No. 113-121, § 7002, 128 Stat. 1193, 1366 (2014).

Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at river mile (RM) 79 to Freeport at RM 45.5 and on both the north and south bank of the American River. Seepage on the Sacramento River was so extensive that soon after the 1986 flood event, Congress funded levee improvements as part of the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport. At the time, seepage through the levees was considered to be the only significant seepage problem affecting the levees in the Sacramento area.

After construction of the Sac Urban project, the Sacramento Valley experienced a flood event in 1997. The seepage from this event led to a geotechnical evaluation of levees in the vicinity of the city of Sacramento which showed that deep underseepage was of concern. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was expected because levee improvements had yet to be constructed. However, the occurrence of significant seepage on the Sacramento River in the reach where levees had been improved as part of the Sac Urban project confirmed that deep underseepage was a significant concern in this area, a conclusion later confirmed by the Levee Seepage Task Force in 2003.

Following the recognition of deep underseepage as a major concern, recommendations to address seepage on the American River needed to be redesigned to address both through- and deep underseepage. The redesign led to considerable cost increases over what was originally authorized by Congress. The WRDA 1996 authorized cost of $56 million increased to $91.9 million under WRDA 1999, and to $205 million under the Energy and Water Development Appropriations Act of 2004,Pub. L. No. 108-137, § 129, 117 Stat. 1827, 1839 (2003).

Because of the considerable cost increase of levee improvements to address seepage on the American River, all funds appropriated by Congress for the project in the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would also require significantly more

effort than was anticipated at the time of authorization, it was decided in 2002 that a reevaluation study would be required for at least the Natomas portion of the ARCF Project. Congress was notified in 2004 that additional authorized cost increases would be required for study, design, and construction of levee improvements in the Natomas Basin.

While the reevaluation study was beginning for the ARCF Project, the Folsom Dam PACR was being completed by the Sacramento District. The results of this study, and of the follow-on Economic Reevaluation Report for Folsom Dam improvements, showed that additional levee improvements were needed on the American River and on the Sacramento River below the confluence in order to truly capture the benefits of the Folsom Dam projects. The levee problems identified in these reports consisted primarily of the potential for erosion on the American River and seepage, stability, erosion, and height concerns on the Sacramento River below the confluence with the American River. Because of this, additional reevaluation needed to include the two remaining basins comprising the city of Sacramento: American River North and American River South.

In December 2010, the Natomas PACR and Interim GRR were completed, which focused on the problems associated with the existing levees in the Natomas Basin. The Natomas PACR and Interim GRR recommended improving levee performance by addressing seepage and stability problems, but did not address measures to raise the height of the levees. The recommendations in the Natomas PACR and Interim GRR were authorized in WRRDA 2014. The Natomas PACR and Interim GRR were accompanied by an EIS/EIR produced in compliance with NEPA and CEQA. The Natomas EIS/EIR evaluated the entire project, including levee raises. This was done so that the non-Federal partner (CVFPB and SAFCA) could move forward with implementation of the project in the event of no Federal authorization.

To date CVFPB and SAFCA have constructed levee improvements on the Natomas Cross Canal and the Sacramento River from the Natomas Cross Canal down to RM 66 (Phase 1 – Phase 4a). The Phase 4b project, which was the area covered in the Natomas PACR, Interim GRR, and the Phase 4b EIS/EIR, is currently in the design phase.

ES.5 Need for Action

The purpose of the ARCF GRR is to reduce the flood risk in the greater Sacramento area. The Sacramento Metropolitan area is one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the American or Sacramento Rivers will stress the network of levees protecting the study area to the point that levees could fail. The consequences of such a levee failure would be catastrophic since the inundated area is highly urbanized and the flooding could be up to 20 feet deep.

NEPA evaluation is required when a major Federal action is under consideration and may have significant impacts on the quality of natural and human environment. The Corps has determined that the proposed project may have significant affects on the environment and, therefore, an EIS is required. The EIS/EIR is intended to evaluate the potential significant environmental impacts of the alternatives presented in the GRR.

The Sacramento metropolitan area has a high probability of flooding due to its location at the confluence and within the floodplain of two major rivers. Both of these rivers have large watersheds with very high potential runoff which has overwhelmed the existing flood management system in the past. The existing levee system was designed and built many years ago, before modern construction methods were employed. These levees were constructed close to the river to increase velocities which would flush out hydraulic mining debris. This debris is essentially gone now and the high velocities associated with flood flows are eroding the levees, which are critical components of the flood management system needed to reduce the flood risk in the study area.

In addition to the high probability of flooding, the consequences of flooding in the study area would be catastrophic. The flooding would rapidly inundate a highly urbanized area with minimal warning or evacuation time. As the Capital of California, the Sacramento metropolitan area is the center of State government and many essential statewide services are located here. The study area is also at the crossroads of four major highway/interstate systems that would be impassable should a flood occur. The effects of flooding within the study area would be felt not only at the local level, but at the regional, State, and National level as well.

Under CEQA, the CVFPB's objectives for the project are as follows:

- Reduce the chance of flooding and damages, once flooding occurs, and improve public safety, preparedness, and emergency response.
- Reduce maintenance and repair requirements by modifying the flood management systems in ways that are compatible with natural processes.
- Integrate the recovery and restoration of key physical processes, self-sustaining ecological functions, native habitats, and species.
- Ensure that technically feasible and cost-effective solutions are implemented to maximize the flood risk reduction benefits given the practical limitations of applicable funding sources.

ES.6 Alternatives

ES.6.1 No Action Alternative

The No Action Alternative, under NEPA, is the expected future without-project condition. Under CEQA, the No Action Alternative is the existing condition at the time the notice of preparation was published (February 28, 2008) as modified by what would reasonably be expected to occur in the foreseeable future if the project were not approved. The No Action Alternative assumes that no work would be completed by the Corps and the study area would continue to be at a very high risk of levee failure and subsequent flooding of the Sacramento Metropolitan area. This area includes the California State Capitol and many other State and Federal Agencies.

ES.6.2 Alternative 1 – Improve Levees

Alternative 1 involves the construction of fix-in-place levee remediation measures to address seepage, slope stability, erosion, and overtopping concerns identified for the American and Sacramento River, NEMDC, Arcade, Dry/Robla, and Magpie Creek levees. A vegetation variance would be sought to allow for vegetation to remain on the lower portion of the waterside levee slope. A complete summary of the measures proposed under Alternative 1 is shown on Table ES-1 below.

Table ES-1. Proposed Measures for the ARCF Project.

Waterway/Location	Extent of Action	Proposed Measures
American River	North and south levees from the Sacramento River upstream for approximately 12 miles.	Construct bank protection or launchable rock trenches
Sacramento River	East levee from the American River to the North Beach Lake levee.	Install cutoff walls Construct bank protection Construct levee raise (Alternative 1 – 7 miles Alternative 2 – 1 mile) Construct geotextile reinforced soil embankment levee near the town of Freeport
NEMDC	East levee from Dry Creek/Robla Creek to the American River.	Install cutoff walls Construct floodwalls
Arcade Creek	North and south levees from NEMDC to Marysville Boulevard.	Install cutoff walls Raise floodwalls Construct geotextile reinforced soil embankment levee in steep areas on the south levee
Magpie Creek Diversion Canal	Downstream of Raley Boulevard	Raise levees
Magpie Creek area	West side of Raley Boulevard	Construct new levee Install floodgates at two properties
Magpie Creek area	East of Raley Boulevard	Acquire property to create a flood detention basin
Sacramento Weir and Bypass (Alternative 2 only)	North bypass levee to 1,500 feet north.	Widen the Sacramento Weir and Bypass by approximately 1,500 feet Construct a new section of weir and levee remove the existing Sacramento Bypass north levee

ES.6.3 Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)

Alternative 2 would include all of the levee improvements discussed in Alternative 1, except levee raises along the Sacramento River would be included to a lesser extent. Instead of the full extent of levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The levees along the American River, NEMDC, Arcade Creek, and Magpie Creek, would be improved to address identified seepage, stability, erosion, and height concerns. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns. A small amount of levee raising would still be required on the Sacramento River. Due to environmental, real estate, and hydraulic constraints within the study area, the majority of the levees would be fixed in place. A complete summary of the proposed measures is shown on Table ES-1.

ES.7 Environmental Effects and Mitigation Measures

The effects to the human and natural environment have been considered throughout the planning phase of the study and opportunities have been evaluated to reduce effects to resources within the project area. A vegetation variance will be sought for the Sacramento River reach of the project which will allow vegetation to remain on the lower one third of the waterside levee slope. The waterside vegetation on the Sacramento River is valuable Shaded Riverine Aquatic (SRA) habitat for many State- and Federally listed fish species and State-listed Swainson's hawk. Because the ARCF GRR alternatives would affect Federally listed fish species, consultation under Section 7 of the Endangered Species Act (ESA) is required with the National Marine Fisheries Service (NMFS). Additionally, during the next phase of the project, design refinements will minimize effects to the American River Parkway where feasible.

A summary of the environmental commitments coordinated with the U.S. Fish and Wildlife Service (USFWS), NMFS, and CDFW, is included in the following paragraph. In addition, Table ES-2 at the end of this section includes a full summary of the expected environmental effects that could result from implementation of the proposed alternatives, and the measures proposed to avoid, minimize, or mitigate for those effects.

A biological assessment was prepared and transmitted to USFWS and NMFS on April 3, 2015 (Appendix G). Consultation pursuant to Section 7 of the Endangered Species Act (ESA) has been on-going as part of the ARCF GRR study phase. The Biological Opinion from NMFS was received on September 9, 2015. The Biological Opinion from USFWS was received on September 11, 2015. With receipt of these opinions from the services, and implementation of the enclosed reasonable and prudent measures and terms and conditions, the ARCF GRR is in full compliance with the Federal ESA.

This project was coordinated with USFWS under the Fish and Wildlife Coordination Act (the Fish and Wildlife Coordination Act Report (CAR) is included as Appendix A). Mitigation recommended in the CAR for the Tentatively Selected Plan is included in Table ES-2, which displays the potential impacts and mitigation proposed for each alternative. This mitigation reflects the recommendations presented in the CAR, and has been coordinated with USFWS, NMFS, and CDFW. Section 4.7 of the EIS/EIR includes the recommendations from the CAR and the Corps' response to those recommendations.

A significant and unavoidable impact is one that would result in a substantial or potentially substantial adverse effect on the environment and that could not be reduced to a less-than-significant level even with implementation of applicable feasible mitigation.

Table ES-2. Environmental Impacts and Proposed Mitigation/Compensation for the ARCF GRR.

Habitat Type	Alternative 1 Impacts	Alternative 2 Impacts	Duration of Impact	Mitigation Alternative 1	Mitigation Alternative 2
GGS Uplands	None	30 acres	Permanent	None	90 acres
GGS Aquatic	None	15 acres	Permanent	None	45 acres
Riparian	184 acres	150 acres	Permanent	368 acres	300 acres
SRA habitat (ESA fish species)	80,825 LF	82,325 LF	Single Construction Season	80,825 LF Self Mitigating with on-site planting[2]	82,325 LF Self Mitigating with on-site planting
Elderberry Shrubs	3,292 stems	3,292 stems	Permanent	70 acres	70 acres
Vernal Pools	0.25 acre	0.25 acre	Permanent	1 acre	1 acre
Delta Smelt Spawning	32 acres	32 acres	Permanent	32 acres	32 acres
Delta Smelt Shallow Water Habitat	14 acres	14 acres	Permanent	42 acres	42 acres
Green Sturgeon Benthic	20 acres	20 acres	Permanent	20 acres	20 acres
Oak Woodland	2 acres	2 acres	Permanent	4 acres	4 acres
Wetlands	0.4 acres	0.4 acres	Permanent	1 acre	1 acres

Notes: [1] Assumes vegetation variance is granted for Sacramento River waterside levee compliance and a SWIF for the landside

ES.8 Cumulative Impacts

Cumulative impacts associated with the proposed alternatives are summarized in Table ES-4 below.

ES.9 Areas of Controversy

Based on the comments received during the public scoping period and the history of the NEPA and CEQA processes undertaken by the Corps, CVFPB, and SAFCA, the major areas of public controversy associated with the project area:

- Temporary construction related effects on residents and businesses adjacent to the project levees.
- Construction related impacts on biological resources.
- Vegetation and tree removal.
- Effects to cultural resources and resources significant to Native American tribes.
- Impacts to recreation facilities.
- Impacts to endangered species and their habitat.
- Conversion of private property to flood risk management features.

ES.10 Public Involvement

The Corps published the notice of intent (NOI) to prepare the ARCF GRR EIS in the Federal Register (Vol. 73, No. 41) on February 29, 2008. A series of public scoping meetings were held in March 2008 to present information to the public and to receive public comments on the scope of the EIS. There is no mandated time limit to receive written comments in response to the NOI under NEPA. Appendix F contains the NOI, the one comment letter received in 2008, and copies of the posters for the March 2008 scoping meetings.

The Central Valley Flood Protection Board published the notice of preparation (NOP) to prepare the ARCF GRR EIR with the State of California Clearinghouse on February 27, 2008. The public comment period extended for 30 days until March 28, 2008. A copy of the NOP is included in Appendix F.

The draft GRR and EIS/EIR were circulated for public review beginning on March 13, 2015. The notice of availability (NOA) was published in the Federal Register on March 13, 2015. The draft GRR and EIS/EIR were made available both on the Sacramento District, Corps of Engineers website as well as the website for the Central Valley Flood Protection Board. Hard copies of the draft GRR and EIS/EIR were provided to area libraries. Letters and/or DVD copies of the GRR and EIS/EIR were sent to interested parties, local residents, and to the agencies and elected officials listed in Section 6.4 of the EIS/EIR. Public workshops were held during the review period to provide additional opportunities for comments on the draft documents. All comments received during the public review period were considered and incorporated into the final GRR and EIS/EIR as appropriate. The meeting locations, dates and times were as follows:

- April 8, Hagginwood Community Center—3270 Marysville Blvd, Sacramento (5-7 p.m.).
- April 9, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5-7 p.m.).
- April 15, Library Galleria—828 I Street, Sacramento (3-5 p.m.).
- April 17, Arden-Dimick Library— 891 Watt Ave., Sacramento (5-7 p.m.).

A total of 137 people attended the four meetings. At the meetings, comments were solicited through the use of court reporters. Additionally, comments could be submitted through mail or electronic mail. Oral and written comments were made throughout the series of meetings by local, State, and Federal agencies, community organizations, and individuals.

Public comments on the draft documents focused in part on: 1) access to recreational features during and after construction; 2) design, placement, and justification for rock erosion protection along the American and Sacramento Rivers; 3) effects to vegetation as a result of the alternatives; 4) clear presentation of the anticipated level of the performance of the project; and 5) coordination with stakeholders in future phases of the project. The comments and the responses to them are summarized in the Public Involvement Appendix (Appendix F).

After considering any additional comments received during public review of the final EIS/EIR, the Corps will sign a Record of Decision (ROD) for the project. The ROD is a written, public record explaining why the Corps chose a particular course of action. The selected action and any practicable mitigation measures will be identified in the ROD. The proposed action cannot be initiated before the ROD is signed. In addition, project construction is also contingent on congressional authorization and appropriation of funds.

ES.11 Recommended Plan

Alternative 2, Improve Levees and Widen the Sacramento Weir and Bypass has been identified as the Recommended Plan. This alternative would include widening the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass and alleviate the need for most of the raises along the Sacramento River downstream of the Sacramento Bypass. This alternative would also include the levee improvements identified in Alterative 1, namely the construction of levee improvement measures to address seepage, stability, and erosion, identified for the Sacramento River, NEMDC, Arcade Creek, and Magpie Creek. Alternative 2 would also include erosion measures for specific locations along the American River.

The Recommended Plan has been identified as the Environmentally Preferable Alternative under NEPA and the Environmentally Superior Alternative under CEQA. The Recommended Plan is also the Least Environmentally Damaging Practicable Alternative under Section 404 of the Clean Water Act as it results in less riparian habitat removal along the Sacramento River and therefore less impacts to the aquatic ecosystem. Additionally, habitat could be created in the expanded Sacramento Bypass. The exact location and amount of habitat to be created in the expanded Bypass would be evaluated during the design phase of the project.

Table ES.3 Summary of Environmental Effects and Mitigation Measures.

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)
Land Use			
Effect	Inconsistent with local land use policies to protect existing urban area.	Acquisition of properties for levee easements along the Sacramento River and Arcade Creek.	Acquisition of properties for levee easements along the Sacramento River and Magpie Creek. Conversion of agricultural lands to floodway.
Significance	Significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	None required.	Federal Relocation Act compliance. Payment of Sacramento County Habitat Restoration Program fees in the American River Parkway.	Federal Relocation Act compliance. Payment of Sacramento County Habitat Restoration Program fees in the American River Parkway.
Hydrology and Hydraulics			
Effect	Emergency repairs during a flood event could result in the loss of channel capacity and alternation of current geomorphic processes.	No effect.	Reduce water surface elevation in the Sacramento River downstream of the confluence of the American River without significantly increasing water surface elevation in the Yolo Bypass downstream of the confluence of the Sacramento Bypass.
Significance	Significant.	Not applicable.	Less than significant.
Mitigation	None possible.	Not applicable.	None required.
Water Quality			
Effect	In a flood event, there is high risk of contaminants entering the water from utilities, stored chemicals, septic systems, and flooded vehicles. In addition, flood flows would increase bank erosion, increasing turbidity in the waterways.	Potential impacts include increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction.	Potential impacts include increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction.

	No Action Alternative	**Alternative 1 – Improve Levees**	**Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)**
Significance	Significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	None possible.	Preparation of a Stormwater Pollution. Protection Plan, Spill Prevention Control and Countermeasures Plan, and a Bentonite Slurry Spill Contingency Plan. Implementation of BMPs listed in Section 3.5.6.	Preparation of a Stormwater Pollution. Protection Plan, Spill Prevention Control and Countermeasures Plan, and a Bentonite Slurry Spill Contingency Plan. Implementation of BMPs listed in Section 3.5.6.
Vegetation and Wildlife			
Effect	Erosion during a flood event could cause significant vegetation loss and wildlife habitat loss. Flood fighting activities could prevent future vegetation growth on river banks.	Construction of levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat on the landside of the Sacramento River levees, in the American River Parkway, and along Arcade Creek.	Construction of levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat on the landside of the Sacramento River levees, in the American River Parkway, and along Arcade Creek. Construction of the Sacramento Weir extension would require the removal of riparian vegetation. Widening of the Sacramento Weir and Bypass would result in a reduced affect to landside vegetation.
Significance	Significant.	Significant short term impacts. Long term effects are less than significant with mitigation.	Significant short term impacts. Long term effects are less than significant with mitigation.
Mitigation	Compensation would likely occur after the fact, but there would still be significant direct impacts due to the temporal loss of vegetation.	When possible, in-kind compensation would be planted on planting berms, on top of launchable rock trenches, or on other lands within the Parkway. Additional mitigation sites are identified in Section 3.6.6.	When possible, in-kind compensation would be planted on planting berms, on top of launchable rock trenches, or on other lands within the Parkway. A hydraulic evaluation will be conducted to determine whether mitigation could occur in the Sacramento Bypass. Additional mitigation sites are identified in Section 3.6.6.

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)
Fisheries			
Effect	Flood fighting could prevent growth of vegetation on levee slopes, and increase turbidity, thus impacting migration, spawning, or rearing habitat.	Indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the placement of rock at bank protection sites, causing an increase in turbidity.	Indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the placement of rock at bank protection sites, causing an increase in turbidity. Widening the Sacramento Bypass creates floodplain, which could provide a benefit to fish species.
Significance	Significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	Compensation would likely occur after the fact, but there would still be significant direct impacts due to the temporal loss of vegetation.	Vegetation variance would allow waterside vegetation to remain on the lower one-third of the waterside slope along the Sacramento River. Bank protection sites and launchable rock trenches would be revegetated following construction. BMPs would be implemented to address turbidity, and are discussed in Section 3.5.6.	Vegetation variance would allow waterside vegetation to remain on the Sacramento River. Bank protection sites and launchable rock trenches would be revegetated following construction. BMPs would be implemented to address turbidity, and are discussed in Section 3.5.6.
Special Status Species			
Effect	Flood event or flood fight could cause loss of habitat and fatality to species.	Direct effects to Giant Garter Snake (GGS), valley elderberry longhorn beetle, salmonids, green sturgeon, Delta smelt, Western yellow-billed cuckoo, vernal pool crustaceans, and Swainson's Hawks during construction. Indirect effects due to loss of habitat and temporal effects while habitat mitigation establishes. Vegetation Variance for the waterside levee slopes would significantly limit the effects to endangered fish species.	Direct effects to Giant Garter Snake (GGS), valley elderberry longhorn beetle, salmonids, green sturgeon, Delta smelt, Western yellow-billed cuckoo, vernal pool crustaceans, and Swainson's Hawks during construction. Indirect effects due to loss of habitat and temporal effects while habitat mitigation establishes. Vegetation Variance for the waterside levee slopes would significantly limit the effects to endangered fish species. Effects to listed

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)
			fish species due to increased stranding potential at the Sacramento Bypass.
Significance	Significant.	Less than Significant with mitigation	Less than Significant with mitigation
Mitigation	None proposed.	Mitigation per the terms of the Biological Opinions (Appendix J). Replace habitat for species either on-site or in close proximity to lost habitat. Implement BMPs discussed in Section 3.5.6 and conservation measures in the BOs during construction to prevent mortality. Implement green sturgeon modeling and monitoring to improve effects assessment, minimize construction impacts, and mitigate for lost benthic habitat per the terms of the BOs.	Mitigation per the terms of the Biological Opinions (Appendix J). Replace habitat for species either on-site or in close proximity to lost habitat. Implement BMPs discussed in Section 3.5.6 and conservation measures in the BOs during construction to prevent mortality. Implement green sturgeon modeling and monitoring to improve effects assessment, minimize construction impacts, and mitigate for lost benthic habitat per the terms of the BOs. Implement fish passage at the Sacramento Bypass, and grade the widened Sacramento Bypass to reduce stranding potential.
Cultural Resources			
Effect	Damage to historic and prehistoric resources during a flood event.	Adverse effects to historic properties from construction of levee improvements.	Adverse effects to historic properties from construction of levee improvements and the bypass widening.
Significance	Potentially significant.	Adverse effects resolved with mitigation under NHPA and reduced to less than significant with mitigationunder NEPA. Potentially significant and unavoidable under CEQA.	Adverse effects resolved with mitigation under NHPA and reduced to less than significant with mitigation under NEPA. Potentially significant and unavoidable under CEQA.
Mitigation	None possible.	Preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans.	Preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans.

	No Action Alternative	**Alternative 1 – Improve Levees**	**Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)**
Transportation and Circulation			
Effect	Potential for flooded roadways in a flood event. Damage to roadways from flooding and clean-up. Flood clean-up would create large volumes of truck traffic to remove flood debris.	Increased traffic on public roadways.	Increased traffic on public roadways.
Significance	Significant.	Significant.	Significant.
Mitigation	None possible.	Preparation of a Traffic Control and Road Management Plan and other BMPs listed in Section 3.10.6.	Preparation of a Traffic Control and Road Management Plan and other BMPs listed in Section 3.10.6.
Air Quality			
Effect	Increased emissions during flood fighting activities without BMPs in place. Increased emissions during clean-up and reconstruction of the urban area including; homes, businesses, public facilities.	Emissions of criteria pollutants from construction equipment, haul trucks, and barges.	Emissions of criteria pollutants from construction equipment, haul trucks, and barges.
Significance	Significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	None possible.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.11.6.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.11.6.
Climate Change			
Effect	Increased GHG emissions during flood fighting activities without BMPs in place. Increased GHG emissions caused by clean-up efforts from a flood event.	Increased GHG emissions from construction equipment, haul trucks, and barges.	Increased GHG emissions from construction equipment, haul trucks, and barges.

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)
Significance	Significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	None possible.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.12.6.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.12.6.
Noise			
Effect	Increased noise during flood fighting.	Increased noise in proximity to sensitive receptors due to construction activities.	Increased noise in proximity to sensitive receptors due to construction activities.
Significance	Less than significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	Not applicable.	Coordination with local residents, compliance with noise ordinances, and other BMPs, as listed in Section 3.13.6.	Coordination with local residents, compliance with noise ordinances, and other BMPs, as listed in Section 3.13.6.
Recreation			
Effect	Damage to recreation facilities, particularly in the Parkway, would be impacted by flooding and potentially loss due to erosion.	Temporary closure of recreation facilities in the American River Parkway during construction, including bike trail, walking trails, and boat launches.	Temporary closure of recreation facilities in the American River Parkway during construction, including bike trail, walking trails, and boat launches. Possible closure of the Sacramento Bypass during portions of hunting season.
Significance	Significant.	Significant.	Significant.
Mitigation	None possible.	Notification and coordination with recreation users and bike groups. Flaggers, signage, detours, and fencing to notify and control recreation access and traffic around construction sites.	Notification and coordination with recreation users and bike groups. Flaggers, signage, detours, and fencing to notify and control recreation access and traffic around construction sites.
Aesthetics and Visual Resources			
Effect	A flood event would damage the visual character in the study area.	Vegetation loss and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River.	Vegetation loss and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River.
Significance	Significant.	Significant.	Significant.

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)
Mitigation	None possible.	Trees would be planted after construction is completed on planting berms and on top of launchable rock trenches, however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.	Trees would be planted after construction is completed on planting berms and on top of launchable rock trenches, however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.
Public Utilities and Services			
Effect	In a flood event there could be significant damage to utility systems. Debris from flooded homes and properties could overwhelm solid waste disposal facilities.	Temporary disruptions to utility services possible, particularly during relocation of utilities that penetrate the levee.	Temporary disruptions to utility services possible, particularly during relocation of utilities that penetrate the levee.
Significance	Significant.	Less than significant.	Less than significant.
Mitigation	None possible.	Notification of potential interruptions would be provided to the appropriate agencies and to landowners.	Notification of potential interruptions would be provided to the appropriate agencies and to landowners.
Hazardous, Toxic, and Radiological Wastes			
Effect	Flooding could release potential household chemicals and cause damage to sewage treatment plants.	No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction.	No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction, including the Old Bryte Landfill.
Significance	Significant	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	None Possible.	Borrow material would be tested prior to use to ensure that no contaminated soils are used for this project.	Borrow material would be tested prior to use to ensure that no contaminated soils are used for this project.
Socioeconomics, Population, and Environmental Justice			
Effect	Flooding of residential areas and displacement of populations during a flood event. Flooding of the State	Disruption to residents alongside construction sites from traffic, noise, and dust. Acquisition of properties for levee	Disruption to residents alongside construction sites from traffic, noise, and dust. Acquisition of properties for levee

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass (Recommended Plan)
	Capitol's government centers also possible.	easements.	easements.
Significance	Significant.	Less than significant.	Less than significant.
Mitigation	None possible.	Federal Relocation Act compliance.	Federal Relocation Act compliance.

Table ES-4. Summary of Potential Cumulative Effects and Mitigation

Resource	Effect	Significance	Mitigation
Water Quality	Regional water quality could be diminished by construction of multiple projects at the same time.	Less than significant.	Implementation of Best Management Practice (BMP'S) on all active construction projects would reduce the risk of effects to water quality.
Vegetation and Wildlife	Multiple projects could impact vegetation and wildlife through the removal of vegetation and wildlife habitat during construction.	Significant.	All projects would implement their own mitigation measures, however, the temporal loss of vegetation and wildlife habitat would remain a significant effect until the time when compensatory planting have fully matured.
Fisheries	Multiple projects could affect fish habitat through construction of bank protection sites and the removal of vegetation to comply with the Engineering Technical Letter (ETL) 1110-2-583.	Less than significant with mitigation.	While there would be a short-term effect to vegetation, any projects removing vegetation would be required to provide compensatory plantings, including planting berms in the bank protection sites, when feasible. In addition, some projects, such as the Folsom Dam Water Control Manual Update, could potentially benefit fish migration and spawning. Overall, these projects should provide a cumulative net benefit to fish species.
Special Status Species	Multiple projects could affect endangered species through	Significant.	All projects would implement their own mitigation measures, however, the

Resource	Effect	Significance	Mitigation
	construction occurring at the same time. Additionally, if multiple projects remove habitat at the same time the temporal loss could be larger due to duration a greater area would take to establish and provide similar value to that removed.		temporal loss of habitat would remain a significant effect until the time when compensatory planting have fully matured. There is potential for the multiple projects to combine mitigation in a single location which could provide cost savings and higher value habitat for listed species.
Cultural Resources	Multiple projects would likely impact cultural resources in a manner consistent with the ARCF project.	Significant.	Each project would be expected to implement mitigation, such as preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans. Resolution of all adverse effects across multiple projects is unlikely considering the nature of finite cultural resources that may be lost or damaged by the implementation of these projects. Although mitigation would minimize these impacts, there is still likely a significant cumulative effect to cultural resources.
Transportation and Circulation	None of the related projects are anticipated to be in close enough proximity to the ARCF construction sites to cause a cumulative effect.	No effect.	None required.
Air Quality	Construction of multiple projects at the same time that result in emissions of criteria pollutants would cause a regional cumulative effect.	Significant.	Each project would be coordinating with the local air quality management district to ensure that project emissions comply with Federal, State, and local thresholds. The Corps would ensure that construction sites in close proximity, such as ARCF and West Sacramento, would not be

Resource	Effect	Significance	Mitigation
			constructing adjacent sites at the same time.
Climate Change	Construction of multiple projects at once could result in cumulative GHG emissions above the reporting requirements.	Less than significant with mitigation.	Each project would be required to implement mitigation measures to reduce GHG emissions to less than significant. In addition, flood risk management projects would reduce potential future emissions from flood fighting and emergency activities.
Noise	None of the related projects are anticipated to be in close enough proximity to the ARCF construction sites to cause a cumulative effect.	No effect.	None required.
Recreation	None of the related projects are anticipated to be in close enough proximity to the ARCF construction sites to cause a cumulative effect.	No effect.	None required.
Visual Resources	Construction of multiple projects along the waterways in the Sacramento region would result in a cumulative impact to visual resources due to the removal of vegetation along these waterways and disturbance from construction activities.	Significant.	Each project would implement mitigation measures to assist with the revegetation in the region. Disturbed areas would be reseeded with native grasses following construction. Regardless, there would be a short-term significant effect.

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ACRONYMS AND ABBREVIATIONS

ACE	annual chance of exceedance
ACHP	Advisory Council on Historic Preservation
AEP	annual exceedance probability
APE	area of potential effect
APN	assessor parcel number
ARCF	American River Common Features
ARFCD	American River Flood Control District
BAAQMD	Bay Area Air Quality Management District
BACT	best available control technology
BDCP	Bay Delta Conservation Plan
BMPs	best management practices
BO	biological opinion
BOD	biochemical oxygen demand
BP	before present
BSSCP	bentonite slurry spill contingency plan
°C	degrees Celsius
CAPCOA	California Air Pollution Control Officers Association
CAR	Coordination Act Report
CAA	Federal Clean Air Act
CAAQS	California ambient air quality standards
CalTrans	California Department of Transportation
CARB	California Air Resources Board
CDC	California Department of Conservation
CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CH_4	methane
CHP	California Highway Patrol
CNDDB	California Natural Diversity Database
CNEL	community noise equivalent level
CNPS	California Native Plant Society
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
CSLC	California State Lands Commission
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CVP	Central Valley Project
Corps	United States Army Corps of Engineers
County Parks	Sacramento County Department of Parks and Recreation
CSUS	California State University, Sacramento

CWA	Clean Water Act
cy	cubic yards
dB	decibel
dBA	A-weighted decibel
DEIS/EIR	draft environmental impact statement/environmental impact report
DO	dissolved oxygen
DPM	diesel particulate matter
DPS	distinct population segment
DSM	deep soil mixing
DTSC	California Department of Toxic Substance Control
DWR	California Department of Water Resources
EC	electrical conductivity
EFH	essential fish habitat
EIS/EIR	environmental impact statement/environmental impact report
EO	executive order
ESA	Endangered Species Act
ETL	Engineering Technical Letter
°F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Maps
FRAQMD	Feather River Air Quality Management District
FWCA	Fish and Wildlife Coordination Act
GGS	giant garter snake
GHG	greenhouse gas
GRR	general reevaluation report
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
HALS	Historic American Landscape Survey
HEP	habitat evaluation procedures
HMMAMP	habitat mitigation, monitoring, and adaptive management plan
HMMP	habitat mitigation and monitoring Plan
HPMP	Historic Properties Management Plan
HPTP	Historic Properties Treatment Plan
HRP	habitat restoration program
HTRW	hazardous, toxic, or radioactive waste
I-5	Interstate 5
I-80	Interstate 80
IPCC	Intergovernmental Panel on Climate Change
IWM	instream woody material
JFP	Joint Federal Project
L_{dn}	day-night sound level
L_{eq}	equivalent sound level
lf	linear feet
LMA	local maintaining agency
L_{max}	maximum sound level
L_{min}	minimum sound level

LOS	level of service
L_{xx}	exceedance sound level (xx = percentage of sound)
M	magnitude
MIAD	Mormon Island Auxiliary Dam
MOA	memorandum of agreement
NAAQS	national ambient air quality standards
NCIC	North Central Information Center
NEMDC	Natomas East Main Drainage Canal
NEPA	National Environmental Policy Act
NF_3	nitrogen trifluoride
NFIP	National Flood Insurance Program
NGA	Next Generation Attenuation
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
NO_x	nitric oxide
NO_2	nitrogen dioxide
NOA	naturally occurring asbestos
NOI	notice of intent
NOP	notice of preparation
N_2O	nitrous oxide
NPDES	National Pollutant Discharge Elimination System
NRCS	U.S. National Resources Conservation Service
NRHP	National Register of Historic Places
NTUs	nephelometric turbidity units
O_3	ozone
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
PA	programmatic agreement
PACR	post authorization change report
Parkway	American River Parkway
pB	lead
PCB	polychlorinated biphenyl
PED	preconstruction engineering and design
PG&E	Pacific Gas and Electric Company
pH	potential of hydrogen
Phase 1 ESA	Phase 1 Environmental Site Assessment
$PM_{2.5}$	fine particulate matter
PM_{10}	inhalable particulate matter
ppm	parts per million
ppt	parts per thousand
ppv	peak particle velocity
PRC	California Public Resources Code
PSHA	Probabilistic Seismic Hazard Analysis
RCEM	SMAQMD Road Construction Emissions Model
RM	river mile
ROD	record of decision
ROG	reactive organic gases

RWQCB	Central Valley Regional Water Quality Control Board
SAFCA	Sacramento Area Flood Control Agency
SAM	Standard Assessment Methodology
SF_6	sulfur hexafluoride
SHPO	State Historic Preservation Officer
SIP	state implementation plan
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMARA	Surface Mining and Reclamation Act of 1975
SMUD	Sacramento Municipal Utility District
SO_2	sulfur dioxide
SPCCP	Spill Prevention Control and Countermeasures Plan
SRA	Shaded Riverine Aquatic (habitat)
SRBPP	Sacramento River Bank Protection Project
SRCSD	Sacramento Regional County Sanitation District
SRFCP	Sacramento River Flood Control Project
SVAB	Sacramento Valley Air Basin
SWA	Sacramento Regional Solid Waste Authority
SWIF	System Wide Improvement Framework
SWP	State Water Project
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	California State Water Resources Control Board
TAC	toxic air contaminates
TCP	traditional cultural properties
TDS	total dissolved solids
TMDL	total maximum daily load
TSP	tentatively selected plan
TSS	total suspended solids
UC Davis	University of California, Davis
UPRR	Union Pacific Railroad
U.S. 50	U.S. Highway 50
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
VELB	valley elderberry longhorn beetle
WCM	water control manual
WRDA	Water Resources Development Act
WRRDA	Water Resources Reform and Development Act
YSAQMD	Yolo-Solano Air Quality Management District

1.0 INTRODUCTION

This document is a joint environmental impact statement/environmental impact report (EIS/EIR) prepared by the U.S. Army Corps of Engineers (Corps), Sacramento District as the Federal Lead Agency under the National Environmental Policy Act (NEPA) and the State of California Central Valley Flood Protection Board (CVFPB) as the State Lead Agency under the California Environmental Quality Act (CEQA). The Sacramento Area Flood Control Agency (SAFCA) is the local sponsor and has a Local Cooperation Agreement with the CVFPB.

NEPA applies to all "major Federal actions significantly affecting the quality of the human environment" (42 U.S.C. § 4332(C)) and is intended to result in better informed decisions and to allow for greater public involvement. Under NEPA, an EIS must be prepared when a major Federal action is under consideration that may have significant impacts on the quality of the natural and human environment. The Corps has determined that the proposed project may have significant affects on the environment and, therefore, an EIS is required. This EIS/EIR has been prepared to evaluate the potential environmental impacts of the alternatives proposed in the American River Common Features Project General Reevaluation Report (ARCF GRR). This document evaluates project alternatives, and includes mitigation measures to reduce, minimize, or avoid, where feasible, any significant and potentially significant adverse impacts.

1.1 Scope of the Environmental Analysis

The ARCF GRR is being prepared by the Corps to consider the level of Federal participation in flood risk management for the Sacramento Metropolitan area. This EIS/EIR will analyze the environmental effects of the proposed alternatives using the largest footprint that is expected to be constructed. The scope of the GRR will include the evaluation of the Federal interest in addressing seepage, slope stability, erosion, and height concerns on the levees in.

During the preconstruction engineering and design phase of the project, if authorized, the Corps would then do a site-specific analysis including full biological site surveys and site-specific engineering. The Corps shall prepare supplements to either draft or final environmental impact statements if: (i) the Corps makes substantial changes in the proposed action that are relevant to environmental concerns; or (ii) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.

The alternatives being analyzed assume a vegetation variance would be obtained for the lower one half of the waterside levee slope on all waterways. This would allow vegetation to remain in place unless required for construction. Additionally, the No Action alternative assumes that the non-Federal sponsor would prepare a System Wide Implementation Framework (SWIF) to bring the levees into compliance with Engineer Technical Letter (ETL) 1110-2-583 *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*, over the next 20 to 40 years. The SWIF involves committing to an approach for addressing operation and maintenance (O&M) issues in the levee system, including vegetation and other encroachments impacting the levees. Details of the alternatives are presented in Section 2.0 Alternatives below.

1.2 Project Location and Study Area

1.2.1 Project Location

The project is located in Sacramento, California. Sacramento is the state capital, located at the confluence of the Sacramento and American Rivers in the northern portion of California's Central Valley. The fourth largest metropolitan area in California, the Sacramento Metropolitan area includes six counties (Sacramento, El Dorado, Placer, Sutter, Yolo, and Yuba) and seven incorporated cities (Sacramento, Rancho Cordova, Elk Grove, Roseville, Citrus Heights, Rocklin, and Folsom).

The project area includes the lower portion of the Sacramento and American River Watersheds. The Sacramento River Watershed covers approximately 27,000 square miles in northern California. Major tributaries of the Sacramento River include the Feather, Yuba, and American Rivers. The American River Watershed covers about 2,100 square miles northeast of the city of Sacramento and includes portions of Placer, El Dorado, Alpine, and Sacramento counties. The American River watershed includes Folsom Dam and Reservoir; inflowing rivers and streams, including the North, South, and Middle forks of the American River; and the American River downstream to its confluence with the Sacramento River in the city of Sacramento. The Sacramento and American Rivers, in the Sacramento area, form a flood plain covering roughly 110,000 acres at their confluence. The flood plain includes most of the developed portions of the city of Sacramento. Plate 1 shows the American and Sacramento River watersheds.

1.2.2 Study Area

The ARCF Project study area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Arcade Creek, and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport where the levee ties into Beach

Lake Levee, and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento in Yolo County, California (Plate 2).

Within the greater study area, there are three subbasins that are defined by either levees or high ground: (1) the American River North Basin; (2) the American River South Basin; and (3) the Natomas Basin. These basins are described in greater detail below and shown on Plate 2. The Sacramento Bypass is an additional geographic area under analysis, and is described separately below. For the purposes of the impact analyses in Chapter 3, the majority of the resources will be discussed by the waterways described in the paragraph above.

American River North Basin

This basin is located east of Natomas and north of the American River, and includes the North Sacramento and Arden Arcade areas of Sacramento. The levees in this basin include the north bank of the American River, the east bank of the NEMDC, Arcade Creek, the Dry/Robla Creek basin, and the Magpie Creek Diversion Channel.

American River South Basin

This basin is located south of the American River. It is bounded by the American River to the north and the Sacramento River to the west. The Downtown Sacramento, Land Park-Pocket-Meadowview, East Sacramento, South Sacramento, and Rancho Cordova areas are included in this basin.

Sacramento Bypass

The Sacramento Bypass is located in Yolo County approximately 4 miles west of Sacramento along the northern edge of the city of West Sacramento. The Sacramento Weir runs along the west bank of the Sacramento River and separates the river from the Bypass. The Sacramento Bypass is located in a rural area owned by the State of California and operated as the Sacramento Bypass Wildlife Area.

1.3 Background and History of the American River Common Features Project

Following the 1986 flood, Congress directed the Corps to investigate additional means to reduce flood risk to the city of Sacramento. The Corps completed this investigation in 1991, recommending a concrete gravity flood detention dam at the Auburn Dam site and levee improvements downstream of Folsom Dam. Congress directed the Corps to conduct supplemental analysis of the flood management options considered in the 1991 study. The resulting *Supplemental Information Report, American River Watershed Project, California* (March 1996) recommended a similar combination of a gravity flood

detention dam at the Auburn Dam site with downstream levee work. It considered, but did not advance, plans for Folsom Dam improvements and a stepped release plan for Folsom Dam accompanied by downstream levee improvements. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features". Thus, the American River Common Features Project was authorized in the Water Resources Development Act (WRDA) of 1996, Pub. L. No. 104-303, §101(a)(1), 110 Stat. 3658, 3662-3663 (1996), and the decision on Auburn Dam was deferred. Major construction components for ARFC Project included construction of seepage remediation along approximately 22 miles of American River levees, and levee strengthening and the raising of 12 miles of the Sacramento River levee in the Natomas Basin (Table 1). Meanwhile, improvements to other levees adjacent to the Natomas Basin were authorized in the Department of Defense Appropriations Act of 1993, Pub. L. No. 102-396, § 9159, 106 Stat. 1876, 1944-1946 (1992). SAFCA constructed these latter improvements between 1995 and 1998.

In WRDA 1999, Pub. L. No. 106-53, § 366, 113 Stat. 269, 319-320 (1999), Congress authorized improvements to Folsom Dam to control a 200-year flood event with a peak release of 160,000 cfs. WRDA 1999 also authorized the Folsom Dam Modification Project to modify the existing outlets to allow for higher releases earlier in flood events, WRDA 1999, Pub. L. No. 106-53, § 366, 113 Stat. 269, 319-320 (1999). At the same time, Congress also directed the Corps to review additional modifications to the flood storage of Folsom Dam, indicating that Congress was looking at maximizing the use of Folsom Dam to reduce flood risk prior to consideration of any additional storage on the American River. The Folsom Dam Raise Project was subsequently authorized by Congress in 2003. EWDAA 2004, Pub. L. No. 108-137, § 129, 121 Stat. 1844, 1947 (2003)

The ARCF Project was modified by WRDA 1999 to include improvements to safely convey an emergency release of 160,000 cubic feet per second (cfs) from Folsom Dam. These improvements included construction of seepage remediation and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of the Natomas Cross Canal levee in Natomas. Additional construction components for both WRDA 1996 and 1999 were authorized, but are not described here.

Construction will be completed on all American River levee features authorized in WRDA 1996 and WRDA 1999 by fall 2015, with the exception of the Natomas features. The Natomas features were deferred for further analysis, and are further discussed below. Design and construction of the WRDA 1996 and WRDA 1999 sites were conducted through a Project Cooperation Agreement with the California Reclamation Board (now known as the Central Valley Flood Protection Board [CVFPB]), which was executed on July 13, 1998. Cost sharing for these features is 75% Federal and 25% non-Federal.

Table 1. Authorized Project Features.

1996 Authorization
Approximately 24 miles of slurry walls along the lower American River
Approximately 12 miles of levee modifications along the east bank of the Sacramento River downstream from the NCC
Three telemeter stream gauges upstream from Folsom Reservoir
Modification of the flood warning system on the American River
1999 Authorization
Raising the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet by an average of 2.5 feet
Raising the right bank of the American River levee from 1,500 feet upstream to 4,000 feet downstream of the Howe Avenue Bridge by an average of 1 foot
Modifying the south levee of the NCC for a distance of 5 miles to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River.
Modifying the north levee of the NCC for a distance of 5 miles to ensure that the height of the levee is equivalent to the height of the south levee as authorized
Installing gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates
Installing a slurry wall in the north levee of the American River from the east levee of the NEMDC upstream for a distance of approximately 1.2 miles
Installing a slurry wall in the north levee of the American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to the end of the existing levee
2004 Folsom Dam Raise
Raising the height of Folsom Dam by 7 feet. In addition, temperature control shutters for the inlets to the Folsom Dam penstock would be mechanized to better regulate the American River Water temperature to increase native salmon and steelhead populations downstream of the dam.
2006 Chief's Discretionary Authority
Installing a total of 3.6 miles of discontinuous slurry wall at nine levee sites beginning at Levee Mile 2.9 and ending at Levee Mile 10.3 on the Sacramento River in the Pocket Area
Installing six relief wells and collector drains and appurtenant features and a landside berm on the levee toe on the Sacramento River in the Pioneer Reservoir area
2010 Natomas PACR and Interim General Reevaluation Report*
Widen 2.0 miles of levee in place and install seepage cutoff wall through levee and foundation on the Lower American River
Widen 18.3 miles of existing levee by construction of an adjacent levee, install 12.3 miles of deep seepage cutoff walls, and install 8.3 miles of seepage berm, all on east bank of Sacramento River below Natomas Cross Canal
Widening of the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet on the Pleasant Grove Creek Canal.
Widening of 12.8 miles of the existing levee and installation of 10.7 miles of soil bentonite cutoff wall on the Natomas East Main Drain Canal
Widening of 5.5 miles of existing levee using in-place construction and install deep seepage cutoff walls on south bank of Natomas Cross Canal

*For the purposes of this report, it is assumed that the recommended plan contained in the Natomas PACR and Interim General Reevaluation Report is authorized and its features are in place. Congressional authorization will be required. (This includes those areas already constructed by SAFCA)

In February 1986, a series of storms led to severe flooding in central and northern California. In many areas, precipitation from this 10-day storm delivered more than half of the normal annual precipitation for the area. The Sacramento River flood control system was overloaded and reservoirs in the system were filled beyond their design capacity. Record flow releases from the reservoirs produced river flows that exceeded the design capacity of downstream levees: water encroached into the design freeboard risking overtopping levees throughout the system including those protecting Sacramento.. The timely cessation of the storm event prevented overtopping of the American River levees. At the runoff peak, an estimated 650,000 cfs flowed past the Sacramento metropolitan area into either the Sacramento River or Yolo Bypass and out to the Sacramento Delta.

Emergency levee work and flood fighting prevented catastrophic flooding. However, the extended high water caused boils, slips, sloughing, seepage, flood flow erosion, and wave erosion that required emergency work to minimize or prevent further damage during the flood. Several levees upstream from Sacramento failed during this flood. At the conclusion of the storm, the Governor declared emergencies in 39 counties, with damages totaling more than $500 million. Sacramento County had damages estimated at $49 million (1986 dollars).

Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5 and on both the north and south bank of the American River. Seepage on the Sacramento River was so extensive that soon after the 1986 flood event, Congress funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport. At the time, seepage through the levees was considered to be the only significant seepage problem affecting the levees in the Sacramento area.

After construction of the Sac Urban project, the Sacramento Valley experienced a flood event in 1997. The seepage from this event led to a geotechnical evaluation of levees in the vicinity of the city of Sacramento which showed that deep underseepage was of concern. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was expected because remediation had yet to be constructed. However, the occurrence of significant seepage on the Sacramento River in the reach remediated as part of the Sac Urban project confirmed that deep underseepage was a significant concern in this area, a conclusion later confirmed by the Levee Seepage Task Force in 2003.

Following the recognition of deep underseepage as a major concern, levees on the American River needed to be redesigned to address both through and deep underseepage. The redesign led to considerable cost increases over what was originally authorized by Congress. The WRDA 96 authorized cost of $56 million increased to $91.9 million under WRDA 1999, and again increased to $205 million under the Energy and Water Development Appropriations Act of 2004 (Pub. L. 108-137).

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress for the project in the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a reevaluation study would be required for at least the Natomas portion of the ARFC Project. Congress was notified in 2004 that additional authorized cost increases would be required for study, design, and construction of levee improvements in the Natomas Basin.

While the reevaluation study was beginning for the ARFC Project, the Folsom Dam Post Authorization Change Report (PACR) was being completed by the Sacramento District. The results of this study, and of the follow-on Economic Reevaluation Report for Folsom Dam improvements, showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to truly capture the benefits of the Folsom Dam projects. These levee problems consisted primarily of erosion concerns on the American River and seepage, stability, erosion, and height problems on the Sacramento River below the confluence with the American River. However, the full extent of these levee problems was not known. Because of this, it was realized that additional reevaluation studies were also needed to include the two remaining basins comprising the city of Sacramento: American River North and American River South. The reevaluation was begun in 2006. The reevaluation of American and Sacramento River levees began in 2006, non-federal interests initiated the Natomas Levee Improvement Program to address severe seepage, underseepage, erosion and levee overtopping issues affecting the levees protecting the Natomas Basin. This non-federal program involving improvements to approximately 18 miles of the basin's 42 mile perimeter levee system was permitted by the Corps under a series of Section 408 permissions and was substantially completed by the non-federal partners in 2012.

In December 2010, the Natomas Basin PACR and Interim GRR were completed, which focused on the problems associated with the existing levees in the Natomas Basin. The Natomas PACR and Interim GRR recommended improving levee performance by addressing seepage and stability problems. The recommendations included in the Natomas PACR and Interim GRR were authorized by the Water Resources Reform and Development Act of 2014 (WRRDA 2014), Pub. L. No. 113-121, § 7002, 128 Stat. 1193, 1366, (2014).

1.4 Project Purpose and Need for Action

The purpose of the ARCF GRR is to reduce the overall flood risk within the study area. An unacceptably high risk of flooding from levee failure threatens the public safety of approximately 530,000 people as well as property and critical infrastructures throughout the study area. Additionally, the State Capitol and many state agencies reside within the study area. Historic flooding events have caused loss of life and extensive economic damages. Approximately 83,000 structures throughout the study area are at risk of flooding in a 100-year event (1% annual change of flooding).

The Sacramento Metropolitan area is one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the American or Sacramento Rivers will stress the network of levees protecting the study area to the point that levees could fail. The consequences of such a levee failure would be catastrophic since the inundated area is highly urbanized and the flooding could be up to 20 feet deep. Plate 3 shows where problems occur throughout the study area.

The Sacramento Metropolitan area has a high probability of flooding due to its location at the confluence and within the floodplain of two major rivers. Both of these rivers have large watersheds with very high potential runoff which has overwhelmed the existing flood management system in the past. The existing levee system was designed and built many years ago, before modern construction methods were employed. These levees were constructed close to the river to increase velocities which would flush out hydraulic mining debris. This debris is essentially gone now and the high velocities associated with flood flows are eroding the levees which are critical components of the flood management system necessary to reducing the flood risk in the study area. In addition to the high probability of flooding, the consequences of flooding in the study area would be catastrophic. The following sections describe in detail the factors which contribute to the high probability of flooding in the study area.

Under CEQA, the CVFPB's objectives for the project are as follows:

- Reduce the chance of flooding and damages, once flooding occurs, and improve public safety, preparedness, and emergency response.
- Reduce maintenance and repair requirements by modifying the flood management systems in ways that are compatible with natural processes.
- Integrate the recovery and restoration of key physical processes, self-sustaining ecological functions, native habitats, and species.
- Ensure that technically feasible and cost-effective solutions are implemented to maximize the flood risk reduction benefits given the practical limitations of applicable funding sources.

1.4.1 Seepage and Underseepage

Seepage beneath and through segments of the levee systems around Sacramento have been identified as a significant risk to the stability and reliability of the system. Through-seepage is seepage through a levee embankment that can occur during periods of high river stages. Depending on the duration of high water and the permeability of embankment soil, seepage may exit the landside face of the levee. Seepage can also pass directly through pervious layers in the levee if such layers are present. Under these conditions, the stability of the landside levee slope may be reduced. Underseepage problems occur in locations where levees are constructed on low-permeability foundation soil (silt and

clay) underlain by higher-permeability layers (sand and gravel). Excessive underseepage makes the affected levee segment susceptible to failure during periods of high river stage. Under these conditions, seepage travels horizontally under the levee and then is forced vertically upward through the low-permeability foundation layer, often referred to as the "blanket." Failure of the blanket can occur either by uplift, a condition in which the blanket does not have enough weight to resist the confined pressure acting upon the bottom of the blanket, or by piping (internal erosion) caused by water flowing under high vertical gradients through the erodible blanket and carrying fine soil particles out of the foundation materials.

1.4.2 Levee Erosion

Because of the deposits of hydraulic mining debris that washed into the American and Sacramento River valleys, early levee builders constructed the flood management features by dredging material from the river beds and placing it on the bank near the river. This served several purposes. First, the resulting levee provided a degree of protection from flooding. Second, it removed material from the river bed, allowing it to convey more water. And finally, by placing the levees close to the river's edge, the river flow was confined, speeding its flow, and causing it to erode away the material that had been deposited by hydraulic mining, further increasing the river's capacity.

The levees continue to confine the flow into a relatively narrow channel, still eroding and degrading the river channel. However, by now, most of the sediment deposited in the river channels has been removed. Both the Sacramento River and the American River are confined by levees and have very little sediment in the water. Additionally, on the American River, Folsom Dam blocks sedimentation from upstream sources. Therefore, the energy of the flow tends to erode riverbanks and levees. This channel erosion and degradation could have detrimental effects on the levees by undercutting the foundation materials beneath the levees, particularly if the riverbank consists of easily erodible materials. The erosion of the riverbank adjacent to levee embankments may increase the underseepage through the foundation soils. It can also reduce the stability of the levee slopes by undermining the levee embankment and eroding the levees themselves. Significant erosion can lead to the failure of the levee.

Empirical evidence and prototype experiments indicate that stream bank erosion in the area can be gradual or episodic. That is to say, some erosion occurs almost every year. This is primarily due to the fact that materials have been placed on the banks by landowners in an effort to halt erosion. These materials are generally random materials, placed without regard to engineering standards. The Sacramento District is currently evaluating erosion trends as part of the WRDA 2007 authorization for Sacramento River Bank Protection Project (SRBPP).

1.4.3 Levee Stability

Stability problems were observed during high water stages on both the landside and waterside slopes. The materials used to construct the levees were not selected for their suitability, merely their availability, and dredged from the riverbed. The construction methods were also not adequate, the levee material not being compacted but constructed with clamshells or dredged with assorted objects indiscriminately buried in the levee embankments, such as dead trees. Seepage through the levee embankment and underseepage through its foundation would raise the water pore pressure at the landside levee toe leading to sloughing and sliding of the landside levee slope. Landside slope failures have been observed during high river stages in areas where impervious soils cover the sandy and gravelly layers in the levee foundation due to high gradients at the levee toe. These slope failures have also been observed in areas where water was seeping through the levee embankment above the toe of the levee.

There are no active faults running through the project area. There are, however, faults that run along the foothills east of Folsom Dam and near Vacaville and Dixon (outside of the study area). Potential of liquefaction of saturated sandy material in the foundation of levees is also a concern, but considering the very low probability that an earthquake may occur during high river stages, the levees are not designed to resist a seismic event. However, the liquefaction assessment is included in the Geotechnical Appendix to the GRR, and it considers that the damages on the levee from a seismic event may be repaired to a temporary condition to assure a protection for a minimum flood event of 25 years.

1.4.4 Levee Overtopping

Fortunately, the levees in the Sacramento area have not been overtopped in recent flood events, although several floods have come close. However, it is possible that a large enough flood event could occur that would overtop the Sacramento River levees. Because these levees were not built to modern engineering standards and levee failures upstream are assumed not to occur, levee overtopping would potentially lead to failure of the levee and cause devastating flooding.

The State has established a standard for urban flood protection in California which applies to cities with populations greater than 10,000 inhabitants. This standard requires levees to withstand flows with a top elevation equal to the mean 200-year water surface profile, plus three feet of freeboard, plus an allowance for wave run-up, plus one foot to account for climate change. USACE does not identify a target level of risk reduction but rather identifies the plan which reasonably maximizes net benefits. The analysis to identify the plan which maximizes net benefits was done with an awareness of the State's goal for urban flood protection for the purpose of informing the State of where the individual plans fall relative to the State's standards. Neither of the final alternatives is currently able to contain a 1/200 ACE event with 90% assurance. The levee improvements along the Sacramento River will increase

the assurance to a level close to 90% but the assurance for the levees along the American River will remain around approximately 60% for the 1/200 ACE. It will be contingent upon the local community to demonstrate to the State that the aggregate flood risk management projects meet the State's standard.

1.4.5 Vegetation and Encroachment Compliance

ETL 1110-2-583, *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*, calls for the removal of wild growth, trees, and other vegetation, which might impair levee integrity or flood-fighting access in order to reduce the risk of flood damage. In certain instances, to further enhance environmental values or to meet state or Federal laws and/or regulations, a variance can be requested from the standard vegetation guidelines set forth in this ETL.

Most California levees were built close together after the Gold Rush to make the rivers run faster to scour out debris in the channel from hydraulic mining. As a result, trees and shrubs on levees now provide the only waterside habitat that remains for many sensitive wildlife species. In some cases, the levee slopes contain brush and trees that are the last remnants of a vast riparian forest, which once extended across the valley floor adjacent to the Sacramento River. Extensive destruction of California's Central Valley riparian forests has occurred during the last 150 years due to agricultural and urban development. According to some estimates, riparian forests in the Central Valley have declined by as much as 89 percent during that time period. Many of the encroachments were granted permits for construction in the past, while some were built without any prior knowledge or approval from any governing agency.

Issues with vegetation on levees are summarized as follows:

- Levee Visibility – Riparian vegetation can cause a reduction in visibility of the levee, particularly in very dense areas of vegetation. Levee visibility is important for maintenance and inspection crews to identify problems in levee integrity such as the presence of burrowing animals, cracks, slumping, and seepage.
- Accessibility – Vegetation can block access to the levee crest or landside of the levee for flood fight requirements and maintenance access purposes.
- Through-levee Seepage – Riparian vegetation roots can cause seepage problems through levees and affect the general integrity of the levee.
- Windthrow – Risk to levee integrity can be caused during storms as a result of windthrow. The root balls of felled trees during storms can displace relatively large amounts of earth which can affect the strength of the levee, or if on the waterside, increase the risk of scour.

- Slope Stability – Riparian vegetation can cause slope stability problems, particularly on the waterside of levees. Tree roots extending in the river flow can cause erosion problems near the toe of the levee, a particularly critical part of the levee in terms of slope stability.
- Burrowing Animals – Riparian vegetation may encourage the development of animal burrows detrimental to the levee or may reduce visibility of burrows.

The American River Common Features GRR has identified significant and extensive seepage, stability, overtopping and erosion problems with the levees that reduce the risk of flooding for the Sacramento area. Due to the potential for catastrophic consequences associated with a levee failure in this urban area, all identified problems, including vegetation and encroachment issues require correction in order to reduce the flood risk to an acceptable level. However, risk reduction measures must be implemented in a "worst first" manner in order to immediately maximize the amount of risk reduction realized for each increment of investment.

The engineering analysis conducted to date generally indicates that seepage and erosion concerns pose a significantly higher risk of levee failure than those associated with vegetation and encroachments. However, specific instances of vegetation and encroachment problems have been identified as high risk and require resolution concurrent with other high risk issues.

In the case of construction associated with the recommended plan, vegetation and encroachment removal is secondary to the primary flood risk management measures (i.e. seepage cutoff barrier, levee raise, slope flattening). In an effort to modernize the levee system to meet current engineering standards, vegetation and encroachment issues (including landside levee access) in the study area will be resolved through a combination of construction actions associated with implementation of the recommended plan and formal agreements. The formal agreements involve the integrated use of a SWIF agreement with the local maintaining agency (LMA) and a variance from vegetation standards in ETL 1110-2-583, *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*.

The ARCF GRR project description (Section 2.0 below) assumes that the variance and SWIF agreements are both in place. The variance is included as a part of the proposed alternatives, while the SWIF would be a part of the future condition, both with or without the project in place. Effects to vegetation and encroachments are assumed to occur in the footprint of all proposed construction activities, to include the upper waterside slope of the levee per the variance. Landside vegetation and encroachments outside of the construction footprint would be addressed through the SWIF process by the LMA.

The Water Resources Reform and Development Act of 2014 (WRRDA 2014) Section 3013 requires a review of the Corps' levee vegetation policy. The review is in progress, therefore no new policies have been established at this time. As a result, the Corps is making no assumptions about what will be included in the new policy. However, WRRDA 2014 Section 3013(g)(1) also requires that vegetation removal not be a condition or requirement for the approval of funding of a project or any other action, unless the specific vegetation has been demonstrated to present an unacceptable safety risk. The engineering analysis described above, which evaluated the safety risk of existing vegetation on the levees, is in compliance with WRRDA 2014.

System Wide Improvement Framework

The SWIF agreement between the Corps and the non-Federal sponsor allows the LMA to defer compliance with ETL 1110-2-583. Under the SWIF agreement, the LMA would address landside vegetation and encroachment (including landside levee access) through the implementation of their standard operation and maintenance (O&M) actions over time. Therefore, vegetation not impacted by project construction would be addressed by the LMA in accordance with the State's Levee Vegetation Management Strategy in the Central Valley Flood Protection Plan (CVFPP) over the next 20 to 40 years. The SWIF will be planned and implemented by the non-Federal sponsor and will include the following:

- An engineering inspection and evaluation shall be conducted to identify trees and other woody vegetation (alive or dead) on the levee and within 15 feet of the levee toe that pose an unacceptable threat to the integrity of the levee. Identified trees shall be removed and associated root balls and roots shall be appropriately remediated. Based on the engineering inspection and evaluation, trees and other woody vegetation that do not pose an unacceptable threat need not be removed.
- In cases of levee repair or improvement projects, vegetation within the project footprint shall be removed as part of construction activities.
- Trees and other woody vegetation that are not removed must be monitored as part of routine levee maintenance to identify changed conditions that cause any of these remaining trees and other woody vegetation to pose an unacceptable threat to levee integrity. Otherwise, such trees and woody vegetation are to be maintained according to the levee vegetation management criteria included in the CVFPP which establish a vegetation management zone (including the landside levee slope, crown and upper 1/3 of the waterside slope) in which trees are trimmed up to 5 feet above the ground (12-foot clearance above the crown road) and thinned for visibility and access while brush, trees and other woody vegetation less than four inches in diameter at breast height, weeds or other such vegetation over 12 inches high are to be removed in an authorized manner.

Vegetation Variance

A vegetation variance will be sought by the Sacramento District to comply with ETL 1110-2-583 on the waterside of the levee. The vegetation variance request requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained if the vegetation were to remain in place. An evaluation of underseepage and waterside embankment slope stability was completed for this study by Corps geotechnical engineers.

This analysis was completed for the section/index point at levee mile (LM) 5.92 on the Sacramento River. This index point was chosen for the variance analyses because it was considered to be representative of the most critical channel and levee geometry, underseepage and slope stability conditions, and vegetation conditions. The cross-section geometry of the index point incorporated tree fall and scour by using maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets Corps seepage and slope stability criteria considering the seepage and stability improvement measures are in place ("with project" conditions). Therefore, it is a reasonable conclusion that by allowing vegetation to remain as stated above, the safety, structural integrity, and functionality of the Sacramento River levee would be retained.

The vegetation variance request would be developed during the design phase to allow for vegetation to remain on the lower portion of the waterside levee slope (Figures 2 to 4). Vegetation on the upper waterside levee slope would be removed as part of project construction. If a variance is not approved, the recommendations for this portion of the project will be reformulated and further environmental compliance efforts would be required.

1.4.6 Releases from Folsom Dam

The Folsom Dam Water Control Manual (WCM) is being updated to reflect authorized changes to the flood management and dam safety operations at Folsom Dam to reduce flood risk in the Sacramento area. The WCM update will utilize the existing and authorized physical features of the dam and reservoir, specifically the auxiliary spillway and submerged tainter gates currently under construction and scheduled to be completed in 2016.

Along with evaluating operational changes to utilize the additional operational capabilities created by the auxiliary spillway and tainter gates, the WCM Update will assess the use of available technologies to enhance the flood risk management performance of Folsom Dam to include a refinement of the basin wetness parameters and the use of real time forecasting operation. Further, the WCM Update will evaluate options for the inclusion of creditable flood transfer space in Folsom Reservoir in conjunction with Union Valley, Hell Hole, and French Meadows Reservoirs (also referred to

as Variable Space Storage). The study will result in an Engineering Report as well as a revised Water Control Manual.

It should be noted that the initial WCM Update effort will focus on additional operational capabilities created by the auxiliary spillway. The WCM will be further revised in the future to reflect the capabilities to be provided by the Dam Raise and additional ARFC Project improvements as appropriate.

1.5 Environmental Regulatory Framework and Authority

1.5.1 National Environmental Policy Act

NEPA provides an interdisciplinary framework for Federal agencies to develop information that will help them to take environmental factors into account in their decision-making. To comply with NEPA, an EIS is required whenever a proposed major Federal action (e.g., a proposal for legislation or an activity financed, assisted, conducted, or approved by a Federal agency) would result in significant effects on the quality of the natural and human environment (42 U.S.C. § 4332[2][C]; 40 C.F.R. § 1508.18[a]).

1.5.2 California Environmental Quality Act

According to the State CEQA Guidelines (14 CCR Section 15064[f][1]), preparation of an EIR is required whenever a project may result in a significant environmental impact. An EIR is an informational document used to inform public agency decision makers and the general public of the significant environmental effects of a project, identify possible ways to mitigate, reduce, or avoid the significant effects, and describe a range of reasonable alternatives to the project that could feasibly attain most of the basic objectives of the project while substantially lessening or avoiding any of the significant environmental impacts. Public agencies are required to consider the information presented in the EIR when determining whether to approve a project.

CEQA requires that state and local government agencies consider the environmental effects of projects over which they have discretionary authority before taking action on those projects (California Public Resources Code [PRC] Section 21000 et seq.). CEQA also requires that each public agency avoid or reduce to less-than-significant levels, wherever feasible, the significant environmental effects of projects it approves or implements. If a project would result in significant environmental impacts that cannot be feasibly mitigated to less-than-significant levels, the project can still be approved, but the lead agency's decision makers must issue a "statement of overriding considerations" explaining in writing the specific economic, social, or other considerations that they believe, based on substantial evidence, make those significant and unavoidable effects acceptable.

1.5.3 State and Local Planning

Many state and local plans and zoning regulations address activities within the project area. These plans and regulations were considered during the preparation of this EIS/EIR. Following is a list of the plans and regulations.

- Sacramento City General Plan
- Sacramento County General Plan
- Sacramento County Zoning Ordinance
- Sacramento County Tree Ordinance
- Sacramento City Zoning Ordinance
- American River Parkway Plan
- Central Valley Flood Protection Plan
- Bay Delta Conservation Plan
- Delta Plan

1.5.3 Study Authority

The basic authority for the Corps to study water resource related issues in the American and Sacramento Rivers is Section 209 of the Flood Control Act of 1962 which authorizes studies for flood control in northern California (Flood Control Act of 1962, Pub. L. No. 87-875, § 209, 76 Stat. 1180, 1196-98 (1962). This EIS/EIR was prepared as an interim general reevaluation study of the ARCF Project, which was authorized by Section 106(a)(1) of WRDA 1996, Pub. L. No. 104-303 § 106(a)(1), 110 Stat. 3658, 3662-3663 (1996), as amended by Section 130 of the Energy and Water Development and Related Agencies Appropriations Act of 2008, Pub. L. No. 110-161, § 130, 121 Stat. 1844, 1947 (2007). Additional authority was provided in Section 366 of WRDA of 1999. WRDA 1999, Pub. L. No. 106-53, § 366, 113 Stat. 269, 319-320 (1999). Significant changes to the project cost were recommended in the Second Addendum to the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works, but before it could be forwarded to Congress, authorized total cost of the project was increased to $205,000,000 by Section 129 of the Energy and Water Development Appropriations Act of 2004, Pub. L. No. 108-137, § 129, 117 Stat. 269, 1839 (2003). The current estimated cost of the authorized project is $305,340,000. The allowable cost limit is $307,071,000.

1.6 Intended Uses of this Document

This EIS/EIR is a public document prepared to disclose potential impacts of the GRR alternatives. Impacts are determined by looking at the environmental conditions in the future with and without the project. This document will also propose mitigation measures, which could be implemented to avoid, reduce, or compensate for impacts to the environment. The public was notified that the EIS/EIR was available for review and the Corps and CVFPB requested public comments on the proposed plan. Public comments received on the DEIS/DEIR have been incorporated into this final EIS/EIR, as appropriate, and are included in Appendix F.

The CVFPB will consider whether or not to certify the EIR and approve the ARCF GRR in late 2015. This decision will be based on numerous factors, including the potential environmental impacts and mitigation measures addressed in this EIS/EIR, permitting requirements, Federal and state authorizations, funding and financing mechanisms, and implementation schedule. This EIS/EIR will also be used by CEQA lead agencies, such as the CVFPB and Central Valley Regional Water Quality Control Board (RWQCB), Sacramento Area Flood Control Agency (SAFCA), and trustee agencies, such as the California Department of Fish and Wildlife (CDFW), to ensure that they have met the requirements of CEQA before deciding whether to issue discretionary permits over which they have authority. It may also be used by other state, regional, and local agencies, which may have an interest in resources that could be affected by the project.

Once finalized, the EIS/EIR will be used in conjunction with the GRR to support the Chief of Engineers' report to Congress on the Corps' preferred alternative. After considering any additional comments, the Corps will sign a Record of Decision (ROD) for the project. The ROD is a written, public record explaining why the Corps chose a particular course of action. The selected action and any practicable mitigation measures will be identified in the ROD. The proposed action cannot be initiated before the ROD is signed. Following the preparation of the Chief's Report and the signing of the ROD, the project would be submitted to Congress for authorization. In addition, project construction is also contingent on appropriation of funds from Congress, which may be a separate action from the project's authorization.

1.7 Resources Relied on in Preparation of this EIS/EIR

1.7.1 Related Documents and Resources

The following documents, previously prepared by the Corps, were reviewed by Corps staff in the analysis of the project and preparation of the EIS/EIR.

- April 1991, Draft American River Watershed Investigation California Feasibility Report: Part I—Main Report and Part II—Draft Environmental Impact Statement/Environmental Impact Report;
- December 1991, American River Watershed Investigation California Feasibility Report: Part I—Main Report and Part II—Environmental Impact Statement/Environmental Impact Report;
- December 1991, American River Watershed Investigation California Feasibility Report, Volume 2, Appendix G: Section 404 Evaluation;
- March 1996, Supplemental Information Report, American River Watershed Project, California: Part I—Main Report and Part II—Final Supplemental Environmental Impact Statement (FSEIS)/Environmental Impact Report;
- June 27, 1996, Chief's Report on FSEIS, signed by Acting Chief of Engineers, Major General Pat M. Stevens; and
- July 1, 1997, ROD on FSEIS, signed by Director of Civil Works, Major General Russell L. Furman.
- November 2008, Final Environmental Impact Statement for 408 Permission and 404 Permit to Sacramento Area Flood Control Agency for the Natomas Levee Improvement Project, Sacramento CA. Prepared by EDAW/AECOM, Sacramento, CA
- August 2009, Final Environmental Impact Statement on the Natomas Levee Improvement Project Phase 3 Landside Improvement Project, Sacramento CA. Prepared by AECOM, Sacramento, CA
- February 2010, Final Environmental Impact Statement on the Natomas Levee Improvement Project Phase 4a Landside Improvement Project, Sacramento CA. Prepared by AECOM, Sacramento, CA
- October 2010, Final Environmental Impact Statement on the Natomas Levee Improvement Project Phase 4b Landside Improvement Project, Sacramento CA. Prepared by AECOM, Sacramento, CA

Additional reference documents used to prepare this EIS/EIR are listed in Chapter 7, "References."

1.7.2 Incorporation by Reference

For the purposes of CEQA, this EIR incorporates by reference the environmental analysis and other information contained in the Consolidated Final Program Environmental Impact Report (FPEIR) for the 2012 CVFPP. The CVFPP FPEIR addresses a broad range of levee system integrity and environmental issues in a planning area that includes the study area. It is referenced in this EIR to provide additional information about broad-scale issues and planning efforts, cumulative activities, macro-level management alternatives, and the associated environmental effects (both beneficial and potentially adverse). Mitigation strategies described in the CVFPP PEIR have been adapted for purposes of this EIR as appropriate. The executive summary of the CFRPP PEIR is included as Appendix M. The full text of the CVFPP PEIR is available online at http://www.water.ca.gov/cvfmp/documents.cfm and the CVFPP PEIR is available for inspection at Central Valley Flood Protection Board, 3310 El Camino Avenue Room 151, Sacramento, CA 95821, David Martasian (916) 574-1442.

1.8 Application of NEPA and CEQA Principles and Terminology

NEPA and CEQA are similar in that both laws require the preparation of an environmental study to evaluate the environmental effects of proposed activities. However, there are several differences between the two regarding terminology, procedures, content of the environmental documents, and substantive mandates to protect the environment. NEPA language is primarily used in this document but can be interchanged with CEQA language. In some cases this document uses both NEPA and CEQA terminology.

Table 2. Terminology of NEPA and CEQA for Common Concepts

NEPA Term	Correlating CEQA Term
Lead Agency	Lead Agency
Cooperating Agency	Responsible Agency
Environmental Impact Statement	Environmental Impact Report
Record of Decision	Findings
Tentatively Selected Plan	Proposed Project
Project Purpose	Project Objectives
No Action Alternative	No Project Alternative
Affected Environment	Environmental Setting
Effect	Impact

1.9 Community Outreach, Agency Coordination, and Issues of Known Controversy

Public involvement activities associated with the project include public meetings, Native Tribe and agency meetings, and distribution of the draft and final EIS/EIR for public review and comment.

The Corps published the notice of intent (NOI) to prepare the ARCF GRR EIS in the Federal Register (Vol. 73, No. 41) on February 29, 2008. A series of public scoping meetings were held in March 2008 to present information to the public and to receive public comments on the scope of the EIS. There is no mandated time limit to receive written comments in response to the NOI under NEPA. Appendix F contains the NOI, the one comment letter received in 2008, and copies of the posters for the March 2008 scoping meetings.

The Central Flood Protection Board published the notice of preparation (NOP) to prepare the ARCF GRR EIR with the State of California Clearinghouse on February 27, 2008. The public comment period extended for 30 days until March 28, 2008. A copy of the NOP is included in Appendix F.

The draft GRR and EIS/EIR were circulated for public review beginning on March 13, 2015. The notice of availability (NOA) was published in the Federal Register on March 13, 2015. The draft GRR and EIS/EIR were made available both on the Sacramento District, Corps of Engineers website as well as the website for the Central Valley Flood Protection Board. Hard copies of the draft GRR and EIS/EIR were provided to area libraries. Letters and/or DVD copies of the GRR and EIS/EIR were sent to interested parties, local residents, and to the agencies and elected officials listed in Section 6.4 of the EIS/EIR. Public workshops were held during the review period to provide additional opportunities for comments on the draft documents. All comments received during the public review period were considered and incorporated into the final GRR and EIS/EIR as appropriate. The meeting locations, dates and times were as follows:

- April 8, Hagginwood Community Center—3270 Marysville Blvd, Sacramento (5-7 p.m.).
- April 9, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5-7 p.m.).
- April 15, Library Galleria—828 I Street, Sacramento (3-5 p.m.).
- April 17, Arden-Dimick Library— 891 Watt Ave., Sacramento (5-7 p.m.).

A total of 137 people attended the four meetings. At the meetings, comments were solicited through the use of court reporters. Additionally, comments could be submitted through mail or electronic mail. Oral and written comments were made throughout the series of meetings by local, State, and Federal agencies, community organizations, and individuals.

Public comments on the draft documents focused in part on: 1) access to recreational features during and after construction; 2) design, placement, and justification for rock erosion protection along the American and Sacramento Rivers; 3) effects to vegetation as a result of the alternatives; 4) clear presentation of the anticipated level of the performance of the project; and 5) coordination with stakeholders in future phases of the project. The comments and the responses to them are summarized in the Public Involvement Appendix (Appendix F).

After considering any additional comments received during public review of the final EIS/EIR, the Corps will sign a Record of Decision (ROD) for the project. The ROD is a written, public record explaining why the Corps chose a particular course of action. The selected action and any practicable mitigation measures will be identified in the ROD. The proposed action cannot be initiated before the ROD is signed. In addition, project construction is also contingent on congressional authorization and appropriation of funds.

To help the community stay informed about current project activities, information is provided in a variety of ways:

- Representatives of the Sacramento District attend and report on the status of the GRR at the American River Task Force meetings which occur quarterly and are open to the public;
- GRR updates are provided at the monthly SAFCA Board of Directors meetings, which typically occur on the third Thursday of each month. These meetings are held at the Sacramento County Board of Supervisors Chambers at 700 H Street, Sacramento, California, 95814, begin at 3 p.m., and are open to the public.
- The Sacramento District briefs the CVFPP on the status of the GRR upon request. The CVFPP meets monthly on the last Friday of the month beginning at 9 a.m. at various locations including the Sacramento City Hall, 915 I Street, Sacramento, California, 95814, and are open to the public. Archived video footage of previous meetings is located at the following link: http://www.cvfpb.ca.gov/meetings/2013/videos/index.cfm
- Quarterly coordination meetings are held with the United Auburn Indian Community of the Auburn Rancheria and the Shingle Springs Band of Miwok Indians.

1.10 Organization of the EIS/EIR

The content and format of this EIS/EIR are designed to meet the requirements of NEPA, as set forth by the CEQ and the Corps' NEPA policy and guidance, and CEQA and the State CEQA Guidelines. The EIS/EIR is organized as follows:

- The Executive Summary summarizes the purpose and intended uses of the EIS/EIR, lead agencies, project location, project background and phasing, need for action, and project purpose/objectives; presents an overview of the proposed alternatives under consideration, as well as the major conclusions of the environmental analysis; documents the known areas of controversy and issues to be resolved; and ends with a summary table that lists the environmental impacts, mitigation measures, and significance determinations for the alternatives under consideration.
- Chapter 1, "Introduction and Statement of Purpose and Need," explains the NEPA and CEQA processes; lists the lead, cooperating, and responsible agencies that may have discretionary authority over the project, including non-Federal partners; specifies the underlying project purpose/objectives and need for action, to which the lead agencies are responding in considering the proposed project and project alternatives; summarizes required permits, approvals, and authorizations; outlines the organization of the document; and provides information on public participation.
- Chapter 2, "Alternatives," presents the proposed alternatives under consideration. This chapter constitutes the project description and describes the project components for each action alternative as well as the No-Action Alternative. This chapter also describes alternatives considered but eliminated from further consideration and provides a summary matrix that compares the environmental consequences of the alternatives under consideration.
- Chapter 3, "Affected Environment, and Environmental Consequences" describes the baseline or existing environmental and regulatory conditions and provides an analysis of the impacts of each alternative under consideration, and identifies mitigation measures that would avoid or eliminate significant impacts or reduce them to a less-than-significant level, where feasible. In addition, compensation is discussed for significant, adverse effects that cannot be reduced to a less than significant level.
- Chapter 4, "Cumulative and Growth-Inducing Impacts and Other Statutory Requirements," describes the cumulative impacts of the project when combined with other past, present, and reasonably foreseeable future projects within the study area. In addition, it analyzes the growth-inducing impacts of the proposed action. The remainder of this chapter includes the following requirements of NEPA and CEQA that are not addressed elsewhere in this EIS/EIR: relationship between short-term uses of the environment and long-term productivity, significant and unavoidable environmental impacts, and irreversible and irretrievable commitments of resources.
- Chapter 5, "Compliance with Applicable Laws and Regulations," summarizes the Federal and State laws and regulations that apply to the project and describes the project's compliance with them.

- Chapter 6, “Consultation and Coordination,” summarizes public involvement activities under NEPA and CEQA; Native American consultation; and coordination and with other Federal, state, regional, and local agencies. A list of organizations and individuals receiving a copy and/or notice of this EIS/EIR is also included.
- Chapter 7, “References,” provides a bibliography of sources cited in this EIS/EIR.
- Chapter 8, “List of Preparers,” lists individuals who were involved in preparing this DEIS/DEIR.
- Chapter 9, “Index,” contains the NEPA-required index for easy reference of topics and issues.

Appendices contain background information that supports this EIS/EIR and can be found on the disc located in the back cover of this EIS/EIR.

2.0 ALTERNATIVES

2.1 Introduction

The ARCF GRR identifies a number of problems associated with the flood risk management system protecting the city of Sacramento and surrounding areas. There is a high probability that flows in the American and Sacramento Rivers will stress the network of levees protecting Sacramento to the point that levees could fail. The consequences of such a levee failure would be catastrophic, since the area inundated by flood waters is highly urbanized and the flooding could be up to 20 feet deep.

2.1.1 Alternative Formulation and Screening

A wide variety of measures were developed to address the planning objectives. These measures were evaluated and then screened using the Corps planning process. Formulation strategies were then developed to address various combinations of the planning objectives and planning constraints. Based upon these strategies, various combinations of the measures were assembled to form an array of preliminary plans. The preliminary plans were then evaluated, screened and reformulated, resulting in a final array of alternatives.

The formulation strategies used to address the objectives and constraints includes:

- Combine measures that improve levee performance;
- Improve conveyance;
- Improve levees in place by various methods;
- Combine measures that reduce flood stages;
- Improve upstream storage;
- Reduce flow which reaches study area;
- Combine measures which improve levee performance and reduce flood stages; and
- Identify measures which together provide optimal storage and conveyance opportunities.

Approximately 35 different measures were developed to address these strategies. The measures were then screened prior to combing them into alternatives. This screening was done by evaluating the measures for completeness, efficiency, effectiveness, and acceptability.

Future Without Project Condition

The future without-project condition is the most likely condition expected to exist in the future in the absence of a proposed Federal water resources project. Proper definition and forecast of the future without-project condition are critical to the success of the planning process. While all the alternatives considered in this EIS/EIR must be compared to existing conditions, the future without project condition constitutes the benchmark against which these alternatives must be compared for Federal planning purposes. Thus, proper definition and forecast of the future without project condition are critical to the success of the planning process. Other adopted plans in the planning area and local planning efforts with high potential for implementation or adoption shall be considered as part of the forecasted without-project condition.

Under the future without project condition, depending on the location of a levee failure, significant loss of life would be expected, as well as injuries, illnesses, and other health and safety problems. Because the flood season in Sacramento is in the winter, residents face additional dangers from hypothermia. Flooding in the Sacramento area could trigger releases of hazardous and toxic contaminants into the waterways surrounding the flood plain and the failure of liquid petroleum gas tanks and underground storage tanks. Post-flood cleanup of these substances could be a major undertaking.

Transportation through the area would be severely hampered by a major flood. Major transportation corridors transect the area, and flooding would cripple movement of people and goods across the region. Sacramento International Airport could be under water, and would have to relocate operations to Mather Field, which is located outside of the floodplain.

Critical infrastructure would be rendered nonfunctional for an extended period of time after a flood. Power and water supply could be interrupted for a substantial period of time. Emergency costs associated with evacuation, flood fighting, fire and police, and government disruptions would occur.

After floodwaters have receded, debris cleanup would be a substantial undertaking. After the flooding in New Orleans resulting from Hurricane Katrina, debris removal included general household trash and personal belongings, construction and demolition debris, vegetative debris, household hazardous waste, appliances, and electronic waste. Curbside debris was in excess of 51 million cubic yards. There were nearly 900,000 units of appliances and over 600,000 units of electronic goods. More than 350,000 cars were abandoned.

The following general assumptions have been made in regard to the future without-project condition for this study:

- In 2017, the Joint Federal Project auxiliary spillway with six submerged tainter gates at Folsom Dam will be completed and a new water control manual will be adopted (Folsom Dam Modifications project).
- In 2019, the 3.5-foot mini-raise of the Folsom Dam will be completed (Folsom Dam Raise project).
- The Levee Vegetation Management Strategy presented in the Central Valley Flood Protection Plan (CVFPP) will be in place.
- The elements of the ARCF Project that have been authorized by WRDA 1996 and WRDA 1999 are assumed to be in place.
- The levee modifications recommended in the Natomas PACR are assumed to be in place (including those already constructed by SAFCA).
- Improvements recommended as part of the West Sacramento GRR are not in place.

While these projects are assumed to be either implemented or not, critical flood risk reduction would not be provided to the city of Sacramento without implementation of this project. People would continue to be at risk of flooding with the study area.

2.1.2 Measures and Alternatives Considered, But Eliminated From Future Consideration

Some measures originally identified that could contribute to addressing Sacramento's flood problems and needs were reviewed and dropped from further consideration. These measures, which are described in the subsections below, include upstream transitory storage, Yolo Bypass improvements, reoperation of upstream reservoirs, a diversion structure on the Sacramento River, and non-structural measures. The downstream levee repairs remain the common element between all alternatives and remain the primary focus of the remaining alternatives detailed in Sections 2.3 through 2.5 below.

Upstream Storage on the American River (Auburn Dam)

This preliminary measure included construction of a dam on the North Fork of the American River near the town of Auburn. This measure was not carried forward because it does not address the high frequency flood risk associated with the poor performance of levees in the study area and does not substantially reduce risk for the highest risk area along the Sacramento River since this area is dominated by Sacramento River flows. In addition, this measure would have adverse impacts on environmental resources through the loss of about 500 to over 2,000 acres of oak woodland, chaparral and coniferous forests. However, this alternative could be considered in a follow-on study to consider ways to reduce the residual risk in the study area.

Transitory Storage in Upstream Basins

Various upstream transitory storage measures were evaluated as part of the Common Features Project. A full analysis of this measure and the various sites along the Sacramento River that were considered is included in the GRR. Initial evaluation indicates that these measures would not be cost-effective. In addition, the analysis indicated that these measures would not be effective in reducing the water surface elevations on the levees that protect the Sacramento area. As a result, the need to correct seepage and stability problems for the levees in the study area would need to be addressed regardless of any use of upstream storage measures. When the cost of the transitory storage measures is added to the cost of the urban levee improvements, the combined cost of these measures makes this option less efficient than other potential plans that would focus on measures within the study area. However, further evaluation of this alternative may be considered as part of the State's Central Valley Flood Protection Plan or the State's Regional Plans.

Yolo Bypass Improvements

This measure would consist of lengthening the Fremont Weir, and widening the Yolo and Sacramento Bypasses to increase the amount of flood water conveyed through these facilities and reduce the amount of flood water conveyed through the Sacramento River channel downstream of the Fremont Weir. This measure would consist of the following features:

- Redesign and reconstruction of the Fremont Weir.
- Construction of a new setback levee along the eastern edge of the Yolo Bypass extending from the Fremont Weir to the north levee of the Sacramento Bypass.
- Construction of a weir and closure structure in the Sacramento Deep Water Ship Channel south of Interstate 80 (I-80).
- Removal of existing Sacramento River Flood Control Project levees in the lower reach of the Yolo Bypass.

With the Yolo Bypass Improvements, all of the levee improvements proposed for the ARCF GRR are still necessary, because the Yolo Bypass Improvements do not reduce water surface elevations to a low enough level to eliminate the need for levee improvements. Therefore, for purposes of this study, it was screened out. It is important to note that the Yolo Bypass widening does potentially provide benefits elsewhere and is being looked at by the State of California as part of the CVFPP, and this feature is still being analyzed by others but would not affect the need for levee improvement in the greater Sacramento urban area.

Reoperation of Upstream Reservoirs

Reoperation of reservoirs upstream of the study area in the Sacramento River basin was considered. Reoperation of Folsom Dam was eliminated from further consideration as part of this GRR because the Folsom Water Control Manual Update, a segment of the overall American River Watershed Investigation, is currently studying reoperation of Folsom Lake. This study takes into account the potential changes to the watershed from all associated American River Watershed projects, including the Folsom JFP, the Folsom Dam Raise, and the ARCF GRR alternatives.

Major reservoirs upstream of the study area include Shasta Lake, Lake Oroville, Folsom Lake, and New Bullards Bar Reservoir. These reservoirs control approximately 11,000 square miles of the 27,000 square mile Sacramento River basin. This is about 40% of the drainage area. The flood storage is a small component of these dams' storage, since they are also water supply reservoirs. These dams were completed prior to the largest floods in Sacramento; therefore, their designs are based on hydrology that does not take these large floods into account. Reoperation of these upstream reservoirs would not substantially reduce the flood risk to the Sacramento area.

Sacramento River I Street Bridge Diversion Structure

This measure would include the construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River. This diversion structure would restrict flows going down the Sacramento River past the cities of Sacramento and West Sacramento, and would cause a portion of the flows from the Sacramento and American Rivers to be backed upstream through the widened Sacramento Weir and Bypass out to the Yolo Bypass. The Sacramento Bypass and Weir would be widened to accommodate the increased flows to the bypass system. The effect of this diversion structure would be to reduce the water surface elevation of the Sacramento River downstream of the structure to the point at which seepage, stability, height, and erosion improvements would not be needed in order to safely convey the 200 year design event.

The I Street Bridge diversion structure was evaluated during the planning phase to limit flood flows through the city of Sacramento and push excess flows into the Yolo Bypass in order to limit the need for levee repairs on the Sacramento River downstream of the structure. This measure was not carried forward for the following reasons:

- The initial cost identified for addressing Yolo Bypass hydraulic mitigation was not adequate. A physical modification to the bypass would be needed to reduce the water surface elevation to effectively mitigate for the additional flows redirected to the bypass by the diversion structure. The costs for this physical modification greatly increase the overall alternative cost to the point that the alternative is more costly than the other alternatives.

- The implementation time (likely 20 years) for this alternative to be implemented would leave the densely populated areas of Sacramento at risk of flooding for an unacceptable period of time.
- This Diversion Structure is not consistent with the CVFPP and it is unlikely that the State would partner with the Corps on a structure that is not consistent with the CVFPP.
- Operation of the structure would inundate the Yolo Bypass more frequently than current operations, causing a significant disruption to the Yolo County agricultural economy.

Non-Structural Measures

Some non-structural measures were considered and eliminated, including flood proofing individual structures, relocating residents out of the flood plain, and raising structures to above the floodplain. These non-structural measures were eliminated because the sheer number of residents in the floodplains, particularly in the American River South Basin in the Pocket and Meadowview neighborhoods, made this alternative cost prohibitive. Additionally, raising commercial structures is impractical due to loss of business during raises, functionality of the business after raising the building, and size of structures. Flood proofing individual structures cannot exceed 3 feet, and in many parts of the study area, flood depths are predicted to be greater than 3 feet, making this measure impractical. Some non-structural elements carried forward, such as flood plain management and risk notification, can be included in any of the alternatives carried forward. Further analysis of the non-structural measures is included in the GRR and Economic Appendix to the GRR.

2.2 No Action Alternative

The Corps is required to consider "No Action" as one of the alternatives for selection in order to comply with the requirements of NEPA. With the No Action Alternative, it is assumed that no additional features would be implemented by the Federal Government or by local interests to achieve the project purpose, over and above those elements of the previously-authorized ARCF Project.

Under the No Action plan the Corps would not conduct any additional work to address seepage, slope stability, overtopping, or erosion concerns in the Sacramento metropolitan area. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system, but it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. As a result, if a flood event were to occur, the Sacramento area would remain at risk of a possible levee failure.

The urban development within the project area would continue to be at risk of flooding and lives would continue to be threatened. The levees within the study area could fail and result in a catastrophic disaster. If a levee failure were to occur, major government facilities would be impacted until flood waters recede. Workers would be unable to perform their duties until the buildings are restored and could be occupied. This could cause a temporary shutdown or slowdown of many State and local government functions. Also, there are many transportation corridors within the study area that could be flooded if levees were to fail.

2.3 Alternative 1 – Improve Levees

Alternative 1 involves the construction of fix-in-place levee improvement measures to address seepage, slope stability, erosion, and overtopping concerns identified for the American and Sacramento River, NEMDC, Arcade, Dry/Robla, and Magpie Creek levees (Plate 3). The purpose of this alternative would be to improve the flood risk management system to safely convey flows to a level that maximizes net benefits. Table 3 summarizes the levee problems discussed in Section 1.4 and the proposed measure for each waterway. The designs for these improvements are detailed in Sections 2.3.1 through 2.3.3.

Table 3. Alternative 1 – Proposed Levee Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, Geotextile, Slope Flattening	Bank Protection, Launchable Rock Trench	Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall, Geotextiles	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek[2]	---	---	---	Floodwall/New Levee/Detention Basin

Notes: [1]American River seepage, stability, and overtopping measures were addressed in the ARCF WRDA 1996 and 1999 construction projects. [2]In addition to the listed measures, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

In addition to the proposed levee improvements measures shown in Table 3, the following measures and policies would be addressed during the design phase:

- During construction of structural levee improvements, the cross section geometry would be improved to meet minimum Corps' and State standards, if they currently do not. The standard levee footprint consists of:
    - A 20 foot crown width for the Sacramento and American Rivers, and
    - A 12-foot crown width for NEMDC, Arcade Creek, and Magpie Creek, and
    - Either 2:1 or 3:1 landside and waterside slopes (depending on the channel, past performance, and engineering analysis).
- Utility encroachments and penetrations will be brought into compliance with applicable Corps policy or removed depending on the type and location. Utilities replacements would occur via one of two methods: (1) utility placement over the design levee prism, or (2) a through-levee conduit equipped with positive closure devices.
- Private encroachments shall be removed by the non-federal partner or property owner prior to construction. Landside encroachments outside the construction footprint will be brought into compliance by the LMA under the SWIF process.

It is estimated that a maximum of 1 million cubic yards (cy) of borrow material could be needed to construct the project. Because this project is in the preliminary stages of design, detailed studies of borrow material needs for each alternative have not been completed. For the purposes of NEPA/CEQA a worst case scenario is being evaluated for the volume of borrow material needed. Actual volumes exported from any single borrow site would be adjusted to match demands for fill.

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 25-mile radius surrounding the project area. These potential borrow locations are shown on Plate 6. Borrow sites would be lands that are the least environmentally damaging and would be obtained from willing sellers. The criteria used to determine potential locations were based on current land use patterns, soil types from Natural Resources Conservation Service (NRCS), and Corps' criteria for material specifications. The data from land use maps and NRCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 25 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

The excavation limits on the borrow sites would provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation would be no steeper than 3H:1V. Excavation depths from the borrow sites would be determined based on available suitable material and local groundwater conditions. The borrow sites would be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites would be returned to their existing use whenever possible, or these lands could be used to mitigate for project impacts, if appropriate.

Construction of Alternative 1 is proposed to take approximately 10 years. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that would occur due to levee failure, availability of real estate, and construction feasibility considerations, such as the availability of equipment at any given time. The tentative schedule of construction is shown in Table 4.

There would be no proposed measures under Alternative 1 for the Sacramento Bypass. The following sections contain more detailed information on the specific measures proposed under this alternative by waterway.

Table 4. Tentative Construction Schedule for Alternative 1.

PRIORITY	WATERWAY	REACH	YEAR OF PROJECT CONSTRUCTION									
			1	2	3	4	5	6	7	8	9	10[1]
1	Sacramento River	ARS F										
2	Sacramento River	ARS E										
3	American River	ARS A										
4	Sacramento River	ARS G										
5	Sacramento River	ARS D										
6	American River	ARS B										
7	American River	ARN A										
8	American River	ARS C										
9	American River	ARN B										
10	Arcade Creek	ARN D										
11	NEMDC	ARN F										
12	Arcade Creek	ARN E										
13	NEMDC	ARN C										
14	Dry/Robla Creek	ARN G										
15	Magpie Creek	ARN I										

2.3.1 American River

Levees along the American River under Alternative 1 require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion of the river bank and levee, which, if unaddressed, could potentially undermine the levee foundation. Plate 3 identifies the reaches where erosion protection measures would be required. There are two measures proposed for the American River levees: (1) bank protection, and (2) launchable rock trench. Both of these measures are described in detail in the subsections below. These measures would be implemented for both of the proposed alternatives discussed in this document. Plate 7 shows the existing and proposed erosion protection sites on the American River.

Bank Protection

This measure consists of placing rock revetment on the river's bank, and in some locations on the levee slope, to prevent erosion (Figure 1). When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and loose materials would be removed. In most cases, large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked on site.

Revetment would be imported from an offsite location via haul trucks and temporarily stored at a staging area located in the immediate vicinity of the construction site. A loader would be used to move revetment from the staging area to an excavator that will be placing the material. The excavator would place a large rock berm in the water up to an elevation slightly above the mean summer water surface. A planting trench would be established on this rock surface for revegetation purposes. The excavator would either be working from the top of the bank placing revetment on the bank beneath it and in the water, or from on top of the rock berm that it established.

The revetment would be placed on the existing bank at a slope varying from 2H:1V to 3H:1V depending on site specific conditions. After revetment placement has been completed, a small planting berm would be constructed in the rock where feasible to allow for some revegetation of the site, outside of the vegetation free zone as required by ETL 1110-2-583. This vegetation will be designed on a site specific basis to minimize the O&M responsibility of the LMA and in such a way to not impact the hydraulic conveyance of the channel.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it (Figure 1). All launchable rock trenches would be constructed outside of the natural river channel. The vegetation would be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration would

include a 2:1 landside slope and 1:1 waterside slope and would be excavated at the toe of the existing levee. All soil removed during trench excavation would be stockpiled for reuse or disposal. The bottom of the trench would be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench would be filled with revetment that would be imported from an offsite location. After rock placement the trench would be covered with a minimum of 3 feet of the stockpiled soil to allow for planting over the trench. Rock placed on the levee slope would be covered with the stockpiled soil. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Some vegetation could be permitted over the trench if planted outside the specified vegetation free zone required by ETL 1110-2-583. This vegetation would likely be limited to native grasses, shrubs, and trees with shallow root systems to ensure that they do not limit the functionality of the trench during a flood event. This vegetation would only be permitted if they establish in a way that does not put undue burden on the maintaining agency and in locations that do not interfere with the conveyance capacity of the channel

2.3.2 Sacramento River

Levees along the Sacramento River require improvements to address seepage, slope stability, and erosion (Plate 3). In addition, these levees would be raised to address overtopping concerns. Private property acquisition would be required along the approximately 7 miles of levee raise. Where levee raise is required a 10-foot landside construction easement would be cleared in order to allow for equipment movement and placement of fill on the levee crown and slope. The measures proposed for the Sacramento River levees include: (1) levee geometry measures, (2) cutoff walls, (3) bank protection (4) 8 miles of levee raise, and (5) launchable rock trench. These measures are described in detail in the subsections below. These measures would be implemented for both of the proposed alternatives discussed in this document.

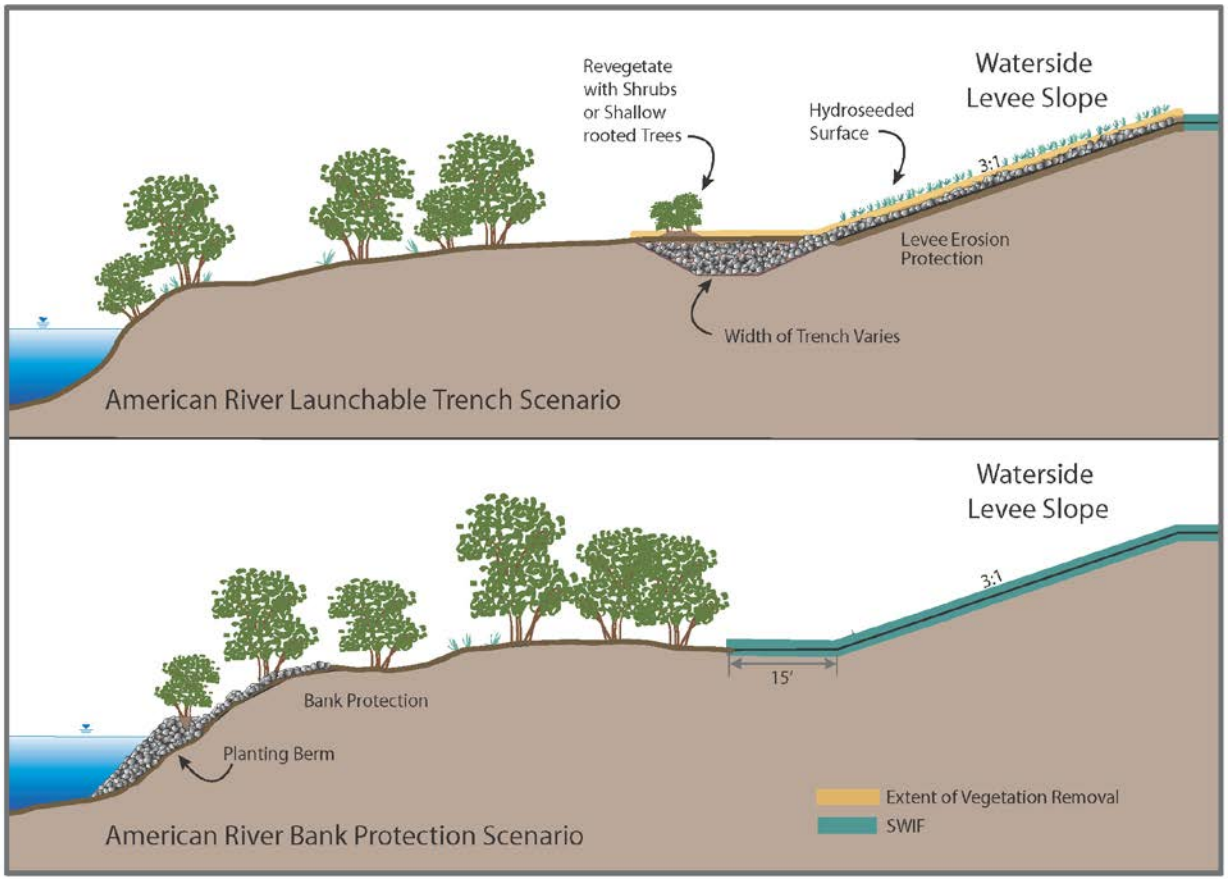

Figure 1. Bank Protection and Launchable Rock Trench Typical Design.

Levee Geometry

Where the existing levee cross section does not meet the levee design requirements, slope flattening, crown widening, and/or a levee raise is required. This improvement measure addresses problems with slope stability, geometry, overtopping, and levee toe and crest access and maintenance. The levee geometry would be adjusted to meet the minimum standards, as described in Section 2.3 above. To begin levee embankment grading, the area would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) would be stockpiled at staging areas. Haul trucks or scrapers would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans.

The existing levee centerline would be shifted landward, where necessary in order to meet the Corps' standard levee footprint requirements. The levee crown patrol road would be re-established and a new toe access corridor would be added 10 feet landward of the levee toe in areas where levee raises are required.

In the lower reach of the Sacramento River, near the town of Freeport, the steepness of the levee slope has created a slope stability problem. To address this problem, the levee would be partially degraded and reconstructed with a geotextile material to reinforce the levee slope. Landside access will likely be required to construct this feature from the levee toe upwards.

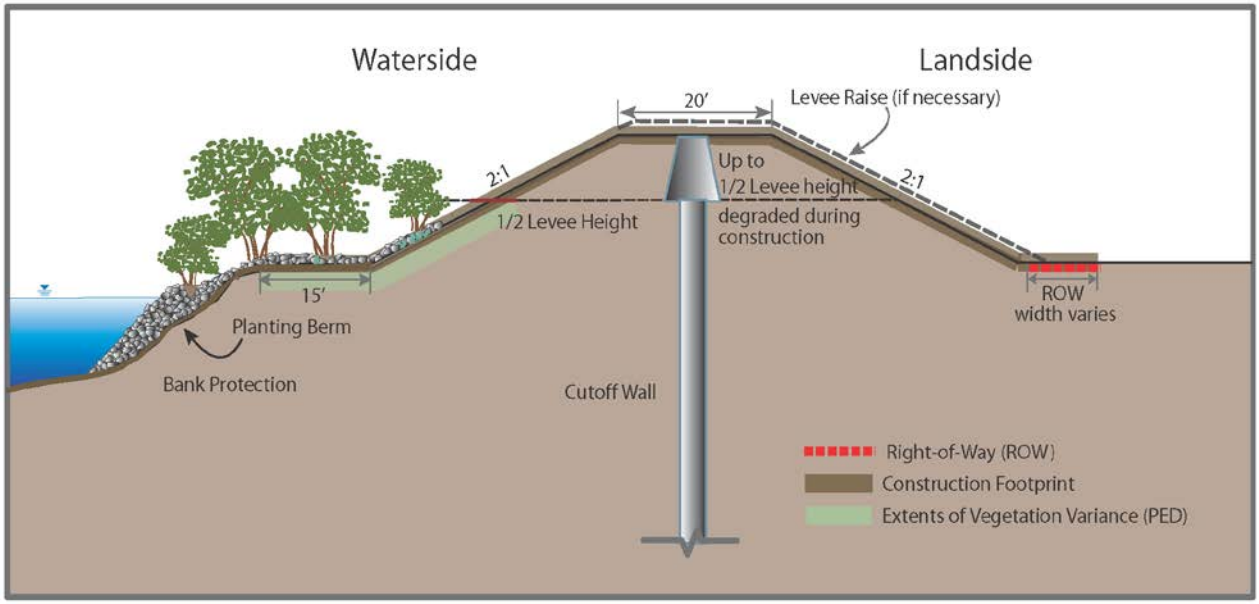

Figure 2. Fix-in-place with Cutoff Wall and Levee Raise.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown (Figure 3). The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 80 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.

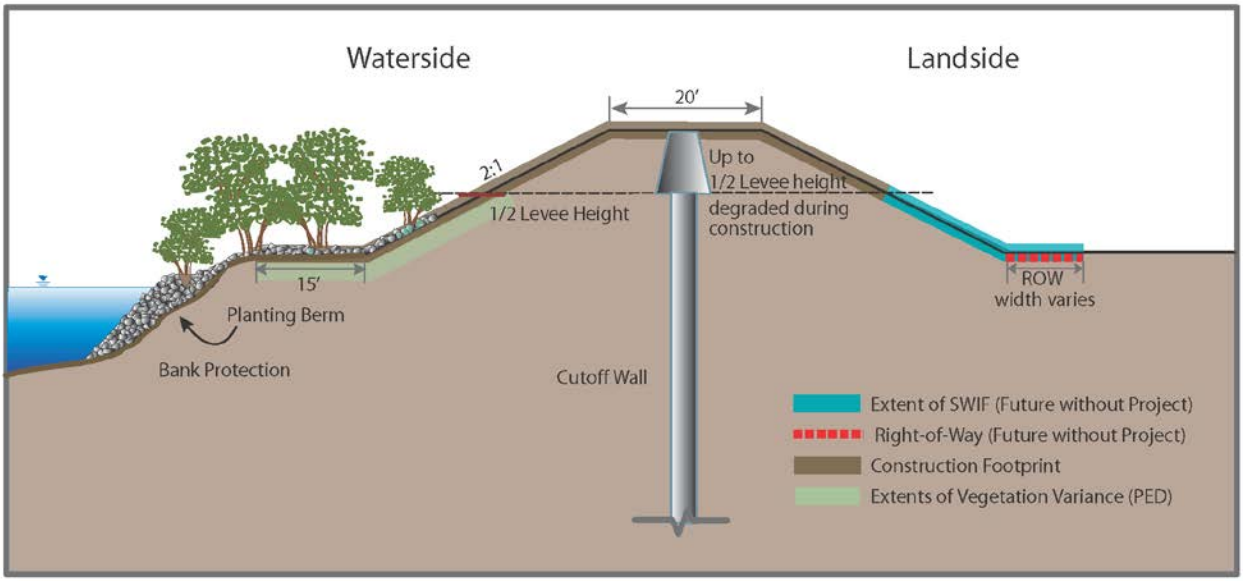

Figure 3. Fix-in-place with Cutoff Wall and No Levee Raise.

Conventional Open Trench Cutoff Wall

Under the open trench method, a trench approximately 3 feet wide would be excavated with a long boom excavator at the top of levee centerline and into the subsurface materials up to 80 feet deep. As the trench is excavated, it will be filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of approximately 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout would be injected through the augers and mixed with the native soils. An overlapping series of mixed columns would be drilled to create a continuous seepage cutoff barrier. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

Bank Protection

Some rock erosion protection was previously placed along the Sacramento River to reduce the risk of erosion on the levee slopes. The majority of the existing bank protection used a reactive approach as part of ongoing maintenance activities or as part of the Sacramento River Bank Protection Project. While some recent designs and construction of rock erosion protection are expected to provide adequate localized erosion protection, other locations may not deliver the same performance during a flood event. Some previous rock erosion protection does not meet current design standards, is past its intended design life, and is in need of repair and/or replacement.

Bank protection on the Sacramento River would be addressed via either the launchable rock trench method described for the American River in Section 2.3.1 above, or by standard bank protection. The standard bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, when necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. If needed, a temporary access ramp would be constructed by removing vegetation along the levee slopes and using borrow material that would be trucked on site.

The placement of rock onto the levee slope would occur from atop the levee and/or from the water side by means of barges. Rock required within the channel, both below and slightly above the water line at the time of placement, would be placed by an excavator located on a barge. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes. Rock required on the upper portions of the slopes would be placed by an excavator located on top of the levee. Rock placement from atop the levee would require one excavator and one loader for each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the water side of the levee.

The revetment would be placed via the methods discussed above on existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a small planting berm would be constructed in the rock when feasible to allow for some revegetation of the site (Figure 4). This vegetation will be designed on a site specific basis to minimize the O&M responsibility of the LMA and in such a way to not impact the hydraulic conveyance of the channel.

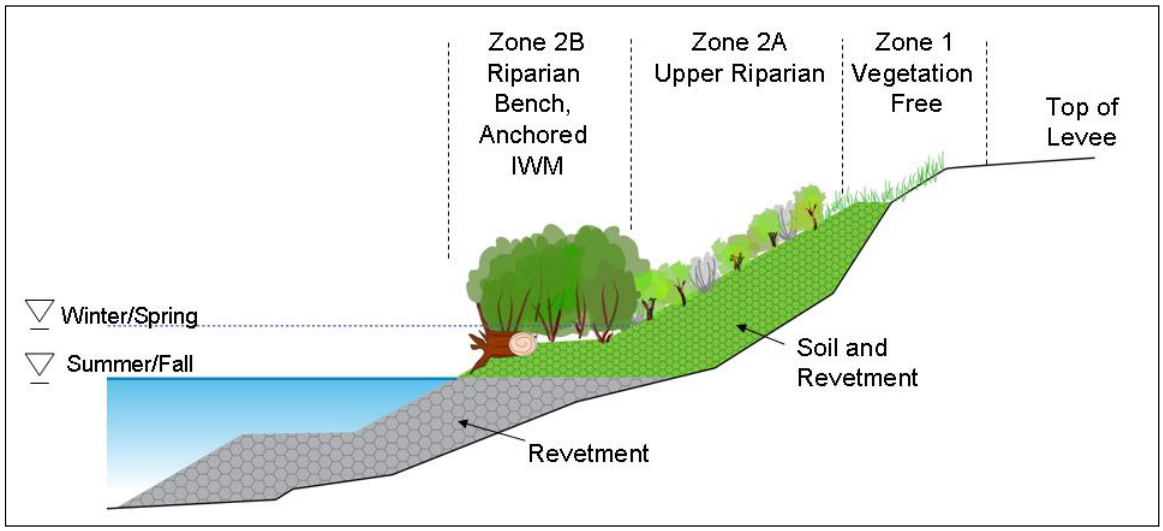

Figure 4. Planting Berm with Vegetation and Woody Material.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it (Figure 1). All launchable rock trenches would be constructed outside of the natural river channel. The vegetation would be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration would include a 2H:1V landslide slope and 1H:1V waterside slope and would be excavated at the toe of the existing levee. All soil removed during trench excavation would be stockpiled for reuse or disposal. The bottom of the trench would be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench would be filled with revetment that would be imported from an offsite location. After rock placement the trench would be covered with a minimum of 3 feet of the stockpiled soil to allow for planting on top of the trench. Rock placed on the levee slope would be covered with the stockpiled soil. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Some vegetation could be permitted over the trench if planted outside the specified vegetation free zone required by ETL 1110-2-583. This vegetation would likely be limited to native grasses, shrubs, and trees with shallow root systems to ensure that they do not limit the functionality of the trench during a flood event. This vegetation would only be permitted if they establish in a way that does not put undue burden on the maintaining agency and in locations that do not interfere with the conveyance capacity of the channel

2.3.3 East Side Tributaries

Natomas East Main Drain Canal

The east levee of the NEMDC requires improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A conventional open trench cutoff wall would be constructed at these locations to address the seepage and stability problems. The open trench cutoff walls would be constructed as described for the Sacramento River levee in Section 2.3.2 above.

The NEMDC east levee would be raised or a floodwall constructed to address overtopping concerns. The levee raise would be constructed in a similar manner to that described for the Sacramento River. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 5). The height of the floodwalls varies from 1 to 2 feet, as required by water surface elevations. The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A cutoff wall would be constructed to address seepage in Reaches D and E (Plate 3). There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path, and could affect the stability of the levee. The ditch would be replaced with a conduit or box culvert and then backfilled. This would lengthen the seepage path and improve the stability of the levee. The Arcade Creek south levee has a slope stability problem in some areas due to the steepness of the levee slope. To address this problem, the levee would be partially degraded and reconstructed with a geotextile material to reinforce the levee slope.

The Arcade Creek levees upstream of Norwood Avenue have existing floodwalls, however there remains an overtopping issue in this reach. A new 1 to 4-foot floodwall and levee raise would allow the levees to pass flood events greater than the current design level. Constructing the floodwall raise would require doweling into the existing concrete floodwall and adding reinforced concrete to the floodwall section. Construction of the floodwall would be consistent with the description for NEMDC, and construction of the levee raise would be consistent with the description for the Sacramento River.

In addition to the measures discussed above, in areas where the current levee geometry does not meet current Corps standards, measures would be implemented to bring these levees into compliance. These measures include widening the crown to 12 feet, when necessary, and flattening slopes that are steeper than 2H:1V.

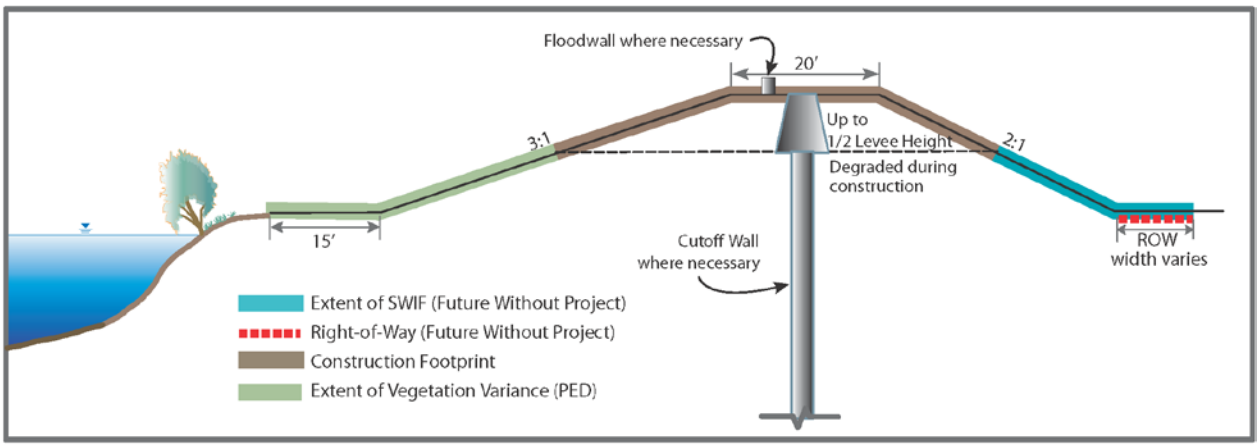

Figure 5. NEMDC and Arcade Creek Scenario.

Magpie Creek Diversion Canal

A number of features are proposed for the Magpie Creek Diversion Canal. This includes raising approximately 2,100 feet of the existing left bank levee of the Magpie Creek Diversion Canal. The levee raise would begin just downstream from Raley Boulevard and continue to about 100 feet south of Vinci Avenue Bridge. A new approximately 1,000 foot levee would be constructed along the west side of Raley Boulevard south from the bridge down to Santa Ana Avenue (Figure 6).

In addition, a new 10-foot-wide maintenance road would be graded at the landside base of the new raised Magpie Creek Diversion Canal levee. A new aggregate base maintenance road would be constructed between Vinci Avenue and Dry Creek Road adjacent to the left bank (looking downstream) of the Magpie Creek Diversion Canal for a distance of approximately 2,700 feet.

A 5-foot high floodgate would be installed across the driveway of the Kelly-Moore Paint Store. An additional 4-foot high floodgate would be required at the driveway of a new development just south of the Kelly-Moore Paint Store property.

In addition, a culvert would be constructed under the Sacramento Northern Railway Bike Trail embankment. The culvert would be a triple 5-foot by 5-foot reinforced concrete box. A new channel would be excavated upstream and downstream from the culvert, connecting the culvert with Robla Creek. The new channel would be slightly above the existing channel invert to allow low flows to continue through the existing bridge. Stone protection would be placed in the bed and sides of the new channel to minimize erosion.

The area inundated by a 250-year event without the project in place is estimated to be 76 acres (excluding roadways and channels, the inundated land would be 73 acres). Construction of the proposed improvements would slightly increase the water surface elevation during all flood events greater than a 5-year frequency. During the 250-year event, the increase in water surface is projected to be 0.5 feet at Raley Boulevard and 0.1 feet at the western boundary of McClellan Business Park. This would increase the inundated area to 79 acres (excluding roadways and channels, 76.5 acres). This area will be purchased and preserved as floodplain in perpetuity.

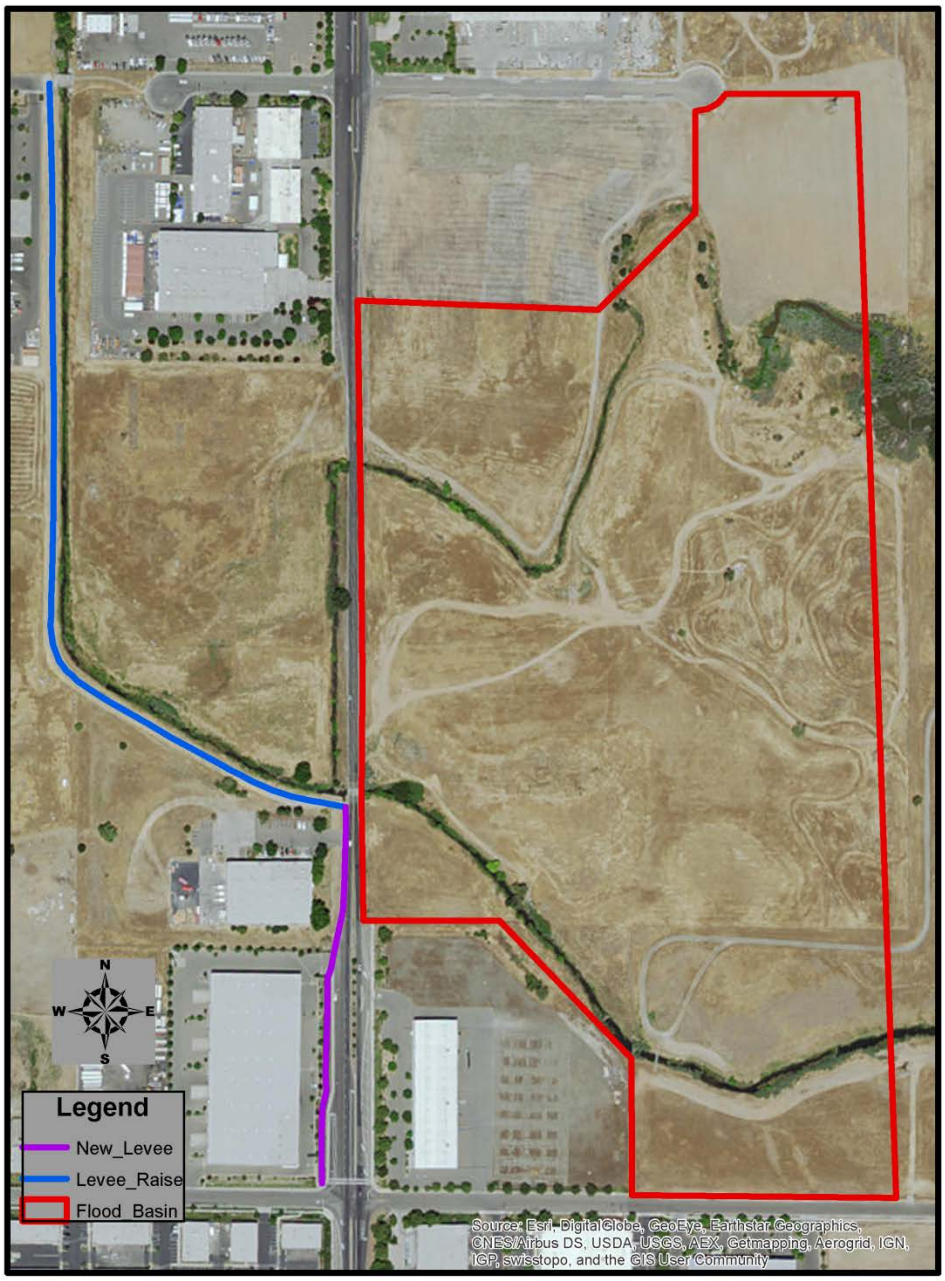

Figure 6. Floodwall and New Levee along Magpie Creek.

2.3.4 Operation and Maintenance

Operation and maintenance (O&M) of the levees in the Sacramento area are the responsibility of the local maintaining agencies, including the American River Flood Control District, DWR's Maintenance Area 9, and the City of Sacramento. The applicable O&M Manual is the Standard Operation and Maintenance Manual for the Sacramento River Flood Control Project. Typical levee O&M currently includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.

Following construction, the O&M manual would be revised to reflect the change in conditions in the study area, including the vegetation variance and the SWIF. Under the adjusted O&M manual, large trees that were protected in place under the variance would be allowed to remain on the waterside slopes, but smaller shrubs would be removed and grasses would be regularly mowed to allow for inspection and access. Vegetation that remains on the landside of the slope under the SWIF would be maintained according to the SWIF plan, which will be prepared by the State of California and the local maintaining agency.

The local maintaining agencies would be responsible for any additional environmental compliance required to implement the SWIF, including any needed Clean Water Act Section 404 permits applicable to O&M activities.

2.4 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Alternative 2 would include all of the levee improvements discussed in Alternative 1, except for the extent of the levee raises along the Sacramento River would be significantly less (Plate 4). Instead of implementing the majority of levee raises included in Alternative 1, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The levees along the American River, NEMDC, Arcade, Dry Creek, Robla Creek, and Magpie Creek, would be improved to address identified seepage, stability, erosion, and height concerns through the methods described under Alternative 1. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns though the measures described under Alternative 1. Due to environmental, real

estate, and hydraulic constraints within the American River North and South basins, the majority of the levees would be improved within the existing levee footprint to the extent practicable.

Alternative 2 has been identified as the Corps' Recommended Plan. Additionally, Alternative 2 is the Environmentally Preferable Alternative under NEPA and the Environmentally Superior Alternative under CEQA. Under the Guidelines developed pursuant to Section 404(b)(1) of the Clean Water Act, Alternative 2 has been identified as the Least Environmentally Damaging Practicable Alternative (Appendix E).

Table 5. Alternative 2 - Proposed Levee Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, Geotextile, and Slope Flattening	Bank Protection, Launchable Rock Trench	Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall, Geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek[2]	---	---	---	Floodwall/New Levee/Detention Basin

Note: [1] American River seepage, stability, and overtopping measures were addressed in the American River Common Features, WRDA 1996 and 1999 construction projects.
[2]In addition to the listed measures, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

In addition to the proposed levee improvements measures shown in Table 5, the following measures and policies would be addressed during construction:

- During construction of structural levee improvements, the cross section geometry of any levees that currently do not meet Corps' and State standards would be improved. The Corps standard levee footprint consists of:
    - A 20 foot crown width for the Sacramento River and American River, or
    - A 12-foot crown width for NEMDC, Arcade Creek, Dry Creek, Robla Creek, and Magpie Creek, and
    - Either 2H:1V or 3H:1V landside and waterside slopes (depending on the channel, past performance, and engineering analysis).

- Utility encroachments and penetrations within the construction area will be brought into compliance with applicable Corps policy or removed depending on the type and location. Utilities replacements would occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.
- Private encroachments shall be removed by the non-federal partner or property owner prior to construction. Encroachments outside the construction footprint will be brought into compliance under the SWIF process as part of O&M.

It is estimated that more than 1 million CY of borrow material could be needed to construct the project. For the purposes of NEPA/CEQA a worst case scenario is being evaluated for the volume of borrow material needed. Actual volumes exported from any single borrow sites would be adjusted to match demands for fill. Borrow sites for Alternative 2 would be identified and excavated in a manner consistent with the description for Alternative 1 in Section 2.3 above.

Construction of Alternative 2 is proposed to take approximately 10 years. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that would occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. The tentative schedule of construction is shown in Table 6.

The following sections contain more detailed information on the specific features and reaches included in this alternative.

2.4.1 Sacramento Weir and Bypass

Alternative 2 includes all of the fix-in-place methods proposed in Alternative 1, with a reduced amount of levee raising on the Sacramento River (less than 1 mile total). The Sacramento Bypass and Weir currently allow excess flood waters to spill out of the system into the Yolo Bypass thereby reducing the loading on the levee system below. Alternative 2 leverages this existing structure by extending the current weir structure 1,500 feet north along with relocating the bypass levee. The weir, combined with the increased bypass width and operations change, will allow more water to be released out of the system eliminating the need for most of the height improvements along the ARS sub-basin, Reaches D to G. However, this alternative does not reduce the need for seepage, stability and erosion improvements within those reaches.

The Sacramento Weir and Bypass were constructed in 1916 and are owned by the State of California. The Sacramento Weir is operated by DWR. The primary purpose of the weir is to protect the City of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The Weir limits flood stages (water surface elevations) in the Sacramento River to project design levels through the Sacramento/West Sacramento area. The project design capacity of the

bypass is 112,000 cfs. Currently, operation of the Sacramento Weir in a flood event is determined by the stage at the I Street Bridge gauge. When the I Street gauge reaches 27.5 feet, the gates of the bypass are manually opened. The number of gates to be opened is determined to meet either of two criteria: (1) to prevent the stage at the I Street gage from exceeding 29 feet, or (2) to hold the stage at the downstream end of the weir to 27.5 feet.

The Sacramento Bypass is operated by CDFW as the Sacramento Bypass Wildlife Area. The Bypass was designated as a wildlife area by the Fish and Game Commission in 1988. The 360-acre Sacramento Bypass Wildlife Area is an important cover and feeding area for wildlife during late fall, winter, and early spring. Vegetation varies throughout the area from mature cottonwood trees, willows, and valley oaks in some locations, to a sparsely-covered sandy soil area on the eastern end. Game birds, raptors, songbirds, and native mammals are all present. CDFW operates the Bypass as a hunting area for waterfowl (when the area is flooded), ring-necked pheasant, and mourning dove.

For this alternative, the existing north levee of the Sacramento Bypass would be degraded and a new levee constructed approximately 1,500 feet to the north. A new weir would be extended north of the existing Sacramento Weir without impacting the existing structure. The new weir will be extended approximately 1,500 feet and include a seepage cutoff wall below. In the Sacramento Bypass, the existing grade slopes towards the southern levee toe drain. Sloping and grading of the bypass expansion will be determined in the preconstruction, engineering, and design (PED) phase with considerations for fish passage and elimination of stranding features.

The new north levee of the Sacramento Bypass will be constructed per new levee construction standards, including 3H:1V waterside and landside slopes and a minimum crest width of 20 feet. As both the existing north and south levees have experienced underseepage and slope stability related distress, the new north levee would include a 300-foot wide drained landside seepage berm (5 feet thick at the landside levee toe tapering to 3 feet thick at the berm toe and constructed of random fill with a 1.5-foot thick drainage and filter layer at the base) with a system of relief wells located at least 15 feet landward of the berm toe and spaced at 200-foot intervals. Existing infrastructure, including roads, railways, canals, and pump stations will be relocated to maintain current operation.

General assumptions for operation of the expanded Bypass were made for the purpose of this study. However, it is expected that these assumptions would be optimized and refined during the PED phase of the project, prior to construction, through coordination with the State of California. For this study, the increase in Bypass flows through the new weir are assumed to occur during high water events only, when the flow released from Folsom Dam on the American River exceeds 115,000 cfs. The existing Sacramento Weir and Bypass would be operated consistent with current conditions based on the stage at the I Street gage.

2.4.2 American River

Measures for the American River levees under Alternative 2 would address erosion. These measures were identified under Alternative 1, and would also be included in Alternative 2. These measures were described in detail in Section 2.3.1. Implementation of these measures under Alternative 2 would be consistent with the description in Alternative 1.

2.4.3 Sacramento River

The measures for the Sacramento River levees would be consistent with Alternative 1, with one exception. Under Alternative 1, Sacramento River levee remediation measures were proposed to address seepage, stability, erosion control, and levee height problems. Under Alternative 2, less than one mile of levee raise would be required instead of the approximately 7 miles required under Alternative 1. The remaining measures from Alternative 1 that would also be implemented under Alternative 2 for the Sacramento River levee include the following: (1) installation of cutoff walls to address seepage concerns; (2) slope reshaping to address stability concerns; and (3) bank protection/launchable rock trench measures to address erosion. The description of these three measures can be found in Section 2.3.2 above.

2.4.4 East Side Tributaries

Measures for the east side tributary levees under Alternative 2 would address seepage, slope stability, and height issues. These measures were identified under Alternative 1, and would also be included in Alternative 2. These measures were described in detail in Section 2.3.3. Implementation of these measures under Alternative 2 would be consistent with the description in Alternative 1.

Table 6. Tentative Construction Schedule for Alternative 2.

PRIORITY	WATERWAY	REACH	YEAR OF PROJECT CONSTRUCTION									
			1	2	3	4	5	6	7	8	9	10
1	Sacramento River	ARS F										
2	Sacramento River	ARS E										
3	American River	ARS A										
4	Sacramento River	ARS G										
5	Sacramento River	ARS D										
6	American River	ARS B										
7	American River	ARN A										
8	American River	ARS C										
9	American River	ARN B										
10	Sacramento Weir & Bypass	--										
11	Arcade Creek	ARN D										
12	NEMDC	ARN F										
13	Arcade Creek	ARN E										
14	NEMDC	ARN C										
15	Dry/Robla Creek	ARN G										
16	Magpie Creek	ARN I										

2.4.5 Operation and Maintenance

O&M of the levee system under Alternative 2 would be consistent with the description for Alternative 1 in Section 2.3.4. In addition, Alternative 2 would include future O&M of the expanded Sacramento Weir and Bypass. The Sacramento Weir and Bypass is currently operated and maintained by the State of California Department of Water Resources (DWR). O&M associated with the expanded Sacramento Weir and Bypass is described below.

Department of Water Resources

The operation of the expanded Sacramento Weir and Bypass would be similar to that of the existing weir. Releases into the weir will occur at the same intervals and durations as currently occur. The expanded weir however, would allow for larger volumes of water to be moved off the urban levees and into the bypass system in a large flood event.

2.5 Comparison of Alternatives

Table 7 shows the overall level of significance for each issue area, and provides a comparison of significance determinations among the No-Action Alternative, Improve Levees, and Sacramento Bypass and Improve Levees (Recommended Plan). These three alternatives are analyzed in this EIS/EIR as the final array of alternatives considered. Other alternatives have been screened out due to various reasons described in Section 2.1.2.

Table 7. Comparison of the Environmental Impacts of the Common Features Project Alternatives.

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)
Land Use			
Effect		Acquisition of properties for levee easements along the Sacramento River and Arcade Creek.	Acquisition of properties for levee easements along the Sacramento River and Arcade Creek (fewer properties impacted than Alternative 1). Conversion of agricultural lands to floodway.
Significance	Significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	None required.	Federal Relocation Act compliance. Payment of Sacramento County Habitat Restoration Program fees.	Federal Relocation Act compliance. Payment of Sacramento County Habitat Restoration Program fees.
Hydrology and Hydraulics			
Effect	Emergency repairs during a flood event could result in the loss of channel capacity and alternation of current geomorphic processes.	No effect.	Reduce water surface elevation in the Sacramento River downstream of the confluence of the American River without significantly increasing water surface elevation in the Yolo Bypass downstream of the confluence of the Sacramento Bypass.
Significance	Significant.	Not applicable.	Less than significant.
Mitigation	None possible.	Not applicable.	None required.
Water Quality			
Effect	In a flood event, there is high risk of contaminants entering the water from utilities, stored chemicals, septic systems, and flooded vehicles. In addition, flood flows would increase erosion of the banks, increasing turbidity in the waterways.	Potential impacts include increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction.	Potential impacts include increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction.
Significance	Significant.	Less than significant with mitigation.	Less than significant with mitigation.

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)
Mitigation	None possible.	Preparation of a Stormwater Pollution Protection Plan, Spill Prevention Control and Countermeasures Plan, and a Bentonite Slurry Spill Contingency Plan. Implementation of BMPs listed in Section 3.5.6.	Preparation of a Stormwater Pollution Protection Plan, Spill Prevention Control and Countermeasures Plan, and a Bentonite Slurry Spill Contingency Plan. Implementation of BMPs listed in Section 3.5.6.
Vegetation and Wildlife			
Effect	Erosion during a flood event could cause significant vegetation loss and wildlife habitat loss. Flood fighting activities could prevent future vegetation growth on river banks.	Construction of levee improvements would result in significant loss of vegetation and wildlife habitat on the landside of the Sacramento River levees, in the American River Parkway, and along Arcade Creek.	Construction of levee improvements would result in significant loss of vegetation and wildlife habitat on the Sacramento River levees, in the American River Parkway, and along Arcade Creek. Construction of the Sacramento Weir extension would require the removal of riparian vegetation.
Significance	Significant.	Significant short term impacts. Long term effects are less than significant with mitigation.	Significant short term impacts. Long term effects are less than significant with mitigation.
Mitigation	Compensation would likely occur after the fact, but there would still be significant direct impacts due to the temporal loss of vegetation.	When possible, compensation would be planted on planting berms, on top of launchable rock trenches, or on other lands within the Parkway. Additional mitigation sites are identified in Section 3.6.6.	When possible, compensation would be planted on planting berms, on top of launchable rock trenches, or on other lands within the Parkway. A hydraulic evaluation will be conducted to determine whether mitigation could occur in the Sacramento Bypass. Additional mitigation sites are identified in Section 3.6.6.
Fisheries			
Effect	Flood fighting could prevent growth of vegetation on levee slopes, and increase turbidity, thus impacting	Indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the	Indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)
	migration, spawning, or rearing habitat.	placement of rock at bank protection sites, causing an increase in turbidity.	placement of rock at bank protection sites, causing an increase in turbidity. Widening the Sacramento Bypass creates floodplain, which could provide a benefit to fish species.
Significance	Significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	Compensation would likely occur after the fact, but there would still be significant direct impacts due to the temporal loss of vegetation.	Vegetation variance would allow waterside vegetation to remain on the Sacramento River. Bank protection sites and launchable rock trenches would be revegetation following construction. BMPs would be implemented to address turbidity, and are discussed in Section 3.5.6.	Vegetation variance would allow waterside vegetation to remain on the Sacramento River. Bank protection sites and launchable rock trenches would be revegetation following construction. BMPs would be implemented to address turbidity, and are discussed in Section 3.5.6.
Special Status Species			
Effect	Flood event or flood fight could cause loss of habitat and fatality to species.	Direct effects to Giant Garter Snake (GGS), valley elderberry longhorn beetle, salmonids, green sturgeon, Delta smelt, Western yellow-billed cuckoo, vernal pool crustaceans, and Swainson's Hawks during construction. Indirect effects due to loss of habitat and temporal effects while habitat mitigation establishes. Vegetation Variance for the waterside levee slopes would significantly limit the effects to endangered fish species.	Direct effects to Giant Garter Snake (GGS), valley elderberry longhorn beetle, salmonids, green sturgeon, Delta smelt, Western yellow-billed cuckoo, vernal pool crustaceans, and Swainson's Hawks during construction. Indirect effects due to loss of habitat and temporal effects while habitat mitigation establishes. Vegetation Variance for the waterside levee slopes would significantly limit the effects to endangered fish species. Effects to listed fish species due to increased stranding potential at the Sacramento Bypass.
Significance	Significant	Less than Significant with mitigation	Less than Significant with mitigation
Mitigation	None proposed	Mitigation per the terms of the Biological Opinions (Appendix J). Replace habitat	Mitigation per the terms of the Biological Opinions (Appendix J). Replace habitat

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)
		for species either on-site or in close proximity to lost habitat. Implement BMPs discussed in Section 3.5.6 and conservation measures in the BOs during construction to prevent mortality. Implement green sturgeon modeling and monitoring to improve effects assessment, minimize construction impacts, and mitigate for lost benthic habitat per the terms of the BOs.	for species either on-site or in close proximity to lost habitat. Implement BMPs discussed in Section 3.5.6 and conservation measures in the BOs during construction to prevent mortality. Implement green sturgeon modeling and monitoring to improve effects assessment, minimize construction impacts, and mitigate for lost benthic habitat per the terms of the BOs. Implement fish passage at the Sacramento Bypass, and grade the widened Sacramento Bypass to reduce stranding potential.
Cultural Resources			
Effect	Damage to historic and prehistoric resources during a flood event.	Adverse effects to historic properties from construction of levee improvements.	Adverse effects to historic properties from construction of levee improvements and the bypass widening.
Significance	Potentially significant.	Adverse effects resolved with mitigation under NHPA and reduced to less than significant with mitigation under NEPA. Significant and unavoidable under CEQA.	Adverse effects resolved with mitigation under NHPA and reduced to less than significant with mitigation under NEPA. Significant and unavoidable under CEQA.
Mitigation	None possible.	Preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans.	Preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans.
Transportation and Circulation			
Effect	Potential for flooded roadways in a flood event.	Increased traffic on public roadways.	Increased traffic on public roadways.
Significance	Potentially significant.	Significant.	Significant.
Mitigation	None possible.	Preparation of a Traffic Control and Road Management Plan and other BMPs listed	Preparation of a Traffic Control and Road Management Plan and other BMPs listed

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)
		in Section 3.10.6.	in Section 3.10.6.
Air Quality			
Effect	Increased emissions during flood fighting activities without BMPs in place.	Emissions of criteria pollutants from construction equipment, haul trucks, and barges.	Emissions of criteria pollutants from construction equipment, haul trucks, and barges.
Significance	Significant	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	None possible.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.11.6.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.11.6.
Climate Change			
Effect	Increased GHG emissions during flood fighting activities without BMPs in place.	Increased GHG emissions from construction equipment, haul trucks, and barges.	Increased GHG emissions from construction equipment, haul trucks, and barges.
Significance	Significant	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	None possible.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.12.6.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.12.6.
Noise			
Effect	Increased noise during flood fighting.	Increased noise in proximity to sensitive receptors due to construction activities.	Increased noise in proximity to sensitive receptors due to construction activities.
Significance	Less than significant.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	Not applicable.	Coordination with local residents, compliance with noise ordinances, and other BMPs, as listed in Section 3.13.6.	Coordination with local residents, compliance with noise ordinances, and other BMPs, as listed in Section 3.13.6.
Recreation			
Effect	During a flood event, recreation facilities, particularly in the Parkway, would be impacted by flooding and potentially loss due to erosion.	Temporary closure of recreation facilities in the American River Parkway during construction, including bike trail, walking trails, and boat launches.	Temporary closure of recreation facilities in the American River Parkway during construction, including bike trail, walking trails, and boat launches. Possible

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)
			closure of the Sacramento Bypass during portions of hunting season.
Significance	Significant.	Significant.	Significant.
Mitigation	None possible.	Notification and coordination with recreation users and bike groups. Flaggers, signage, and fencing to notify and control recreation access and traffic around construction sites.	Notification and coordination with recreation users and bike groups. Flaggers, signage, and fencing to notify and control recreation access and traffic around construction sites.
Aesthetics and Visual Resources			
Effect	A flood event would damage the visual character in the study area.	Vegetation loss and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River.	Vegetation loss and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River.
Significance	Significant.	Significant.	Significant.
Mitigation	None possible.	Trees would be planted after construction is completed on planting berms and on top of launchable rock trenches, however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.	Trees would be planted after construction is completed on planting berms and on top of launchable rock trenches, however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.
Public Utilities and Services			
Effect	In a flood event there could be significant damage to utility systems. Debris from flooded homes and properties could overwhelm solid waste disposal facilities.	Temporary disruptions to utility services possible, particularly during relocation of utilities that penetrate the levee.	Temporary disruptions to utility services possible, particularly during relocation of utilities that penetrate the levee.
Significance	Significant.	Less than significant.	Less than significant.
Mitigation	None possible.	Notification of potential interruptions would be provided to the appropriate agencies and to landowners.	Notification of potential interruptions would be provided to the appropriate agencies and to landowners.

	No Action Alternative	Alternative 1 – Improve Levees	Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)
Hazardous, Toxic, and Radiological Wastes			
Effect	No effect.	No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction.	No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction, including the Old Bryte Landfill.
Significance	Not applicable.	Less than significant with mitigation.	Less than significant with mitigation.
Mitigation	Not applicable.	Borrow material would be tested prior to use to ensure that no contaminated soils are used for this project.	Borrow material would be tested prior to use to ensure that no contaminated soils are used for this project.
Socioeconomics, Population, and Environmental Justice			
Effect	Flooding of residential areas and displacement of populations during a flood event. Flooding of the State Capitol's government centers also possible.	Disruption to residents alongside construction sites from traffic, noise, and dust. Acquisition of properties for levee easements.	Disruption to residents alongside construction sites from traffic, noise, and dust. Acquisition of properties for levee easements (fewer properties impacted than Alternative 1).
Significance	Significant.	Less than significant.	Less than significant.
Mitigation	None possible.	Federal Relocation Act compliance.	Federal Relocation Act compliance.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

The baseline environmental conditions assumed in this EIS/EIR for analyzing the effects of the ARCF Project consist of the existing physical environment as of 2008, the date when the State of California Department of Water Resources published the notice of preparation (NOP) to prepare an EIS/EIR with the State Clearinghouse. The 2008 existing physical environment is consistent with the current conditions in the project area because no major changes to resources have occurred within the last several years in the project area. The Corps published the Notice of Intent (NOI) in the Federal Register for this EIS/EIR concurrent with issuance of the State's NOP.

This chapter describes the methodology and threshold of significance for each resource, analyzes the significant environmental impacts of the project, and presents mitigation measures.

Geological resources have been presented for the existing conditions. However, because there is no effect to geological resources as a result of implementing the alternatives, it is not evaluated further in this document.

3.2 Geological Resources

3.2.1 Environmental Setting

This section describes the affected environment for geological resources in the ARCF project area.

Regulatory Setting

Federal

The following Federal regulation related to geology, soils, and mineral resources may apply to the implementation of the ARCF project

- Clean Water Act Section 402 (National Pollutant Discharge Elimination System Program)

State

The following State regulations related to geology, seismicity, soils, and mineral resources may apply to implementation of the ARCF GRR project.

- Alquist-Priolo Earthquake Fault Zoning Act
- California Seismic Hazards Mapping Act
- California Building Standards Code
- California Surface Mining and Reclamation Act

Existing Conditions

The following conditions are relevant to geology, seismicity, soil, and mineral resource conditions in the proposed ARCF GRR project area.

Geology

The ARCF GRR project area lies in the central portion of the Sacramento Valley which lies in the northern portion of the Great Valley Geomorphic Province of California. The Great Valley is a narrow, elongated topographic depression that is approximately 450 miles long and 40 to 70 miles wide. The Sacramento Valley lies between the northern Coast Ranges to the west and the northern Sierra Nevada to the east, and has been a depositional basin throughout most of the late Mesozoic and Cenozoic time. A large accumulation of sediments, estimated at over two vertical miles in thickness in the Sacramento area, were deposited during cyclic transgressions and regressions of a shallow sea that once inundated the valley (Hackel, 1966). This thick sequence of clastic sedimentary rock units was derived from adjoining easterly highlands erosion during the Late Jurassic period with interspersed Tertiary volcanics. They form bedrock units now buried in mid-basin valley areas. These bedrock units were covered by coalescing alluvial fans during Pliocene-Pleistocene periods by major ancestral west-flowing Sacramento Valley rivers (Feather, Yuba, Bear, and American). These rivers funneled large volumes of sediment into the Sacramento basin. Late Pleistocene and Holocene (Recent) alluvial deposits now cover low-lying areas. These deposits consist largely of reworked fan and stream materials deposited by meandering rivers prior to construction of existing flood control systems.

The Sacramento River is the main drainage feature of the region flowing generally southward from the Klamath Mountains to its discharge point into the Suisun Bay in the San Francisco Bay area. Located in central northern California, the Sacramento River is the largest river system and basin in the state. The 27,000 square mile Sacramento River Basin includes the eastern slopes of the Coast Ranges, Mount Shasta, and the western slopes of the southernmost region of the Cascades and the northern portion of the Sierra Nevada. The Sacramento River, stretching from the Oregon border to the Bay-Delta, carries 31% of the state's total runoff water. Primary tributaries to the Sacramento River include

the Pit, McCloud, Feather, and American Rivers. Within the Sacramento area, the Sacramento and American Rivers have been confined by man-made levees since the turn of the century. The confluence with the Sacramento River, only 20 feet above sea level, is subject to tidal fluctuation although more than 100 miles north of the Golden Gate and San Francisco Bay. Within the study area, these levees were generally constructed on Holocene age alluvial and fluvial sediments deposited by the current and historical Sacramento River and its tributaries. Pleistocene deposits underlie the Holocene deposits.

The major source of sediments deposited in the ARCF GRR project area is from the erosion of the Sierra Nevada mountain range and foothills to the east of the Sacramento Valley. Naturally occurring asbestos (NOA) is known to occur in the foothill metamorphic belt. Therefore, NOA may be present; however, the likelihood of project area soils containing significant concentrations of NOA is low due to the long distance from the source rock.

Seismicity

The ARCF GRR project area has experienced relatively low seismic activity in the past and does not contain any Alquist-Priolo Earthquake Fault Zones (California Geological Survey, 1999; Hart and Bryant, 1999). Numerous earthquakes of magnitude (M) 5.0 or greater have occurred on regional faults, primarily those within the San Andreas Fault System. The west side of the Central Valley is a seismically active region. The nearest known active (Holocene or Historic) fault trace to the project area is the Dunnigan Hills fault, approximately 30 miles northwest of downtown Sacramento (Jennings, 2010).

Three pre-Quaternary faults/fault zones are located within an approximately 20-mile radius of the ARCF GRR project area. The Willows fault zone runs northwest to southeast of the project area; the East Valley fault runs to the west of the project area; and the Midland fault zone runs to the southeast of the project area (Jennings 2010). None of these faults/fault zones are within an Alquist-Priolo Special Studies Zone. The active fault nearest to the project area is the Dunnigan Hills fault, which is 30 miles to the northwest and is within an Alquist-Priolo Special Studies Zone (California Geological Survey, 2007).

Probabilistic Seismic Hazard Analysis (PSHA) based on the 2008 Next Generation Attenuation (NGA) relationships was used to develop the seismic loading parameters used in the ARCF GRR. The deaggregations are from the United States Geologic Survey's (USGS) 2008 Interactive Deaggregations web program. The mean magnitude or the weighted average considering the percent contribution to the total hazard for the study levees is 6.7. Peak horizontal ground horizontal acceleration outputs from the USGS deaggregation program for 20% exceedance in 50 years (224-year average return period) ranged between 0.17 and 0.20 with an average of 0.18 for the project area.

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is fault ground rupture, also called surface faulting. Because there are no active faults mapped in the ARCF GRR project area by the California Geological Survey or the U.S. Geological Survey, and the area is not located within an Alquist-Priolo Earthquake Fault Zone, fault ground rupture is unlikely. Common secondary seismic hazards include ground shaking, liquefaction, subsidence, and seiches.

Liquefaction and Settlement

Liquefaction is the liquefying of certain sediments during ground shaking of an earthquake, resulting in temporary loss of support to overlying sediments and structures. Differential settlement occurs when the layers that liquefy are not of uniform thickness, a common problem when the liquefaction occurs in artificial fills. Poorly consolidated, water-saturated fine sands located within 30 to 50 feet of the surface typically are considered the most susceptible to liquefaction. Soils and sediments that are not water-saturated and that consist of finer grained materials are generally not susceptible to liquefaction.

The ARCF GRR performed liquefaction triggering analyses and found liquefiable material at several locations within the project area. Static limit equilibrium stability analyses were performed for locations with liquefiable material. Based on those analyses the flood protection ability after a 200-year seismic event for American River North Reach A, and American River South Reaches C through G (Plate 3). This shows the potential for lateral spreading or differential settlement, which in turn could result in structural degradation of flood management structures. If a large regional earthquake occurred during a major flood event, these potential effects would be magnified, and the potential for levee breach would be increased.

Regardless, implementation of the project would not substantially alter the composition of the subject levees or foundation soils or change their susceptibility to liquefaction. Because of the relative small likelihood of coincidence flood event and a major earthquake, and because the expected magnitude of ground shaking from large regional earthquakes is relatively low in the project area, the potential for failure or significant damage of project structures is low.

Soils

The Sacramento County soil survey identified a variety of soil map units in the ARCF GRR project area. Most of the soils in the project area are shallow to moderately deep, sloping, well-drained soils with very slowly permeable subsoils underlain with hardpan. These soils have good natural drainage, slow subsoil permeability, and slow runoff.

The project area generally consists of deep soils derived from alluvial sources, which range from low to high permeability rates and low to high shrink-swell potential. Soils range from low to high hazard ratings for construction of roads, buildings, and other structures related to soil bearing strength, shrink-swell potential, and the potential for cave-ins during excavation. Soils immediately adjacent to the Sacramento River are dominated by deep, nearly level, well-drained loamy and sandy soils. The natural drainage is good, and the soils have slow to moderate subsoil permeability. The river terraces consist of very deep, well-drained alluvial soils (NRCS, 2007-2012). The porous nature of the soils underneath the existing levee system is an important consideration for the design of levee improvements within the ARCF GRR project area.

Minerals

Sacramento and Yolo Counties protect aggregate (i.e., sand and gravel) from land uses that could preclude or inhibit a timely mineral extraction to meet market demand. According to the California Department of Conservation (CDC), Division of Mines and Geology, the majority of the ARCF Project area is classified as either MRZ-1, meaning that no significant mineral deposits are present in this area or that little likelihood exists for their presence, or as MRZ-3, meaning it is an area containing mineral deposits, the significance of which cannot be evaluated from existing data (California Division of Mines and Geology, 1988a). Portions of the American River Parkway have been classified as MRZ-2, meaning that it is an area where adequate information indicates that significant mineral deposits are present or it is judged that a high likelihood to be present. There are no MRZ-designated areas within the Sutter County portion of the ARCF project area.

Lands classified as MRZ-1 or MRZ-3 are not affected by state policies pertaining to the maintenance of access to regionally significant mineral deposits under the California Surface Mining and Reclamation Act of 1975. As such, the proposed use would not result in the loss or availability of a known mineral resource that would be of value to the region and the residents of the state. The MRZ-2 sectors are all within the American River Parkway, which is a public regional recreational resource that have been designated a Wild and Scenic River by the Federal Government and State of California. Because of this designation it is unlikely that permitting would occur in the future in this area of the project sectors (California Division of Mines and Geology, 1988a).

3.2.2 Methodology and Basis of Significance

Methodology

The U.S. Army Corps of Engineers, Sacramento District, Geotechnical Levee Practice SOP-EDG-03 establishes the requirements of engineered fill used for the construction of the levee embankments. The material is expected to be sourced from several sites including: newly identified

borrow sites within approximately 25 miles of the study area; existing borrow sites identified for the Natomas Basin by SAFCA; the DWSC dredge disposal area; the existing levees; and existing commercial sources. A desktop regional borrow study was performed to identify potential borrow sites within 25 miles of the study area, where enough soil could be sourced to satisfy the project needs. Test pits and laboratory testing on materials collected from test pits were provided by SAFCA as part of the NLIP. Additionally, the Sacramento District has studied the DWSC spoil areas as a borrow source several time in the past, and a discussion of that borrow source is included below. Typically projects constructed by the Sacramento District utilize commercial borrow sites near the project area.

Basis of Significance

The thresholds of significance are developed to determine the significance of an action in terms of its context and intensity. Under NEPA and CEQA, consideration is given to determine possible conflicts between the proposed action and the objectives of Federal, State, Regional, and local land use plans, policies, and controls for the study area. Alternatives considered were determined to result in a significant impact to geologic resources if they would expose people or structures to substantial effects involving:

- Rupture of a known earthquake fault, strong seismic shaking, or seismic-related ground failure, including liquefaction;
- Landslides, substantial soil erosion, or permanent loss of topsoil;
- Locating the project on an unstable geologic unit, or on a geologic unit that would become unstable as a result of the project; and/or,
- Locating the project on expansive soil, as defined in the Uniform Building Code.

The proposed alternatives would not expose people or structures to substantial effects involving earthquakes, landslides, and expansive soils. Additionally, the proposed measures would not be located on unstable geographic units. As a result, these criteria are not discussed further in this section.

3.2.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system, but it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area.

The Corps would not excavate potential borrow sites under this scenario; therefore conditions would likely remain consistent with the existing conditions. However, if a levee were to break, the flooding could result in significant effects to soils from the deposition of alluvial soils throughout the flooded area. Additionally, a flood event would result in substantial soil erosion, and could permanently displace substantial amounts of topsoil in flooded areas. As a result, there would be significant effects to geological resources under the No Action Alternative.

3.2.4 Alternative 1 – Improve Levees

The Corps proposes to excavate approximately 1 million cy of borrow material for this alternative. Excavation of these borrow sites could significantly impact geological resources by causing substantial soil erosion or the permanent loss of topsoil. This alternative would not result in impacts to seismic resources.

The excavation limits on the borrow sites would provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation would be no steeper than 3H:1V. Excavation depths from the borrow sites would be determined based on available suitable material and local groundwater conditions. The borrow sites would be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites would be returned to their existing use whenever possible. It is also possible that, if appropriate, these lands could be used to mitigate for project impacts.

In addition, levee improvement measures would include substantial construction and earth moving activities over large areas, including excavation, trenching, levee crown degradation, and bank protection construction. These activities would result in temporary disturbance of soil during the construction period, and could expose these disturbed areas to substantial erosion during rain storms following construction, if not properly restored. However, with the implementation of the avoidance and minimization measures discussed in Section 3.2.6 below, any potential impacts to geological resources from excavation of borrow sites and construction disturbance would be less than significant.

There would be minimal effects to geological resources associated with O&M following construction. The Corps would ensure that the construction areas, including the borrow sites, are monitored per the guidelines established in the Habitat Mitigation and Monitoring Plan to ensure that the native grasses associated with the site restoration meets the success criteria identified in the plan (Appendix I). With successful revegetation of the sites, these effects would be less than significant.

3.2.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Under Alternative 2, more than 1 million cy of soil would be excavated during construction. However, the potential effects from this action would be consistent with the effects described above for Alternative 1, only of a greater magnitude. Like Alternative 1, these effects would be less than significant with the implementation of the avoidance and minimization measures listed in Section 3.2.6 below.

3.2.6 Mitigation Measures

The following measures would be implemented during construction to reduce potential impacts to geological resources to less than significant:

- Prior to construction, the Corps or its contractor would be required to acquire all applicable permits for construction.
- Prior to construction, a Stormwater Pollution Protection Plan (SWPPP) would be prepared, and best management practices (BMPs) would be proposed to reduce potential erosion and runoff during rain events.
- Minimize ground and vegetation disturbance during project construction by establishing designated equipment staging areas, ingress and egress corridors, spoils disposal and soil stockpile areas, and equipment exclusion zones prior to the commencement of any grading operations.
- Stockpile soil on the landside of the levee reaches, and install sediment barriers (e.g., silt fences, fiber rolls, and straw bales) around the base of stockpiles to intercept runoff and sediment during storm events. If necessary, cover stockpiles with geotextile fabric to provide further protection against wind and water erosion.
- Install sediment barriers on graded or otherwise disturbed slopes as needed to prevent sediment from leaving the project site and entering nearby surface waters.
- Install plant materials to stabilize cut and fill slopes and other disturbed areas once construction is complete. Plant materials could include an erosion control seed mixture or shrub and tree container stock. Temporary structural BMPs, such as sediment barriers, erosion control blankets, mulch, and mulch tackifier, could be installed as needed to stabilize disturbed areas until vegetation becomes established.

3.3 Land Use

3.3.1 Environmental Setting

Regulatory Setting

The following land use plans were used to determine impacts on land use if the project were implemented:

- American River Parkway Plan
- Sacramento County General Plan
- Sacramento City General Plan
- Yolo County General Plan
- SAFCA Joint Powers Agreement
- Delta Plan

Existing Conditions

Much of the study area has been developed and is at or near build out. The geographic boundaries of Sacramento County include seven incorporated cities, four of which are within the study area. Portions of the cities of Citrus Heights, Elk Grove, Rancho Cordova, and Sacramento are located within the study area. While the alternatives considered provide reduced risk of flooding to the unincorporated areas of Sacramento and Sutter Counties, construction activities would be located along the river systems and not within these unincorporated areas. No future development economic benefits have been included as part of the justification for this project. Since the project area is at or near build out and only minimal infill development is expected to occur with the implementation of the project, Executive Order 11988 will not be discussed further in this analysis.

American River North

This portion of the study area contains portions of Sacramento County, and the city of Sacramento. Most of the area has changed from agricultural to urban uses over time. The former McClellan Air Base, which is now the McClellan Business Air Park, is located in this portion of the study area. Since the conversion from a military airfield to a public/commercial facility, non-military operations have steadily increased at this facility. Housing, employment, and recreation are equally dispersed throughout the area.

The American River Parkway (Parkway) is an open space greenbelt which extends approximately 29 miles from Folsom Dam at the northeast to the American River's confluence with the Sacramento River southwest. The lower American River is classified as a "Recreation" river within the State and Federal Wild and Scenic River Systems. The American River is the central focus of the Parkway which provides enjoyment to residents and visitors of the region. The land uses in the Parkway are defined in the 2008 American River Parkway Plan (Parkway Plan). The Parkway Plan acts as the management plan for the Federal and State Wild and Scenic Rivers Act.

The goal of the plan is to provide, protect, and enhance a continuous open space greenbelt along the American River for public use. Human developments and facilities are prohibited in the "Open Space Preserve Areas", except as necessary to protect the public health, safety, welfare, or for the purposes of habitat restoration.

The American River Parkway Plan flood control policies, which are established in the Parkway Plan as Goals and Policies 4.9 to 4.18, include the following:

- Flood management agencies should continue to maintain, and improve, when required, the reliability of the existing public flood control system along the lower American River to meet the need to provide a high level of flood protection to the heavily urbanized floodplain along the lower American River consistent with other major urban areas. This effort is expected to include raising and strengthening the levees as necessary to safety contain very high flows in the river (up to 160,000 cfs) for a sustained period.
- Flood control projects, including levee protection projects and vegetation removal for flood control purposes, shall be designed to avoid or minimize adverse impacts on the Parkway, including impacts to wildlife and wildlife corridors. To the extent that adverse impacts are unavoidable, appropriate feasible compensatory mitigation shall be part of the project. Such mitigation should be close to the site of the adverse impact, unless such mitigation creates other undesirable impacts.
- Where feasible, multi-use buffers should be created on the land side of the levees, including additional access points from public streets that enhance levee operation and maintenance activities, improve flood fight capabilities, provide opportunities to relocate or expand levees or supporting stability berms, if required, and support recreational opportunities.
- Vegetation in the Parkway should be appropriately managed to maintain the structural integrity and conveyance capacity of the flood control system, consistent with the need to provide a high level of flood protection to the heavily urbanized floodplain along the lower American River and in a manner that preserves the environmental, aesthetic, and recreation quality of the Parkway.
- Flood control berms, levees, and other facilities should be, to the extent consistent with proper operation and maintenance of these facilities, open to the public for approved uses, such as hiking, biking and other recreational activities.

- Public facilities and private encroachments that inappropriately constrain the operation and maintenance of the flood control systems should be redesigned or relocated.
- The flood control system should be maintained in a condition that ensures adequate flood fighting capability, consistent with the demands of protecting a heavily developed floodplain.
- Bank scour and erosion shall be proactively managed to protect public levees and infrastructure, such as bridges, piers, power lines habitat and recreational resources. These erosion control projects which may include efforts to anchor berms and banks with rock revetment, shall be designed to minimize damage to riparian vegetation wildlife habitat, and should include a revegetation program that screens the project from public view, provides for a naturalistic appearance to the site, and restores affected habitat values.
- Projects to address bank stabilization and erosion that are threatening privately-owned structures shall secure appropriate permits. The engineering of these projects should give preference to biotechnical or non-structural alternatives, where feasible, over alternative involving revetments, bank re-grading, or installation of river training structures. Use of rubble, gunnite, bulkheads, or similar material in these projects is prohibited.
- It is recognized that flood control agencies have the authority to take action(s) to prevent or respond to flood emergencies occurring in or adjacent to the Parkway. In the event that these action(s) have an adverse impact on biological resources in excess of the estimated impacts of the projected flood damage to such resources, the agency(ies) undertaking the emergency work will implement feasible compensatory mitigation measures pursuant to Policies. Nothing in the Policy shall be construed to interfere with the existing authority of flood control agencies to prevent or respond to an emergency situation occurring in or adjacent to the Parkway.

American River South

This part of the study area contains portions of Sacramento County and the cities of Sacramento, Rancho Cordova, and Elk Grove. Most of the area has changed from agricultural to urban uses over time. Mather Airport, located in this portion of the study area, houses many commercial businesses and air cargo facilities. The southern end of this area has not been urbanized and includes the Sacramento County water treatment plant and the surrounding buffer lands, which are open fields, creeks, and ponds. The Fish and Wildlife Service Beach Stone Lakes Wildlife Refuge is located across Interstate 5 (I-5) from the buffer lands and is open space land with large grazing fields and various waterways.

Downtown Sacramento is located in this area of the project, along with the State Capitol. Many people live and work in the downtown area and there is very little vacant land remaining. Outside of the downtown area is primarily residential development with small shopping areas intermixed. The Sacramento Executive Airport, a general aviation airport, is also located in this area along with a rail corridor that aligns with the light rail system.

Sacramento Bypass

The Sacramento Bypass is a 363-acre floodway between the Sacramento River and the Yolo Bypass. The 360-acre portion of this floodway situated west of the Sacramento Weir is also designated as the Sacramento Bypass Wildlife Area, which is leased, operated, and managed by CDFW. The wildlife area is open to the public and is used for fishing, hunting, wildlife viewing, and bird watching. Just to the north of the Bypass are various agricultural lands currently in cultivation for orchards and row crops. There is also an abandoned landfill on the northern side of the Bypass near its western end. This site is the Old Bryte Landfill (West Sacramento Landfill). The site is approximately 17 acres and is under continued investigation by the California Integrated Waste Management Board for clean-up.

3.3.2 Methodology and Basis of Significance

Methodology

Local land use plans were reviewed to determine the effects to land use if the project were to be constructed. Each alternative was evaluated based on land use designations within the project area. This section also describes any changes to existing land use that would result if the project were to be implemented. This section evaluates the consistency of the project alternatives with local land use plans and policies. Local land use plans include Sacramento County General Plan and zoning code, the City of Sacramento General Plan and zoning code, Yolo County General Plan and zoning codes, the Delta Plan, and the American River Parkway Plan.

Basis of Significance

The thresholds of significance encompass the factors taken into account under NEPA and CEQA to determine the significance of an action in terms of its context and intensity. Under NEPA and CEQA, consideration is given to determine possible conflicts between the proposed action and the objectives of Federal, State, Regional, and local land use plans, policies, and controls for the study area. Alternatives under consideration were determined to result in a significant impact to land use if they would do any of the following:

- Conflict with any applicable land use plan, policy, or regulation;
- Conflict with approved Habitat Conservation Plans or Natural Community Conservation Plans;
- Physically divide an established community;
- Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere;
- Convert a significant amount of prime farmland, unique farmland, or farmland of statewide importance to non-agricultural use; or,
- Conflict with existing zoning for agricultural use.

The proposed alternatives would not divide an established community or displace substantial numbers of people. As a result, these criteria are not discussed further in this analysis.

3.3.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The City of Sacramento's Resource Protection Policy states; "The City shall seek to minimize or avoid adverse impacts to historic and cultural resources from natural disasters. To this end, the City shall promote seismic safety, flood protection, and other building programs that preserve, enhance, and protect these resources." The No Action Alternative is inconsistence with this policy because it fails to improve flood protection. Additionally, the No Action Alternative would be in conflict with any habitat plans in the study area, because protected habitat would remain at risk during a flood event and could be damaged if a levee were to break. The No Action Alternative would not conflict with existing zoning for agriculture, nor would any agricultural lands be converted under this alternative.

The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system, but it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. As a result, if a flood event were to occur, the Sacramento area would remain at risk of a possible levee failure.

The high potential for flooding would result in continued threat to property, lives, and economic damages for Sacramento. Homes and businesses within the floodplain would continue to be at risk of flooding. Thousands of people could be displaced and houses destroyed, requiring the replacement of commercial buildings and housing. For a flood event that has a 1% chance of happening in any given year, the Corps estimated $22.5 billion in damages to structures and its contents could result.

Along with the potential for loss of lives is the ability for the study area to recover from a flood event. The study area contains many government agencies and the California State Capitol. While the City and County of Sacramento, and the State of California have emergency plans in place, recovery would be slowed due to the damage anticipated to government facilities within the study area. The slower recovery or lack of recovery would result in lower land, housing, and overall property value.

The waterside berms within the Parkway would erode over time resulting in the loss of Parkway lands. The exact timing of this is unknown due to the fact that each storm event could remove small amounts of berm or a larger event could result in a loss of a significant amount of berm. The American River Parkway Plan, the Management Plan for the Wild and Scenic Rivers Act, designates most of the lands within the project area for natural, recreational, or habitat enhanced uses. This alternative would be inconsistent with the American River Parkway Plan because it would not allow for the protection of the recreational and fisheries resources that are designated as significant under the Wild and Scenic Rivers Act. As a result, the No Action Alternative would be considered to have a significant effect on land use.

The Delta Plan's Regulatory Policy RR P1 addresses the prioritization of State investments in delta levees and flood risk reduction. Some of the goals stated in this policy include:

- Protect existing urban and adjacent urbanizing areas by providing 200-year flood protection.
- Protect small communities and critical infrastructure of statewide importance (located outside of urban areas).
- Protect floodwater conveyance in and through the Delta to a level consistent with the State Plan of Flood Control for project levees.

The No Action Alternative is inconsistent with these goals since it would not help achieve the Delta Plan's goals cited above. The No Action Alternative does not provide a 200-year level of protection for urban or adjacent urbanizing areas, and allows critical infrastructure of statewide importance to remain at risk of damage during a major flood event. The No Action Alternative would not result in any changes to the conveyance of floodwaters in and through the Delta.

3.3.4 Alternative 1 – Improve Levees

The following subsections describe potential effects to land use associated with construction of Alternative 1. There would be no effects to land use associated with long-term project O&M. Alternative 1 would not result in the permanent conversion of any agricultural lands, nor would it conflict with any agricultural land zoning.

Borrow Sites

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. Borrow sites would be lands that are the least environmentally damaging and would be obtained from willing sellers. The criteria used to determine potential locations were based on current land use patterns and soil types from the NRCS. The data from land use maps and NRCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps is considering all locations within the 20 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material. It is estimated that a maximum of 1 million cubic yards of borrow material could be needed to construct the project. Because this project is in the preliminary stages of design, detailed studies of each alternative borrow needs have not been completed. For the purposes of NEPA/CEQA a worst case scenario is being evaluated for the volume of borrow material needed. Actual volumes exported from borrow sites would be adjusted to match demands for fill.

The excavation limits on the borrow sites would provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation would be no steeper than 3H:1V. Excavation depths from the borrow sites would be determined based on available suitable material. The borrow sites would be stripped of top material and excavated to appropriate depths. After excavation, disturbed areas would be finish graded in compliance with criteria for drainage of reclaimed land uses. Once details of borrow locations have been finalized, coordination with the California Department of Conservation would occur to ensure compliance with the Surface Mining and Reclamation Act of 1975 (SMARA). Once material is extracted, borrow sites would be returned to their existing use whenever possible. If it is determined that borrow sites can be used to mitigate for project impacts and it would be an appropriate use of that land it could be a land use change. Land use changes in borrow sites is expected to be less than significant because these sites would be returned to their pre-borrow conditions or used for mitigation. Once the borrow locations and reclamation of the sites has been finalized, a determination will be made if additional NEPA/CEQA documentation is needed. This would occur only if the changes in land use are determined to be substantial, or if there are significant new circumstances or information relevant to environmental concerns that have bearing on the proposed action or its impacts.

American River

The American River Parkway Plan acknowledges that the Parkway is a management floodway that has a shared purpose of protecting Sacramento from seasonal flooding and supporting recreational use along with natural habitat areas (Parkway Plan, Chapter 4). As such, the Parkway Plan establishes policies that address flood risk reduction and levee protection activities with the overall aim of facilitating these activities as necessary to achieve established flood risk reduction objectives in a manner which provides optimum protection to the open space, recreation, and fish and wildlife resources of the Parkway.

Further, the Parkway Plan acknowledges that:

Erosion of the berms and banks supporting the levees along the lower American River is an ongoing threat to the stability of the flood control system that has been heightened by the need to convey very high flows through the system for sustained periods as part of the program to provide a high level of flood protection to the urbanized floodplain (Parkway Plan, Chapter 4, "Erosion Control").

The Parkway Plan further establishes that "The Parkway Manager also has an interest in protecting threatened berms that support remnant stands of cottonwood forest and provide recreational access to the river" (Parkway Plan, Chapter 4, "Erosion Control"). Consistent with these policies, bank protection improvements and, to a lesser extent, launchable rock trench improvements, have been constructed at various locations in the Parkway over the past 20 years. The Parkway Plan clearly establishes both the importance and need to provide erosion protection measures within the Parkway; therefore, by proposing to construct these improvements, the ARCF GRR is consistent with these aspects of the Parkway Plan.

Policy 4.16 of the Parkway Plan, as described in the Existing Conditions discussion above, establishes that erosion control projects should be designed "to minimize damage to riparian vegetation and wildlife habitat, and should include a revegetation program that screens the project from public view, provides for a naturalistic appearance to the site, and restores affected habitat values". The Corps is proposing a combination of bank protection measures and launchable rock trench measures to address the need for erosion protection. Each of these measures would involve the removal of riparian vegetation during construction, however the habitat removed under each measure provides different types of habitat values; in areas where bank protection is constructed, bank side habitat would be impacted and proposed mitigation measures would focus on replacing this habitat. In areas where launchable rock trench is constructed, upland habitat would be impacted and the proposed mitigation measures would focus on replacing this habitat type. As a result, the Corps would evaluate each stretch of levee on a site-specific basis during the design phase of the project, including potential site-specific effects and the site's hydraulic conditions, in order to determine the appropriate measure to implement at each site.

In selecting which of these methods of protection should be deployed, the Corps will coordinate closely with the Sacramento County Department of Parks and Recreation, the National Park Service, the other Federal and State agencies responsible for managing the resources of the Parkway, and non-governmental stakeholders. In carrying out this effort, the Corps will coordinate through the formal and informal processes that have been created to facilitate management of the Parkway. Where erosion protection is needed to meet established flood risk management objectives, the selection of the measure will be based on a determination of which method would do the most to protect valuable Parkway fish and wildlife resources, and recreational facilities considering both the short term impacts of construction and the long term implementation of any mitigation included in the project.

Launchable Rock Trench

Minimum land use changes would occur along the 11 miles of erosion protection proposed for the American River under this alternative. Erosion protection could consist of either launchable rock trench or bank protection. Construction activities could cause temporary changes to the land use within the levee structure, adjacent waterside berm or river bank. These changes include the use of Parkway land for staging areas and the actual construction footprint. As construction progresses along the levee, staging areas no longer needed would be returned to their prior use. Construction footprints would be returned to the prior use, with the exception of the 15-foot wide vegetation free zone on waterside of the levee.

The levee structure would be changed by placing a launchable trench into the adjacent levee toe. The width of the toe trench would be a maximum of 70 feet resulting in a temporary disturbance to approximately 65 acres within the Parkway. In much of the Parkway there is an existing 15 foot maintenance road along the waterside levee toe. Outside of this 15 foot area, the land contains riparian habitat intermixed with recreation facilities and open space. Under this alternative the 15 foot maintenance road would be replaced over the toe trench and the riparian area would be replanted with vegetation. Recreation facilities affected would be replaced to the pre-construction condition in coordination with the Sacramento County Department of Parks and Recreation (County Parks). Any riparian area within the 15 foot landside toe would not be replanted in this location. The levee slope would be planted with native grasses to prevent erosion. Re-establishment of the riparian habitat would take many years; however, the land use designation would not change except for the 15 foot maintenance road and vegetation free zone.

Existing maintenance roads would be used for construction access whenever possible. Temporary construction access roads and ramps could also be built at various locations. Roads not needed for long term maintenance would be removed and returned to the pre-construction use. Some ramps may be left in place to allow for easier waterside maintenance access in coordination with County Parks and the American River Flood Control District (ARFCD).

The launchable rock trench measure would allow for the protection of the existing SRA habitat by constructing erosion protection measures against the waterside levee toe. This measure would require the removal of upland riparian scrub habitat and grasses close to the levee in order to construct the trench. However, this measure would also incorporate mitigative features through the installation of plantings on the surface of the trench. More information on the revegetation at the proposed rock trench sites is discussed in Section 3.6.4 below, and in the Habitat Mitigation and Monitoring Plan (Appendix I). Additionally, this measure is consistent with the Parkway Plan in that once installed, these trenches would be completely screened from public view. As a result, once the vegetative features have reached full growth, the rock trenches would provide a natural appearance to the site with the affected habitat values fully restored. This alternative is in compliance with the Parkway Plan Flood Control Policy and land use impacts are considered to be less than significant and no mitigation is required.

Bank Protection

To reduce the impacts to riparian habitat within the Parkway, bank protection may be installed along the river channel instead of the rock trench. At this stage in the planning process approximately 11 miles of erosion protection has been identified. Erosion protection could consist of either launchable rock trench or bank protection. No long term change in land use would occur if Alternative 1 were constructed. Access to the construction sites would be from existing maintenance roads and ramps whenever possible. However, additional ramps and roads could be required to access the river channel and for the placement of rock. Rock would be trucked on existing roads to staging areas and transported to the channel using smaller off road vehicles. Roads and ramps would be returned to pre-construction condition as areas are completed. The exact location of the bank protection is unknown; however roads and ramps to the sites would be designed to minimize impacts to the natural environment of the Parkway.

The proposed bank protection measures would require the removal of smaller shrubs and grasses associated with SRA habitat in order to place the rock protection, but impacts on SRA would be minimized by protecting existing large trees in place and incorporating them into the bank protection designs. Additionally, the Corps proposes to incorporate planting berms into these sites, as shown in Chapter 2, to allow for on-site revegetation. More detail on the revegetation proposed at the bank protection sites is discussed in Section 3.6.4 below, and the Habitat Mitigation and Monitoring Plan (Appendix I). With the incorporation of the mitigative features, Alternative 1 would be consistent with the Parkway Plan and effects to Land Use would be less than significant.

Sacramento River

Changes to land use along the Sacramento River would occur primarily on the landside in the Pocket and Little Pocket area of Sacramento (Reaches E, F and G) where levee raises are required (Plate 3). Many homes in this area back up to the levee with little to no land between the levee toe and the fence or backyard. Flood protection levee easements extending over private parcels have not yet been determined, but it is assumed that some takings of private property would be required. No land surveys have been conducted at this stage in the project. For planning purposes, a general assumption was made that a levee easement exists from toe to toe and extends 10 feet beyond the toe landside and waterside. The taking would be required to allow for construction equipment to move material into the site and to construct the embankment fill required for levee raising. After construction of levee raises, where needed, the landside construction access would be converted to a landside maintenance easement. Both State and Corps policy require a 10 to 20 foot landside easement for maintenance. The maintenance corridor is used during high waters to patrol for potential levee failures and for flood fighting. Areas beyond the approximately 7 miles of levee raise would be brought into compliance by the local maintaining agency over the next 20 to 40 years under the SWIF.

All property acquisitions would be conducted in compliance with Federal and State relocation law, and relocation services would be accomplished in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1960. These laws require that appropriate compensation be provided to displaced residential and nonresidential landowners and tenants, and that residents are relocated to comparable replacement housing and receive relocation assistance. This law applies to farms and businesses if they would be displaced for any length of time. With compliance with these relocation laws, and appropriate compensation to impacted landowners, this effect would be less than significant, with mitigation required.

East Side Tributaries

Changes in land use along the East Side Tributaries would be minimal. Construction activities would be within the existing levee footprint. This land is already in an existing levee easement and would remain within a levee easement. There would be a change in land use at Magpie Creek. A 79-acre vacant parcel of vernal pools and grasslands would be acquired and protected in perpetuity under a flood easement. This land already floods during high water events and there would be no impact on land use from the acquisition of this land.

3.3.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Impacts for Alternative 2 are the same for borrow sites, the American River, and the East Side Tributaries as Alternative 1.

Sacramento River

Under this alternative levee raises along the Sacramento River would be reduced from 7 miles to approximately 1 mile compared to Alternative 1 (Plate 4). This would significantly reduce the amount of private property taking required to construct the project. Within the 1 mile of levee raise, private property would need to be acquired to allow for construction of the levee raise. A landside construction access area would also be included in the construction footprint. Once construction of levee raises is complete the landside construction access area would be transitions into a landside maintenance easement. The extent of levee easements extending over private parcels have not yet been determined. No land surveys have been conducted at this stage in the project. For planning purposes, a general assumption was made that a levee easement exists from toe to toe and extends 10 feet beyond the toe landside and waterside. Areas beyond the approximately 1 mile of levee raise would be brought into compliance by the local maintaining agency over the next 20 to 40 years under the SWIF.

All property acquisitions would be conducted in compliance with Federal and State relocation law, and relocation services would be accomplished in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1960. These laws require that appropriate compensation be provided to displaced residential and nonresidential landowners and tenants, and that residents are relocated to comparable replacement housing and receive relocation assistance. This law applies to farms and businesses if they would be displaced for any length of time. With compliance with these relocation laws, and appropriate compensation to impacted landowners, this effect would be less than significant, with mitigation required.

Sacramento Weir and Bypass

This alternative would add an additional 1,500 feet of weir to the existing Sacramento Weir along the Sacramento River and approximately 315 acres of additional bypass (floodway) space. Primary components of the proposed weir and bypass expansion would include extending the current weir structure, degrading the existing north levee of the Sacramento Bypass, constructing a new levee and seepage berm at the northern terminus of the weir extension, and grading the expanded floodway area. The overall construction "footprint" (e.g. limits of construction) for these expansion features would encompass a total of approximately 427.7 acres.

Table 8 below identifies the existing land uses within the bypass construction footprint and the approximate acres of each existing land use type within the footprint of the new bypass area, the new levee, and the new weir.

Table 8. Land Use Impacts from the Sacramento Weir and Bypass Expansion.

Existing Land Use	ACRES			
	Within New Bypass Footprint	Within New Levee Footprint	Within New Weir Footprint	Totals
Levees (& roads)	43.5	2.5	0.5	**46.5**
Roadways	1.7	0.6	0	**2.3**
Railroad	1.1	1.2	2.8	**5.1**
Agricultural: Row Crops	55.3	43.5	0	**98.8**
Agricultural: Nut Orchards	180.4	55.6	0.7	**236.7**
Other Agricultural Lands	5.6	1.3	0.5	**7.4**
Canals	10.0	3.5	0	**13.5**
Landfill (abandoned)	17.4	0	0	**17.4**
Totals	**315.0**	**108.2**	**4.5**	**427.7**

The following provides a brief description of the existing land uses identified in Table 8:

- Levees – This includes the levee adjacent to the north side of the existing bypass (floodway), a portion of the levee along the west bank of the Sacramento River, and a portion of a levee along the east side of the Yolo bypass. Some of the levee area includes paved and gravel roadways on top of the levee (especially Old River Road, County Road 126, and East Yolo Levee Road). The levee area east of the existing weir includes a large dirt parking area and several trees along its side slopes.
- Roadways – This is limited to a portion of County Road 124. This category does not include small dirt roads in agricultural fields.
- Railroad – A portion of the existing Yolo Shortline Railroad and its apparent right-of-way, which in this area includes an elevated dirt platform (berm) for the railroad tracks.
- Agricultural: row crops – Actively managed agricultural fields used to produce various row crops such as tomatoes and safflower.
- Agricultural: nut orchards – Actively managed agricultural orchards used to produce nut-bearing trees. These trees were too young to identify the species, but potentially are walnut trees.
- Other agricultural lands – Such areas are used for various agricultural purposes, except for growing crops. Examples include; major dirt roads between fields, staging and equipment storage areas, etc. One such area contains large trees.
- Canals – This group includes one large irrigation canal along with portions of other large agricultural irrigation/drainage ditches. It excludes small agricultural ditches.
- Landfill – This is the abandoned "Old Bryte" landfill, now dominated by various grasses and forbs.

The existing Sacramento Weir would remain in place and would have no change in land use designation. This alternative would add an additional 1,500 feet of weir along the Sacramento River and approximately 315 acres of additional bypass space (e.g. floodway). It is anticipated that the additional bypass area would be made available to the CDFW for incorporation into the existing Sacramento Bypass Wildlife Area, thereby expanding the wildlife area by over 85 percent. Assuming this occurs, these 315 acres would be converted from the existing land uses identified in Table 8 to recreational uses presently allowed within the current wildlife area.

A total of approximately 335.5 acres of actively farmed lands, which are also designated as prime farmland, would be eliminated from agricultural uses through the proposed weir and bypass expansion. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. The proposed bypass expansion is located in Yolo County and Section 8-2.2416 of the Yolo County Code

requires agricultural mitigation for changes from agricultural use to a predominantly non-agricultural use. However, land use conversion for public uses is exempt from this mitigation requirement. Yolo County has a total of approximately 250,000 acres of prime farmland. The land use conversion proposed would represent a decrease of approximately 0.13 percent in the total acreage of prime farmland within the county. While the conversion of the existing actively farmed lands (prime farmland) to non-agricultural use would result in only a minor loss of prime farmland in Yolo County, this loss is still considered significant because it would conflict with existing zoning for agricultural use in the footprint of the widened Sacramento Bypass.

It is noted that the draft EIS/EIR indicated that the existing farmland within the expanded bypass would be converted to a floodway and could either be managed as open space/wildlife area or continue as farmland. Some public comments received recommended that agricultural uses should not be allowed within the new floodway (bypass) as this would present land management conflicts and problems within the overall bypass. It is also likely that allowing the production of agricultural crops within the bypass expansion area could detrimentally affect surface water flows through the overall bypass. As such, it was determined that it would be more appropriate to not allow agricultural uses within the bypass expansion.

All property acquisitions necessary for construction of the weir extension and bypass expansion would be conducted in compliance with Federal and State relocation law, and relocation services would be accomplished in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1960. With compliance with these relocation laws and appropriate compensation to impacted landowners, the effect of land use conversion to the affected existing property owners would be less than significant, with mitigation required.

Construction of the proposed weir extension and bypass expansion would directly impact segments of existing roadways, including Old River Road, CR 124, CR 126, and East Yolo Levee Road, as well as a segment of an existing railroad (Yolo Shortline Railroad). The affected portions of the roadways would be relocated and the affected railroad segment would be rebuilt as part of the project. Given this, these localized land uses would only be temporarily impacted and the effects to these transportation land uses would be less than significant, with the required mitigation.

3.3.6 Mitigation Measures

Alternatives 1 and 2 would result in less than significant impacts to land use for the American River measures, with the restoration of the impacted construction footprint and establishment of habitat mitigation, as discussed further in Section 3.6, Section 3.8, and the Habitat Mitigation and Monitoring Plan (Appendix I). Additionally, the Corps would ensure that recreation facilities within the American River Parkway would be restored to pre-project conditions, as discussed further in Section 3.14.

Mitigation for property acquisition on the Sacramento River, East Side Tributaries, and Sacramento Weir and Bypass would be compensation to land owners under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1960. No additional mitigation would be required for land use under the ARCF GRR.

3.4 Hydrology and Hydraulics

3.4.1 Environmental Setting

Regulatory Setting

Federal

- Clean Water Act of 1972
- Safe Drinking Water Act of 1974
- National Flood Insurance Program

State

- Porter-Cologne Water Quality Control Act of 1970

Existing Conditions

The project area is divided into two basins – American River North and American River South – and has an upstream boundary at Verona and a downstream boundary at Freeport on the Sacramento River (Plate 2). These basins include the leveed portions of the American River, the Natomas East Main Drain Canal (NEMDC), Magpie Creek, and the leveed portions of Dry and Arcade creeks.

Flood control channels and other features in the Sacramento area are part of a much larger flood management system known as the Sacramento River Flood Control Project (SRFCP). The SRFCP in the Sacramento Valley consists of a series of levees and bypasses, constructed to protect urban and agricultural areas and take advantage of several natural overflow areas. See Plate 1 for a graphic depiction of the system layout. The SRFCP system includes levees along the Sacramento River south of Ord Ferry Road; levees along the lower portion of the Feather River, Bear River, and the Yuba River; and levees along the American River. The system benefits from three natural overflow areas – Butte, Sutter, and Yolo. These areas run parallel to the Sacramento River and receive excess flows from the Sacramento River, Feather River, and the American River via natural overflow channels and constructed weirs. During floods, the three overflow areas form one continuous waterway.

Geomorphic Conditions

The present-day Sacramento River system has been shaped by thousands of years of complex river processes. These processes include channel migration, erosion, and flood-stage deposition. During most of Holocene time (since the last ice age, generally defined as the last 11,000 years), sediments from the Sierra Nevada and Klamath Mountains were carried by the Sacramento River and its tributaries and deposited into the Central Valley. Natural levees were built up along the riverbanks that frequently overflowed during flood stages, depositing sediments into low-lying basins and wide floodplains.

Recent changes in the lower Sacramento River basin that have affected channel morphology in the project reach include land reclamation, levee construction, dredging, hydraulic mining, impoundment of water and sediment by upstream dams and other diversions, and the construction of water diversion facilities and consequent alteration of flow and sedimentation patterns. The effects of these changes on channel morphology in the project reach are summarized below.

- Waterways in the project reach and vicinity are largely confined by levees and able to convey significantly greater flow and sediment discharges than during historical times.
- Water regulation, diversions, and the impoundment of water and sediment by dams have resulted in a decline in the total annual water and sediment outflows to the Delta from the Central Valley, a trend that is expected to continue into the future (NHC 2003)..
- Since the late 1800s the planform geometry of the Sacramento River through the project reach essentially has been fixed in place by levees and riprap and has not changed significantly to date. Localized changes in depositional bars and other in-channel sedimentation features have been observed over time (cbec, inc. eco engineering 2011).
- In the early 1900s large amounts of sediment were deposited in the Sacramento River as a result of hydraulic mining practices in Sierra foothill rivers and streams. This raised the channel bed of the Sacramento River substantially. Subsequently, the channel incised and widened, leading to its current planform, as a result of upstream anthropogenic impacts, such as reservoir and dam construction and urbanization (cbec, inc. eco engineering 2011). As a result, the channel may be experiencing a net sediment loss over time.

Present geomorphic conditions of the lower Sacramento River basin are a function of the intensity of water management in each of the tributary rivers, local farming practices, water transfers, and an extensive human-made levee system. Today, the channel alignment is largely fixed by artificial levees and erosion control measures. Flooding, except when levees fail, no longer occurs under most flows. Instead, flow and sediment remain confined to the existing channel network.

Sedimentation

Hydrologic regime, channel pattern, and sediment transport in the Sacramento River system have been significantly affected by historic human activities which included hydraulic and dredge mining for gold, building of levees for land reclamation and flood control, bank protection works, land use changes, construction and operation of upstream reservoirs, water export projects, and dredging of alluvium for navigation and levee maintenance purposes. Following a massive influx of sediment from hydraulic mining activities in the mid- and late 1800s, the lower Sacramento River and its major tributaries significantly aggraded (by up to 10 to 25 feet) and then began to gradually degrade into residual mining debris. The transportation of residual mining debris into the Delta of the Sacramento River and further to the bay system probably continued until the mid-1900s. Many researchers believe that present sediment loading on the Sacramento River is approaching its pre-gold rush (i.e., pre 1900) value.

A sedimentation analysis was not completed for this study. However, a Sacramento basin-wide sediment study has been conducted under the Sacramento River Bank Protection Project (NHC, 2012). The main objective of this sediment study was to investigate sediment transport processes and geomorphic trends along the lower Sacramento River and its major tributaries and distributaries. A HEC-6T sediment transport model was developed for the study reaches of the Sacramento, Feather, and American Rivers. HEC-6T is a one-dimensional (1-d) model that computes aggradation and degradation of the streambed profile over the course of a hydrologic event.

For the entire ARCF study reach of the Sacramento River (RM 79 to 46), the average bed elevation decreases by 0.02 foot for the 50-year simulation period and decreases by 0.10 foot for the 100-year simulation period. Despite significant (by a few feet) localized vertical adjustments in the channel geometry (mostly associated with infilling of deep pools and scour of elevated riffles), the study reach of the Sacramento River have a slight degradational trend. The potential for lateral movement of the river is of greater concern due to the possibility for river bank and levee erosion in this narrow channel. Some rock erosion protection has been placed along the Sacramento River to protect the levees from erosion. Often this rock was placed using the reactive approach, such as part of ongoing maintenance activities or under the Sacramento River Bank Protection Project (SRBPP). While some recent designs and construction of rock erosion protection are expected to provide adequate localized erosion protection, other locations may not deliver the same performance during a flood event. Some previous rock erosion protection does not meet current design standards, is past its intended design life, and is in need of repair and/or replacement.

The long-term simulation results indicate that most of the 22 miles long study reach of the lower American River is actively degrading. Upstream sediment supply on the American River is interrupted by Folsom and Nimbus Dam, which results in “sediment-hungry” waters and channel degradation below the dams. Up to 9 to 10 feet of channel degradation is simulated between RMs 22 and 12 for both the

50- and 100-year periods. About 3 to 4 feet of channel aggradation is simulated between RMs 12 and 11. Downstream of RM 11, maximum channel degradation is 15 to 16 feet for the 50-year simulation and 19-20 ft for the 100-year simulation. For the entire study reach of the American River, reach-average thalweg degradation is 5.39 feet for the 50-year simulation and 6.42 feet for the 100-year simulation. Average bed degradation is 4.83 feet and 5.84 feet, respectively. It should be noted that the channel of the lower American River is highly irregular at many locations (especially in braided reaches upstream of RM 8). These irregular reaches may not be adequately represented in the 1-d HEC-6T model. Therefore, the application of the generalized results for the entire reach to the irregular reaches may be subject to simulation errors and should be treated with caution. Further site specific analysis could potentially reduce this error. In general, however, degradational trends predicted by the model for the lower American River agrees with the stage-discharge records obtained for the American River gage at the Fair Oaks Bridge which shows ongoing channel degradation. In general, however, degradational trend predicted by the model for the lower American River agrees with the stage-discharge records obtained for the American River gage at the Fair Oaks Bridge which shows ongoing channel degradation.

Potential implications of the simulated long-term changes in bed profiles can be increased stress along the toe of the project levees or overbank berms in the degradational reaches, which may result in increased scour along unrevetted channel sections. In the aggradational reaches, an increase in bed elevations may result in higher flood stages and reduced flood conveyance.

To evaluate trends in channel planform evolution and changes in overbank berms (floodplain terraces), a series of historical bankline shift maps were produced for the study reach of the Sacramento River for the 1949-1952 to 2005 period using historical aerial photographs and maps. For most of the study reach, the river channel is closely bordered by extensively revetted levees and lateral channel evolution is limited.

The results of the long-term HEC-6T simulations show that the longitudinal bed profile in the study reach of the Sacramento River is generally stable, as has been observed by small changes in stage discharge rating curves over the previous few decades. Future trends in the river planform evolution are not expected to change from those identified in this study, measured over the same multi decadal time period. Assuming persistence of present day climatic conditions and the generally stable to slightly degradational longitudinal profile determined in this modeling study, the potential future loss in overbank berm area in the study reach of the Sacramento River is estimated to be similar to the historic loss, i.e. on the order of 84 acres (or 4.0% of the total overbank berms area) over the next 50 years.

American River Erosion Susceptibility

The *Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events*, evaluated the potential for erosion of grass-covered levees and overbanks in response to different stream discharges resulting from releases of various magnitudes from Folsom Dam (Ayers, 2004). This study

concluded that the river system is degrading under present operating conditions because the lower American River is starved of sediments by Folsom Dam and Nimbus Dam. Hardpan has been reached in the channel bottom as far downstream as Guy West Bridge (RM 7.0), and this hardpan is slowing further degradation. With the river starved for sediment and unable to further scour its channel the river is now eroding laterally to satisfy its need for sediment. Erosion of the riverbank is occurring even at low flow conditions of 7,000 cfs, which was the peak flow from the 2003 runoff season. Ongoing erosion has scarred the channel banks leaving them susceptible to further erosion, especially during high flow events. Lateral erosion is further reducing the amount of berm separating the main channel from the levee. The loss of vegetation on the berm and bank is leaving bare soil, which is more susceptible to erosion at a lower velocity than if the berm or bank was covered with vegetation.

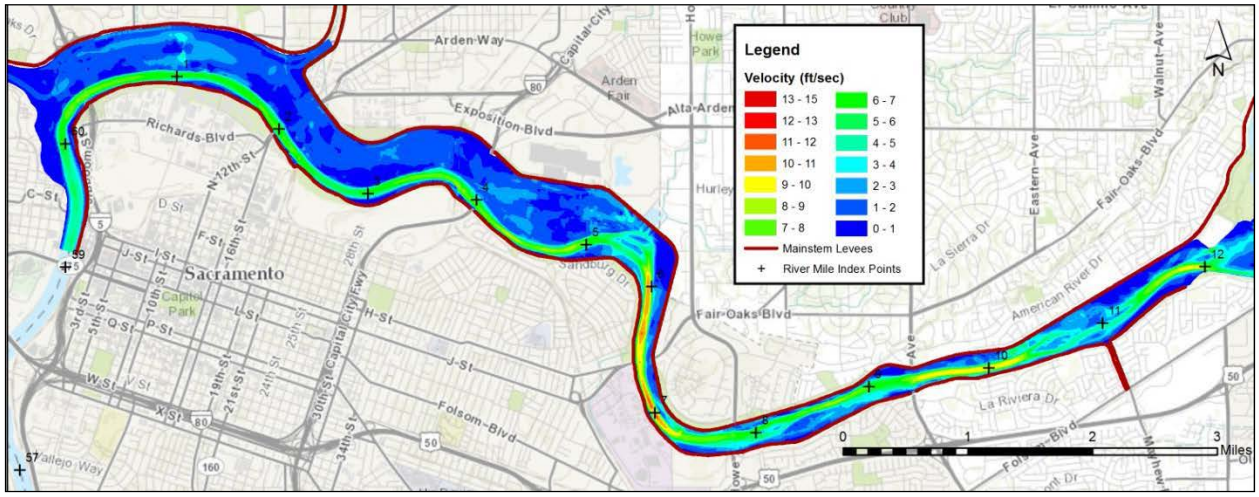

Figure 7. Velocities in the Lower American River at 115,000 cfs.

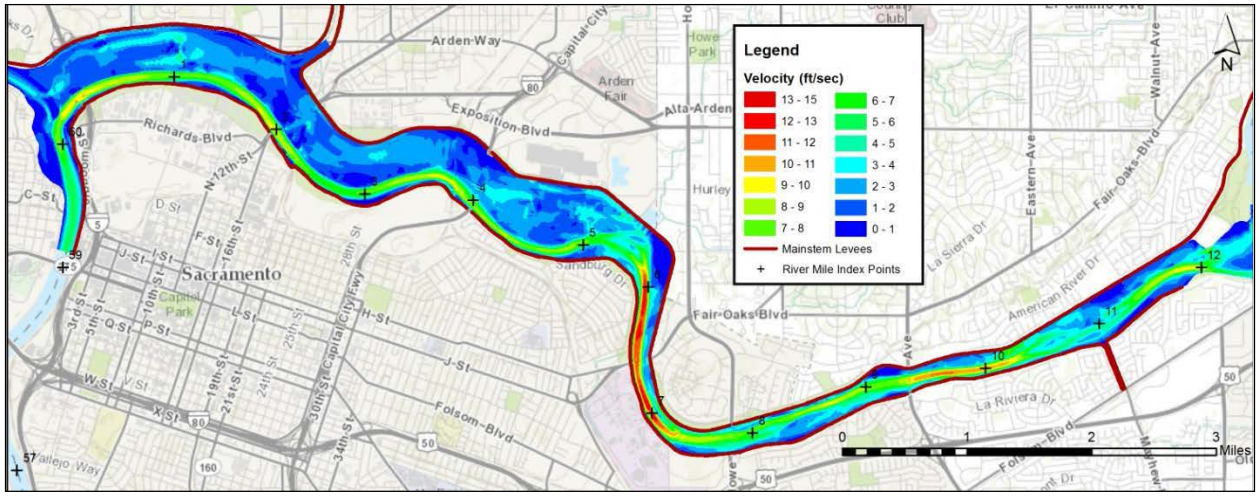

Figure 8. Velocities in the Lower American River at 160,000 cfs.

Figure 7 shows the velocities for a discharge of 115,000 cfs, which average about 6 to 8 feet per second in the channel with maximum velocities ranging up to about 12 feet per second. Figure 8 shows the velocities for a discharge of 160,000 cfs which average about 6 to 9 feet per second in the channel with maximum velocities ranging up to about 13 feet per second. Of concern in both of these figures are the proximities of the relatively high velocities to the levees along the Lower American River. Additionally, the range of the computed velocities is of concern since the magnitude of the velocities is great enough to erode many of the relatively fine grained material present in the channel lining. The results of the analysis indicate that the large discharge events are capable of eroding the material typically found along the Lower American River channel.

Figure 9 shows velocity contours in the area where erosion is greatest, between RM 6 and RM 7.5. As can be seen in Figure 9, velocities reach 11 feet per second for flows of 115,000 cfs, and get as high as 14 feet per second for 160,000 cfs. The study concluded that a flow of 145,000 cfs could cause damage at most of the study's identified priority sites, and could cause a levee failure to occur for at least one of the sites (Ayers, 2004). This reach of river represents the worst conditions regarding velocity (11 to 14 feet per second). Downstream and upstream of this reach, velocities for the same peak releases average between 6 to 9 feet per second.

Bare soil can withstand approximately 1.5 to 2.5 feet per second. Soil with good turf cover can withstand between 3.5 to 8 feet per second. The conditions of grass cover along the American River are not good and erosion occurs at velocities much less than the 11 to 14 feet per second in the RM 6 to RM 7.5 reach. This is illustrated by the fact that emergency erosion repairs have needed to occur as far downstream as near Highway 160 (RM 1.8) and as far upstream as between Watt Avenue and the Mayhew Drain (RM 10.2). Plate 7 shows the existing and proposed erosion protection on the American River.

Climate

Sacramento has a mild, Mediterranean-type climate. Average annual precipitation is about 18 inches, with approximately 80% of the total rainfall occurring between November and March. Cloud-free skies generally prevail throughout the summer months, and in much of the spring and fall. Thunderstorms occasionally occur in the late summer and other times of the year when unstable air masses are situated over the region. The highest rainfall generally occurs in January, when the average is about 4.2 inches of precipitation. The driest month is July, during which rainfall is rare.

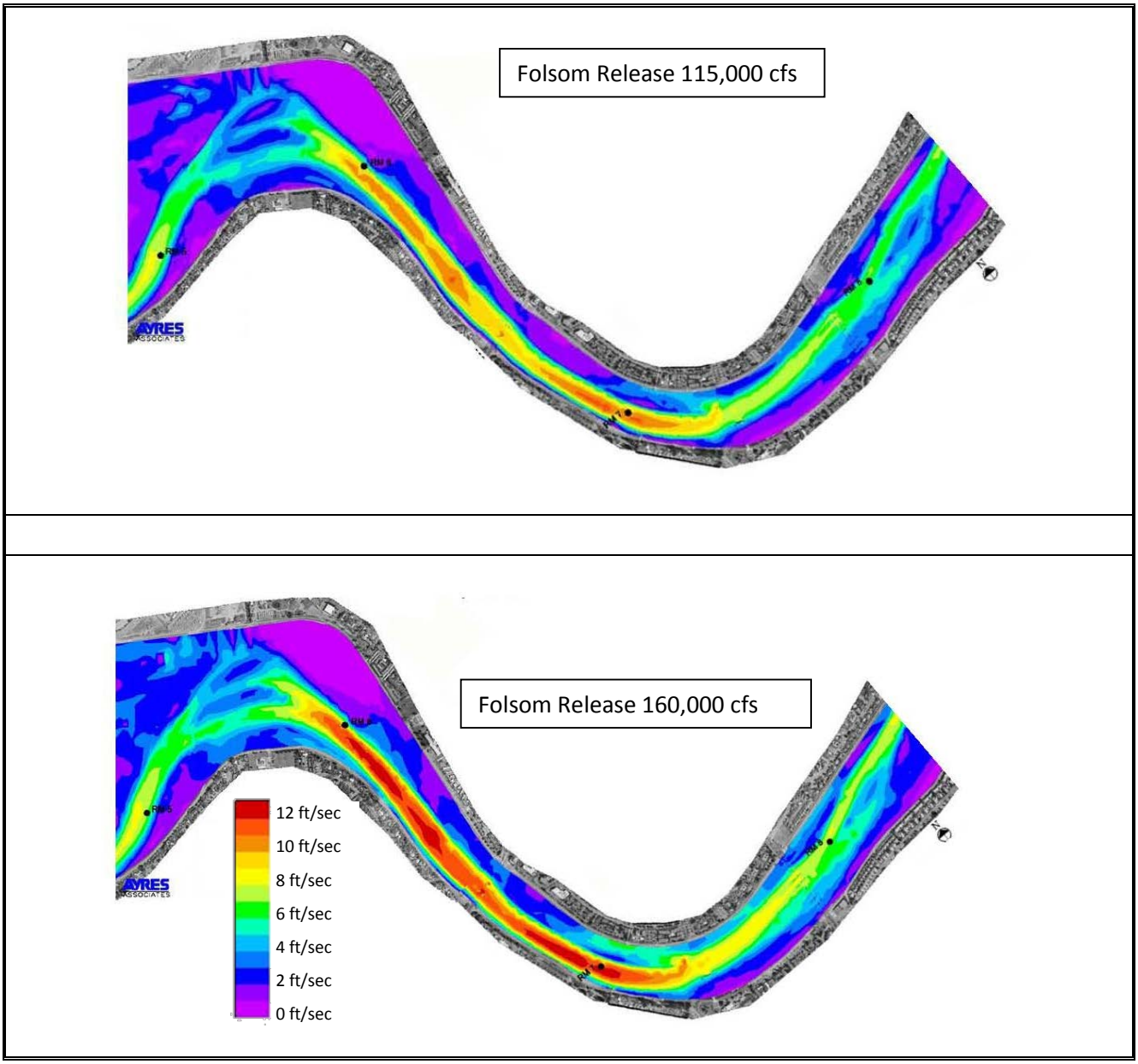

Figure 9. American River Velocity Contours.

Surface Water Hydrology

The Sacramento River drainage basin covers approximately 27,000 square miles. Total annual precipitation within the Sacramento River watershed falls as both rain and snow. Precipitation in winter falls primarily as snow in the higher elevations. Annual, monthly, and daily precipitation varies widely within the watershed, with the highest precipitation totals generally falling in winter, in the Sierra Nevada, and in the northern part of the watershed. The high variability in precipitation, snowfall, and snowmelt results in highly variable runoff patterns each year and month during late fall, winter, and spring.

Two major tributaries, the American River and the Feather River, produce about 90% of the flood flows approaching Sacramento from the north and the east. Both historically and as part of the design of the SRFCP, flood flows approaching from the north are split between the Sacramento River and the Yolo Basin. Under the current design of the SRFCP, the Yolo Bypass absorbs about 70% of this flow at the latitude of Verona and 80% at the latitude of Sacramento. To the east, the entire flow of the American River must be passed through the urban core of Sacramento. Improved flood protection for the Sacramento area is thus dependent on the strength of the levee system along the lower Sacramento and American Rivers and on the capability of Folsom Dam to limit American River flows to the design capacity of the American River levee system.

Hydrology from the Sacramento-San Joaquin Comprehensive Study was used with several updates. This includes greater detail and refinement of the tributaries streams on the east side of the Natomas Basin and an update on Outflows releases through Folsom with the new Joint Federal Project (JFP) in place. For details regarding all hydrologic inputs, see the Hydrology Appendix of the GRR. As described in that hydrologic appendix, a hypothetical storm centering method was developed in the Comprehensive Study to position an n-year flood event at a particular location in the river system. Inflow hydrographs were generated for use at several frequencies including the 2-year through 500-year events.

Existing and Future Without Project Condition Assumptions

The future without project condition assumptions include construction and operation of all previously authorized work on the American River as part of the WRDA 1996 and 1999 Common Features authorizations, levee repairs as described in the Natomas PACR authorized in WRRDA 2014, the new JFP spillway under construction at Folsom Dam, and the future planned raise of Folsom Dam. The work proposed as part of this GRR, is considered part of the with-project condition.

The existing condition for ARCF is different than the future without project condition. The existing condition describes the existing releases from Folsom Dam and is compared to the future without project condition to assess the no action alternative. The existing condition assumes the Bureau of Reclamation and SAFCA reservoir operation agreement is in place which allows for greater flood storage in the reservoir beyond what the original operations manual designated.

The future without project condition assumes the JFP and dam raise are in place and are operated as intended. All alternatives developed as part of this GRR were then compared to the future without-project condition for evaluation. The major hydrologic/hydraulic difference between the existing condition as compared to both the future without project condition (FWOP) and the with-project condition is that the peak flow on the American River is higher for the FWOP for the more frequent events (10- and 25-years) but lower for the FWOP for the less frequent events (100- and 200-years) due to Folsom Dam operational changes. Table 9 displays the different flow releases from Folsom Dam for the Existing and the Future Without Project (with JFP and dam raise in place).

Table 9. Comparison of Existing and Future Without Project Flow Releases from Folsom Dam.

Frequency (Year Event)	Existing Condition (Existing Releases, cfs)	Future Without Project Condition (with JFP, cfs)
10	43,000	72,000
25	100,000	115,000
50	115,000	115,000
100	145,000	115,000
200	320,000	160,000
500	520,000	530,000

Figure 10 compares the flow releases from Folsom Dam for the existing and future without project condition with the JFP. The graph shows the flow releases will be higher with the JFP in place for frequent events as compared to the existing conditions. However, flow releases will be lower for the less frequent events with the JFP in place as compared to the existing condition. The advantage of the JFP is that it allows the dam operators to have greater flexibility to release more water from Folsom Dam in advance of storm peaks. The intent of the JFP is to be able to release larger magnitude flows when the reservoir stage is lower which artificially creates additional storage because it has been evacuated.

The effect of the modifications at Folsom Dam will be most noticeable for the frequent flood events. As shown above, the 10-year and 25-year events have increases in flow release because of the Folsom Dam improvements as compared to the existing; the 10-year release increases by about 29,000 cfs and the 25-year release increases 15,000 cfs. As a trade off however, for larger flood events, peak releases drop, in some cases significantly; the 100-year release decreases by about 30,000 cfs, and the 200-year release decreases by 160,000 cfs. The Folsom Dam improvements are intended to control up to a 200-year event, beyond which, control is lost, and which is why there is little change for the 500-year event.

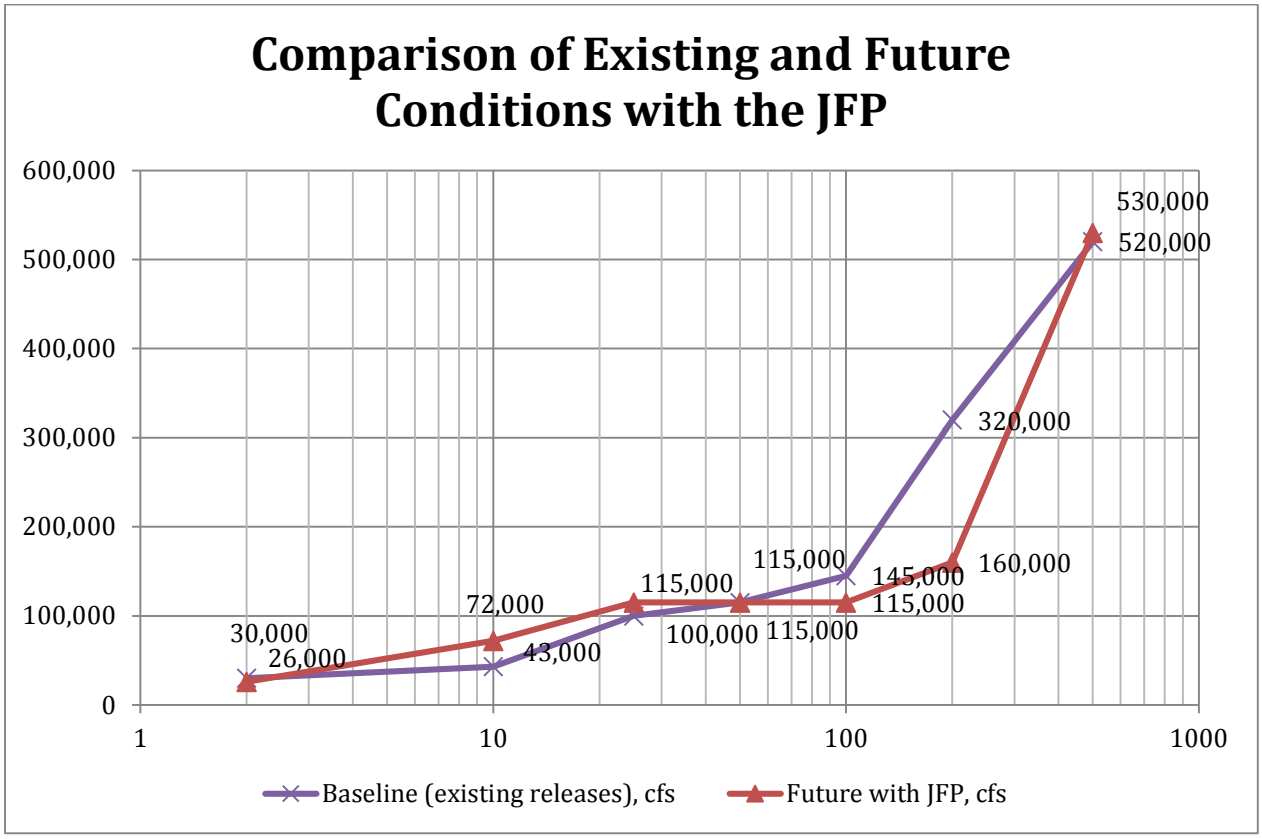

Figure 10. Comparison of Existing and Future Folsom Dam Releases.

3.4.2 Methodology and Basis of Significance

Methodology

The hydraulic analysis evaluates the potential flood-related impacts of the action alternatives on water surface elevations in the stream and river channels in the project area and in the larger watershed within which the project is situated. Specifically, a HEC-RAS hydraulic computer model was used to compare existing conditions to the alternatives in the waterways surrounding each of the basins and within the Sacramento River Watershed. Additional information can be found in the Hydraulic Appendix to the GRR.

The study area was divided into 25 river reaches according to the geotechnical similarity of their levees. For the purposes of the economic analysis, a single point is needed to represent each reach and is often referred to as an index point. In an effort to support SMART Planning, the project area was determined to be adequately represented by index points at five key locations. The five index points represent the three basins (including Natomas, which is no longer a part of this study). The index points are listed in Table 10.

Table 10. Index Points.

Index Point	Basin	Index Point	Project Reach	River Mile
American River North Levee	ARN	A	American River	7.8
Arcade Creek North Levee	ARN	E	Arcade Creek	0.9
American River South Levee	ARS	A	American River	8.9
Sacramento River South	ARS	F	Sacramento River	50.3
Natomas Cross Canal South Levee	NAT	D	Natomas Cross Canal	2.7

HEC-RAS (1-dimensional channel model) and FLO-2D (2-dimensional gridded model) hydraulic models were used to produce necessary outputs for the economic evaluation of the future without-project conditions and alternatives. The ARCF used the same basic models that were developed and refined for the existing conditions analyses and the Natomas PACR (Corps, 2010). HEC-RAS was used to model the main flood control channels of the system to determine the water surface profiles and flood hydrographs into the floodplain areas. This HEC-RAS model includes much of the Sacramento River Basin. This was done to capture upstream and downstream influences to the project area as well as to eventually determine the potential project impacts to areas outside the project area.

Flood hydrographs generated in HEC-RAS from a levee break were input into FLO-2D for delineation of the floodplain in each basin. In order to generate flood damages for economic evaluations, floodplains were delineated for the 2-, 10-, 25-, 50-, 100-, 200-, and 500-year events. The analysis was limited to flooding within the basin from levee breaches and does not include localized flooding from rainfall-runoff and smaller streams and drainages.

Floodplain delineations presented in this study are based on a single levee break within a levee reach. The levee break location was determined by the most significant geotechnical concerns along that reach and by any overriding hydraulic concerns, such as low levee elevations or locations where a large amount of water could travel through the levee break and out into the floodplain. The resultant flood depths from FLO-2D and the stage-discharge-frequency curves derived from HEC-RAS outputs were used to perform the risk analysis for the without-project condition and the alternatives.

The analysis consisted of calibrating the hydraulic model to historic flood events using high-water marks and stream gauge data gathered in connection with the 1997 flood, and modeling the existing fix-in-place and no action conditions under the following flood scenarios: (1) the 1957 water surface profiles that serve as the minimum design standard for the SRFCP; (2) the 0.01 AEP (100-year) design flood elevation that affects management of SRFCP-protected floodplains under the National Flood Insurance Program (33 CFR Section 65.10); (3) the 0.005 AEP (200-year) design flood elevation that is likely to affect implementation of the floodplain management standards recently adopted by the California Legislature (Chapter 364, Statutes of 2008 [adding Water Code Section 9602(i)]); and (4) the 0.002 AEP (500-year) design flood elevation that represents an extreme flood event and is the largest flood event for which hydrologic input data have been developed for the hydraulic simulation model.

Basis of Significance

The thresholds of significance encompass the factors taken into account under NEPA to determine the significance of an impact in terms of its context and intensity. The thresholds for determining the significance of impacts for this analysis are based on the environmental checklist in Appendix G of the State CEQA Guidelines. The alternatives under consideration were determined to result in a significant impact related to hydrology and hydraulics if they would do any of the following:

- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river in a manner that would result in: (1) substantial erosion or siltation on- or off-site, and (2) substantial increase in the rate or amount of surface runoff in a manner that would result in flooding on- or off-site.
- Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.
- Place housing within a 100-year flood hazard area.
- Place within a 100-year flood hazard area structures which would impede or redirect flood flows.
- Expose people or structures to a significant risk of loss, injury, or death involving flooding.

The proposed alternatives would not place housing or other structures within a 100-year flood hazard area, therefore, these criteria are not discussed in the analysis below.

3.4.3 No Action Alternative

Under the No Action Alternative, the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. Flow conditions in the system would be consistent with the future without project condition, as described above. If a levee breach were to occur, people and structures would be exposed to significant risk of loss, injury, or death involving flooding. In addition, significant erosion or siltation could occur due to the substantial increase in flows. Flood flows would contain significant contaminants and would be highly polluted, spreading and exposing people to substantial health and safety risks. Emergency repair activities would be implemented and could result in the loss of channel capacity and alteration of present day geomorphic processes with the placement of large quantity of rock into the river to close the breach. As a result, effects to hydrology and hydraulics under the No Action Alternative would be significant.

3.4.4 Alternative 1 – Improve Levees

Alternative 1 involves the construction of levee remediation measures to address deficiencies such as seepage, slope instability, overtopping, erosion, lack of vegetation compliance, and lack of O&M access along the American River, the Sacramento River, NEMDC, Arcade Creek, Dry Creek, Robla Creek; and Magpie Creek. This alternative combines construction of improvement measures while maintaining the present levee alignment in its existing location (fix in place). Due to the urban nature and proximity of existing development to the levees Alternative 1 proposes fix-in-place levee remediation. The stated purpose of this alternative would be to improve the flood risk management system to safely convey flows up to a level that maximizes net benefits.

The work in Alternative 1 primarily includes landside fixes of levees that do not change in-channel geometry or characteristics, so the hydraulics do not change. As a result, Alternative 1 would not substantially alter the erosion or siltation in the system or increase the rate of surface runoff in a manner that would result in any flooding. Additionally, Alternative 1 would not impact stormwater drainage systems or create additional sources of runoff.

The water surface elevations for Alternative 1, which is also the future without project condition, Alternative 2, and the baseline for both the 10-year and the 200-year events can be found in the Engineering Appendix to the GRR. A crest elevation of 200-year plus 3 feet was used as a baseline to compare the current top of levee. Levee raising was added when the current top of levee fell below this baseline. Plate 3 shows the locations where levee raises are proposed.

Since Alternative 1 involves fix-in-place only, the footprint of the levee system would not significantly change. As a result, the proposed measures would not place housing within a 100-year flood hazard area or place structures in a flood hazard area that would impede or redirect flood flows.

Since Alternative 1 would not alter flows from those expected under the future without project condition, there would be no significant change or effect on hydraulics with the project in place. Long-term O&M would not be significantly different under Alternative 1 from existing conditions and would have no impact of hydrology and hydraulics. As a result, effects from Alternative 1 on hydrology and hydraulics would be less than significant and no mitigation would be required.

3.4.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Alternative 2 starts with Alternative 1 (Improve Levees in place) as a base and adds the widening of the Sacramento Weir and Bypass to reduce the extent of levee repairs in the project area. Currently, the Sacramento Weir is 1,920 feet wide with 48 wooden gates that are manually removed when the water surface elevation on the Sacramento River at the I Street gage reaches 30.0 feet. If the Sacramento Bypass were widened, it would allow more water to flow into it and, therefore, into the

Yolo Bypass. This would lower the water surface elevation downstream of the confluence with the American River and subsequently reduce the need for levee raising along the Sacramento River in the Pocket area.

If the expanded Sacramento Weir were to be operated as the existing weir is operated, the Recommended Plan would result in a diversion of flows from the Sacramento River to the Yolo Bypass that would slightly raise water surface elevations in the Yolo Bypass during frequent events (10 year) compared to both the existing and future without project conditions. To avoid potential effects to the Yolo Bypass, the widened portion of the Sacramento Weir will only be operated when the release from Folsom Dam is increased to above 115,000 cfs. Therefore, for events up to and including 115,000 cfs, only the existing weir will be operated per the criteria previously established. For events when the release from Folsom Dam will go above 115,000 cfs, the new weir will be opened. As a result of the increased flood storage space and anticipatory releases at Folsom Dam, this translates into a reduction of flows into the Yolo Bypass with Alternative 2 in place compared to the existing conditions. See Table 11 for a comparison of the flows at various locations for the Existing, Future Without Project (which are the same flows as with Alternative 1), and with Alternative 2 in place. For events greater than 115,000 cfs, the benefits of the Folsom Dam improvements would be realized in the form of reduced flows compared to the existing condition.

Table 11. Comparison of 10-, 100-, and 200-year Frequency Flows under Various Conditions.

10 year event	**Existing Condition**	**Future Without Project Condition (also Alternative 1)**	**Alternative 2**
American River	43,000 cfs	72,000 cfs	72,000 cfs
Sacramento Bypass	50,000 cfs	66,000 cfs	66,000 cfs
Yolo Bypass below Sac Bypass	270,000 cfs	296,000 cfs	296,000 cfs
100 year event	**Existing**	**Future Without Project and Alt. 1**	**Alt. 2 (Recommended Plan)**
American River	145,000 cfs	115,000 cfs	115,000 cfs
Sacramento Bypass	131,000 cfs	115,000 cfs	115,000 cfs
Yolo Bypass below Sac Bypass	555,000 cfs	535,000 cfs	535,000 cfs
200 year event	**Existing**	**Future Without Project and Alt. 1**	**Alt. 2 (Recommended Plan)**
American River	320,000 cfs	160,000 cfs	160,000 cfs
Sacramento Bypass	183,000 cfs	149,000 cfs	164,000 cfs
Yolo Bypass below Sac Bypass	656,000 cfs	631,000 cfs	643,000 cfs

The widening of the Sacramento Weir and Bypass diverts flood flows from the Sacramento and American River into the Yolo Bypass. The widened portion of the weir will only be operated when flood releases from Folsom Dam are above the existing objective release of 115,000 cfs. Therefore, for events up to 115,000 cfs, there would be no change in flow conditions in the Sacramento and Yolo Bypasses. For flood events when releases from Folsom Dam would go above 115,000 cfs (such as a 1/200 ACE

event in which the Folsom release goes up to 160,000 cfs), because of the additional flood storage provided by anticipated operation and physical improvements to Folsom Dam coupled with the widened Sacramento Weir and Bypass, the net effect would be to slightly decrease the peak compared to the existing peak flow in the Yolo Bypass. Therefore, the effect is less than significant.

For the 10- and 100- year event, the changes in flows are tied to the change in operations at Folsom Dam. With regard to the 200-year event, flow on the American River is also tied to the change in operations at Folsom Dam, but for flow in the Sacramento and Yolo Bypasses there is a change in flow as a result of operating the widened Sacramento Weir. The flow changes associated with Folsom Dam will be analyzed as part of the ongoing Folsom Dam Water Control Manual Update, and the effects of those flows, including cumulative effects, will be addressed in the EIS/EIR accompanying the Manual Update.

Although Alternative 2 would result in the creation of a new drainage area within the Sacramento Bypass, the area would be contained within the levee system and would not result in substantial additional erosion, siltation, or runoff. The expanded bypass would not create or contribute flows in excess of the existing capacity of the system, as shown in Table 11 above. No housing would be permitted within the new flood hazard area, and no structures would be permitted that would impede or redirect flows within this area. As a result, effects to hydrology and hydraulics from the implementation of Alternative 2 would be less than significant, and no mitigation would be required.

3.4.6 Mitigation Measures

Because the flows would not increase under these alternatives, effects to hydrology and hydraulics are less than significant, and no hydraulic mitigation is required.

3.5 Water Quality and Groundwater Resources

3.5.1 Environmental Setting

The groundwater table in the study area is very deep and is separated from the slurry walls by a layer of non-permeable soil. Slurry walls have been installed along both the Sacramento and American Rivers over the last 20 years and no contamination of the aquifers has been identified from these construction activities. Additionally, MBK Engineering performed an analysis of the Natomas Basin construction activities and determined that the slurry wall construction was not expected to contaminate groundwater (MBK Engineering 2008). Because there is minimal risk to groundwater supply it will not be discussed further in this EIS/EIR.

Regulatory Setting

The following Federal, State, and Local laws and regulations apply to the resources covered in this section. Descriptions of the laws and regulations are discussed in Chapter 5.0.

Federal

- Clean Water Act

State

- Porter-Cologne Water Quality Control Act

Existing Conditions

Pursuant to the Porter-Cologne Act, the Central Valley Regional Water Quality Control Board (RWQCB) prepares and updates the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan) every 3 years. The most recent update was completed in October 2011. The Basin Plan describes the officially designated beneficial uses for specific surface water and groundwater resources and the enforceable water quality objectives necessary to protect those beneficial uses. The American River Common Features project is located within the Central Valley RWQCB's jurisdiction and is subject to the Basin Plan.

American River

The American River originates in the high Sierra Nevada just west of Lake Tahoe, in the Tahoe and El Dorado National Forests. Its three main forks – the South, Middle, and North – flow through the Sierra foothills and converge east of Sacramento. The waters of the American River provide recreation, municipal power, and irrigation for the northern California area.

American River water is generally characterized as high-quality surface water that is low in alkalinity, mineral content, and organic contamination (RWA et.al. 2006). The only contaminate listed on the Section 303(d) list for the American River within the project area is Polychlorinated biphenyls (PCB), which is from an unknown source (SWRCB 2012). However, mercury resulting from historical mining activities is of concern. The Central Valley RWQCB identified eight waterways in the American River Watershed as impaired because some fish have elevated levels of methylmercury that may harm human and wildlife consumers. Of the eight waterways identified the Lower American River is the only one within the study area.

Sources of inorganic mercury in the American River Watershed include tunnels and hydraulic mine workings from historic gold mining operations, municipal discharges, urban and agricultural runoff, and deposition from the air. Methlymercury, a highly toxic form of mercury, is formed by particular bacteria in lakes and stream beds. Methlymercury sources include production within wetland, river, and reservoir sediments, municipal wastewater, agricultural drainage, and urban runoff.

Mercury was mined from the Coast Ranges of California starting in the late 1800s. Much of this mercury was transported to the Sierra Nevada and Klamath-Trinity Mountains to be used for placer gold mining operations. Mercury lost during historic mining activities is now distributed along miles of downstream streams and rivers. Controlling erosion and transport of contaminated sediment are important for reducing fish mercury levels.

Sacramento River

The Sacramento River is the largest river and watershed system in California. This 27,000 square mile basin drains the eastern slopes of the Coast Range, Mount Shasta, the western slopes of the southernmost region of the Cascades, and the north portion of the Sierra Nevada.

The Sacramento River waterways historically were used as places to dispose of contaminants. In recent decades, treatment for municipal wastewater, industrial wastewater, and management of urban stormwater runoff have increased and improved greatly. Industries and municipalities now provide at least secondary treatment of wastewater. Large and medium-size cities are implementing urban stormwater programs to reduce the impacts of urban runoff to adjacent waterways.

The Sacramento River from Knights Landing to the Delta is listed on the Section 303(d) list for chordane, DDT, dieldrin, mercury, and PCB. However, the river's flow volumes generally provide sufficient dilution to prevent concentrations of contaminants in the river from reaching elevated levels (DWR 2012). Sediment transport in the Sacramento River in the study area is affected by historical hydraulic gold mining. Sediment supply to the lower Sacramento River has declined over recent years because dams on tributaries have resulted in less sediment to transport.

East Side Tributaries

The NEMDC conveys drainage water from Dry Creek, Arcade Creek, Magpie Creek, and a large portion of the Natomas area north of the confluence with Dry Creek. The NEMDC outfalls to the Sacramento River are at the northern edge of Discovery Park near the confluence of the Sacramento and American Rivers. Urban stormwater runoff is discharged to the Sacramento River, the American River, and the NEMDC via pumps operated by the City of Sacramento. Urban stormwater runoff contains sediments, nutrients, pathogens, oil and grease, metals, and pesticides.

Sacramento Bypass

The Sacramento Bypass is typically dry, except for during flood and high water events. All water in the Sacramento Bypass consists of overflow from the Sacramento and American Rivers. As a result, water quality conditions in the Sacramento Bypass during high water events would be consistent with the descriptions for the Sacramento and American Rivers, as discussed above.

Surface Water Quality

The Porter-Cologne Water Quality Control Act required the identification of the beneficial uses of waters impacted by proposed actions, and the associated effects. Water quality objectives identified within each Basin Plan are established for the reasonable protection of beneficial uses of waters of the State. Designated beneficial uses for the Sacramento River and its tributaries within the study area include the following:

- Municipal and domestic supply;
- Industrial service supply;
- Industrial process supply;
- Agricultural supply;
- Groundwater recharge;
- Navigation;
- Water contact recreation;
- Non-contact water recreation;
- Shellfish harvesting;
- Commercial and sport fishing;
- Warm freshwater habitat;
- Cold freshwater habitat; and,
- Migration of aquatic organisms.

Surface water quality in the hydraulic region is generally good. Possible types of contamination that can affect water quality include turbidity; pesticides and fertilizers from agricultural runoff; water temperature exceedances; and toxic heavy metals, such as mercury, copper, zinc, and cadmium from acid mine drainage (USGA 2000, DWR 2005). The portion of the Sacramento River within the project area is part of a 16-mile segment from Knights Landing to the Sacramento-San Joaquin Delta that is on the Section 303(d) list for mercury from abandoned mines and toxicity from unknown sources. In addition, the portion of the American River in the study area is part of a 27-mile segment from Nimbus Dam to the confluence with the Sacramento River that is also on the Section 303(d) list for mercury from abandoned mines and toxicity from unknown sources (SWRCB 2006).

The water quality of the Sacramento River is good to excellent, with relatively cool water temperatures, low biochemical oxygen demand (BOD), medium to high dissolved oxygen (DO), and low mineral and nutrient content. In general, the surface water quality of the Sacramento River is representative of agricultural return flows, urban runoff, and natural sedimentation from scouring. CWA Section 303(d) establishes the total maximum daily load (TMDL) process to assist in guiding the

application of state water quality standards. It requires the states to identify streams in which water quality is impaired (i.e., affected by the presence of pollutants or contaminants) and to establish the TMDL—the maximum quantity of a particular contaminant that a water body can assimilate without experiencing adverse effects. The 303(d) list breaks up the Sacramento River into four sections: Keswick Dam to Cottonwood Creek, Cottonwood Creek to Red Bluff, Red Bluff to Knights Landing, and Knights Landing to the Delta. All sections of the Sacramento River are listed on the 303(d) list for unknown toxicity, and the Knights Landing to the Delta section is listed for mercury. Mercury is primarily a legacy of gold mining.

Total Suspended Sediment and Turbidity

Total suspended sediment (TSS) is indicative of upstream scouring, bank erosion, and agricultural return flow transporting and depositing sediment. Sediment is considered a pollutant by the Central Valley RWQCB and can transport other contaminants, such as phosphorus, and hydrophobic contaminants, such as organochlorine pesticides. Data were downloaded from the USGS web site from 1997 to 2007 for the Sacramento River at Freeport. Note that more recent flow data (2007 to 2009) are available; however, there is no matching TSS data available for this more recent time frame. Therefore, the most recent available data (2007 to 2009) were used to calculate sediment loads. Monthly average data points are presented in Table 12. Although sedimentation is a natural part of the flow regime for rivers, the Central Valley RWQCB also considers it a pollutant. Excessive sedimentation from construction practices such as placement of riprap on levees or constructing slurry cutoff walls can smother filter-feeding organisms and cause other serious water quality related issues.

Table 12. Monthly Average Total Suspended Sediment and Turbidity for the Sacramento River at Freeport from 1997 to 2007.

Month	Discharge (cfs)	TSS (mg/L)	TSS Load (tons)	Turbidity (NTU)
January	41,414	104	11,670	64
February	44,084	83	9,839	68
March	39,586	70	7,476	15
April	28,552	51	3,946	11
May	25,152	48	3,279	12
June	21,461	30	1,741	17
July	20,432	37	2,019	21
August	18,235	27	1,332	9
September	16,121	29	1,266	10
October	11,950	29	940	6
November	13,612	24	868	8
December	25,105	81	5,463	12

Note: Flow and TSS data are from the USGS and are presented as monthly average from 1997 to 2007. Turbidity data are from CDEC from March 2007 to January 2009 and also are presented as a monthly average. Turbidity data are from the Sacramento River at Hood, a few river miles downstream from the USGS station.
Source: USGS 2013; DWR 2012b.

Turbidity is another measurement of how much sedimentation is in the water and could be measured using an optical light probe. Turbidity is measured in nephelometric turbidity units (NTUs). The Basin Plan states that where ambient turbidity is between 5 and 50 NTUs, projects would not increase turbidity on the Sacramento River by more than 20 percent above the ambient conditions. Furthermore, if the ambient diurnal variation in turbidity fluctuates in and out of the 5 and 50 NTUs threshold, the Basin Plan states that averaging periods can be applied to data to determine compliance. For example, during the summer months, the Sacramento River turbidity could be less than 50 NTUs, and during the winter months, the turbidity could be more than 50 NTUs because of the higher flow rate causing more river scouring. Thus, the monthly average was calculated using hourly California Data Exchange Center (CDEC) data and is presented in Table 12 above. Specific construction activities that are part of the potential alternatives would need to comply with the above-stated thresholds for turbidity.

Dissolved Oxygen, Temperature, Electrical Conductivity, and pH

DO is a critical component for all forms of aquatic life. It also could be highly variable and subject to large oscillations in short time periods. With calm waters and low flows, water bodies could thermally stratify, causing deeper zones to have very low DO concentrations. Additionally, high levels of nutrient loading could cause algal blooms. These blooms could cause large swings in DO levels as the algae populations fluctuate in size, producing oxygen while growing and consuming it while decaying. When DO concentrations fall below certain limits, the resulting low DO throughout the water column could act as a barrier to fish migration and potentially adversely affect spawning success. In extreme cases, persistent low concentrations of DO can result in mortality of benthic organisms and other less mobile aquatic species. The Basin Plan objective for DO in the Sacramento River from the I Street Bridge to the Delta is 7.0 milligrams per liter (mg/L) (Central Valley RWQCB 2007). As shown in Table 13 below, the Sacramento River DO concentrations near Hood from 2003 to 2009 are typically 10 mg/L during the storm season and 8 mg/L or more during the dry season when flows are lower than during the rainy season.

Water temperature is a critical constituent from the standpoint of aquatic life. The Basin Plan objective for temperature requires that it not deviate more than 5°F from ambient river temperature (Central Valley RWQCB 2007). During the summer months of July and August, the temperature of the Sacramento at Hood was approximately 71°F (Table 13). However, this location is downstream of the I Street Bridge, and with the cold water inflow of the American, the I Street Bridge temperature could be within Basin Plan standards. While an unlikely scenario, excessive sedimentation in large quantities could affect the temperature of the Sacramento River.

The potential of hydrogen (pH) is a unit for measuring the concentration of hydrogen ion activity in water and is reported on a scale from 0 to 14. If a solution measures less than 7, it is considered acidic. If a solution measures more than 7, it is considered basic, or alkaline. If a solution measures 7, it is considered neutral. Many biological functions could occur only within a narrow range of pH values.

The Basin Plan objective for pH is between 6.5 and 8.5. Furthermore, discharges cannot result in changes of pH that exceed 0.5. The monthly average pH of the Sacramento River from 2003 to 2009 remained stable throughout the year (Table 13). Construction materials such as concrete or other chemicals could affect the pH of the Sacramento River if a discharge were to occur.

Table 13. Monthly Average Physical Data for the Sacramento River at Freeport from 2003 to 2009.

Month	Temperature (°F)	pH (Standard)	DO (mg/L)	EC (µs/cm)
January	48.7	7.5	10.5	170
February	50.9	7.4	10.1	170
March	55.3	7.5	9.7	154
April	58.3	7.4	9.6	138
May	64.3	7.4	8.6	145
June	68.8	7.3	8.2	139
July	71.1	7.3	7.9	134
August	71.0	7.4	7.8	156
September	67.9	7.5	8.0	166
October	62.5	7.2	8.6	145
November	55.9	7.4	8.9	186
December	49.5	7.4	10.2	186

Source: DWR 2012b

Electrical conductivity (EC) is a measure of the degree to which a given water sample conducts an electrical current. The amount of total dissolved solids (TDS) in water is related directly to EC (i.e., high EC is an indicator of high TDS). TDS and EC are general indicators of salinity and are regulated under the Basin Plan. Basin Plan objectives for EC on the Sacramento River are 340 microSiemens per centimeter (µS/cm). Table 13 above shows that monthly average EC levels in the Sacramento River remain below this threshold.

3.5.2 Methodology and Basis of Significance

Methodology

Water quality impacts that could result from project construction activities and project operations were evaluated based on the construction practices and materials that would be used, the location and duration of the activities, and the potential for degradation of water quality or beneficial uses of project area waterways.

Basis of Significance

For this analysis, an effect pertaining to surface water quality and groundwater quality was considered significant under CEQA and NEPA if it would result in any of the following environmental effects, which are based on professional practice, Federal guidelines, and State CEQA Guidelines Appendix G (14 CCR 15000 *et seq.)*:

- Violate water quality standards or waste discharge requirements;
- Substantially deplete groundwater supplies or interfere substantially with ground water recharge;
- Substantially degrade water quality; and
- Alter regional or local flows resulting in substantial increases in erosion or sedimentation.

3.5.3 No Action Alternative

Under the No Action Alternative, the levee improvement project would not be constructed, therefore, there would be no construction-related effects to water quality in the study area. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. Without levee improvements, there is the continued high risk of levee failure and continuing under seepage and loss of levee foundation soil. If a levee overtopping or breach was to occur floodwaters could be pumped back over levees or recede back through the levee breach into the waterways. Flooded areas could contain contaminants from stored chemicals, septic systems, and flooded vehicles—all of which would be released into floodwaters and subsequently contaminate the Sacramento River and the Delta surface waters and potentially soil and groundwater. These contaminants would likely exceed acceptable established water quality standards and impair beneficial uses.

A catastrophic levee failure could result in collapse of miles of levee slopes and alteration of regional and local flows that would result in substantial increases in erosion and sedimentation. Erosion causing the loss of the levee foundation and eroded topsoil from banks of a river or sloughs would increase turbidity and total dissolved solids in the Sacramento River and ultimately, affecting the environmental resources of the Delta by impairing the beneficial uses of waters of the Delta. Furthermore, if a levee breach were to occur, emergency construction and repair activities would be implemented without the use of Best Management Practices (BMPs) and could result in the release of hazardous construction materials such as oil and other petroleum related products.

Under the No Action Alternative, regular O&M of the levee system would continue as presently executed by the local maintaining entities, with the inclusion of the SWIF plan to address vegetation and encroachment issues long-term. Some erosion repairs could occur under the SRBPP; however the Corps would not implement erosion repairs system-wide within the study area as proposed this project. As a result, erosion would continue and the risk of levee failure and subsequent flooding would increase. If a levee breach were to occur, emergency construction and repair activities would be implemented without the use of BMPs and could result in release of contaminants into the soil (groundwater) and adjacent surface water, as well as increased erosion, which could raise TSS and turbidity in adjacent water bodies. If floodwaters were conveyed beyond the levees throughout the program area, water quality could be significantly affected due to increases in total suspended solids and turbidity. Additionally, significant water quality effects due to levee failure in which flooding occurs in urban, suburban, and agricultural areas would likely be considerable and could include bacterial and chemical (e.g., pesticides, petroleum products, heavy metals) contamination.

3.5.4 Alternative 1 – Improve Levees

The slurry cutoff walls will be constructed primarily of soil mixed with bentonite, but Portland cement may be used as an additive in some cases. Bentonite is a naturally occurring form of clay, and Portland cement is made from limestone and clay. Neither bentonite nor cured Portland cement are water soluble, and grouts composed of both materials are widely used in the water well industry. Both bentonite and cement are used to construct seals in wells drilled for various purposes, including drinking water supply. No groundwater contamination would be expected due to construction of the proposed slurry cutoff walls and other improvements proposed for the levees within the study area (MBK Engineering 2008). Because there is no risk to groundwater supply it will not be discussed further in this EIS/EIR. Under Alternative 1, O&M is not expected to change from existing conditions. As a result, there would be no effects from long-term O&M of the levees in the study area.

American River

Installation of the rock trench would not have an impact on water quality because the trench would be located outside of the river natural channel and no in-water work would occur. However, because work would occur on the waterside of the levee there is a potential for spills from construction operations. Construction contractors would be required to prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) and comply with the conditions of the National Pollution Discharge Elimination System (NPDES) general stormwater permit for construction activity. The contractor would be required to obtain a permit from the Central Valley RWQCB detailing a plan to control any spills that would occur during construction. The plan would describe the construction activities to be conducted, BMPs that would be implemented to prevent discharges of contaminated stormwater into waterways, and inspection and monitoring activities that would be conducted.

Where bank protection construction is proposed, revetment would be placed along the river bank to prevent erosion. The placement of revetment along the river banks would temporarily generate increased turbidity in the immediate vicinity of the construction area. Additionally, placement of revetment in the water could result in a sediment plume, generated from the channel bottom and levee side, becoming suspended in the water and could generate turbidity levels above those identified as acceptable by the Basin Plan (Central Valley RWQCB 2007). Turbidity effects from landside construction (e.g., vehicle, staging, placement of construction equipment) would be limited to stormwater runoff carrying loose soil from staging areas and construction vehicle access areas. Best management practices would be implemented to reduce the effect of runoff into the stormwater system to less than significant. Best management practices include such things as coir mats or hay bales to prevent runoff, rock groins to retain sediment, sand bags to prevent erosion, and drain screens to prevent sediment from traveling outside the construction area footprint and into the storm drains system.

Additionally, there is the potential for some increases in water temperature, due to the removal of waterside vegetation during construction. However, the vegetation that would be removed would primarily consist of shrubby vegetation and grasses, which do not significantly contribute to shade. The larger trees in the bank protection footprint, which are the primary contributors to shade, would be protected in place. As a result, short term effects to water temperature are expected to be less than significant. With the new plantings and trees installed during construction growing to contribute to the riparian/shaded corridor over time, the long-term effect is expected to be beneficial to water temperature.

Construction of the bank protection measure is not expected to impact any of the beneficial uses identified above. With the exception of the potential turbidity and water temperature effects discussed above, with the implementation of the BMPs discussed in Section 3.5.6 below, the project is not expected to result in any contamination to surface waters, nor is it expected to result violate any of the Basin Plan water quality objectives identified above. Coordination with the Central Valley RWQCB will occur prior to construction through the Section 401 certification process to ensure that any appropriate measures, to include, but not limited to the BMPs discussed in Section 3.5.6 below, are implemented during the construction period. Impacts associated with recreation uses are described in Section 3.14, and impacts associated with fisheries are discussed in Sections 3.7 and 3.8.

As rock revetment is placed in the open water, significant indirect effects would result as the sediment and turbidity plume would drift further downstream and later affect the water qualify in those areas found further downstream of the project area. By implementing the avoidance and minimization measures discussed in Section 3.5.6 water quality effects would be reduced to less than significant.

Sacramento River

Construction of this alternative would have the same effects as those discussed for the American River where bank protection work would occur, including effects associated with turbidity, water temperature, and potential impacts to beneficial uses. The use of barges to install the revetment could cause additional turbidity beyond those effects discussed for the American River above, as the barge moves into the site and anchors. This is considered a significant affect to water quality during construction. Once construction is complete there could be reduced turbidity in the direct vicinity of the site because there would be no exposed soil to erode and deposit into the river. Further, the bank protection sites would include the installation of riparian vegetation which could slow the flows down and reduce turbidity during high flows, and contribute to the riparian/shaded corridor long-term. This alternative would result in significant effects to water quality during construction activities. Additionally, upstream and downstream of the bank protection area could erode because no rock protection is present now, however, this could occur with or without the construction of the project.

Construction contractors would be required to prepare and implement a SWPPP and comply with the conditions of the NPDES general stormwater permit for construction activity. The contractor would be required to obtain a permit from the Central Valley RWQCB detailing a plan to control any spills that could occur during construction. The plan would describe the construction activities to be conducted, BMPs that would be implemented to prevent discharges of contaminated stormwater into waterways, and inspection and monitoring activities that would be conducted. By implementing the avoidance and minimization measures discussed in Section 3.5.6 water quality effects would be reduced to less than significant.

East Side Tributaries

The installation of the slurry walls along these creeks would be done from the top of the levees and no in-water work would occur. Additionally, the construction of the floodwall would be accomplished during the dry season from the landside of the levee. BMPs would be implemented to prevent runoff from the construction site into drainage systems. Staging areas would be designed and located in areas to prevent potential runoff into waterways.

Construction contractors would be required to prepare and implement a SWPPP and comply with the conditions of the NPDES general stormwater permit for construction activity. The contractor would be required to obtain a permit from the Central Valley RWQCB detailing a plan to control any spills that would occur during construction. The plan would describe the construction activities to be conducted, BMPs that would be implemented to prevent discharges of contaminated stormwater into waterways, and inspection and monitoring activities that would be conducted. Because no in-water work would occur and there is a very low risk of discharge into waterways, this alternative would have a less than significant effect on water quality.

3.5.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Effects to water quality would be the same as Alternative 1 with the additional affects associated with the widening of the Sacramento Weir and Bypass. Construction of the new north levee would occur when water is not flowing through the bypass, and therefore there would be not impacts to water quality during construction of the new north levee of the bypass.

Within the expanded bypass, the existing land use is agriculture; there is approximately 13.5 acres of agricultural ditches and canals within this area. These ditches would likely be removed as a part of construction of the new bypass. During construction, the widened bypass area would be graded to ensure that there is positive drainage during flows and to reduce potential stranding pits for fish as water recedes. Following construction of the expanded bypass, the area would be revegetated with native grasses to stabilize soils in the construction footprint.

Additionally, effects could occur during the construction of the expanded weir along the Sacramento River. There is a potential for water quality impacts to occur if the weir is constructed in a way that debris or other construction materials could enter the Sacramento River. However, it is likely that the weir could be constructed behind the existing levee, which would result in no impacts to water quality.

Following construction, the expanded bypass would be revegetated with native grasses and trees and the area would be monitored, per the requirements established in the Habitat Mitigation and Monitoring Plan, to ensure that the revegetation meets the success criteria defined in the plan (Appendix I). With successful revegetation, it is expected that any effects from erosion and runoff during operation of the widened weir would be less than significant.

3.5.6 Mitigation Measures

As part of a turbidity monitoring program the contractor would monitor turbidity in the adjacent water bodies, where applicable criteria apply, to determine whether turbidity is being affected by construction and to ensure that construction does not result in a rise in turbidity levels above ambient conditions, in accordance with the Central Valley RWQCB Basin Plan turbidity objectives. The monitoring program would be coordinated with the Central Valley RWQCB prior to construction, and would be implemented by the construction contractor. The contractor would be required to use BMPs, as described below, to prevent runoff from all construction areas.

Environmental commitments included in the project to reduce the potential for impacts to water quality include: preparation of the SWPPP, Spill Prevention Control and Countermeasures Plan (SPCCP), and a bentonite slurry spill contingency plan (BSSCP). Typical elements of the SWPPP are described below.

In general, the following measures would be implemented as part of the SWPPP, as required by the SWRCB for any construction activities that disturb more than 1 acre, to limit erosion potential.

- Conduct earthwork during low flow periods (July 1 through November 30).
- To the extent possible, stage construction equipment and materials on the landside of the subject levee reaches in areas that have already been disturbed.
- Minimize ground and vegetation disturbance during project construction by establishing designated equipment staging areas, ingress and egress corridors, spoils disposal and soil stockpile areas, and equipment exclusion zones prior to the commencement of any grading operations.
- Stockpile soil on the landside of the levee reaches, and install sediment barriers (e.g., silt fences, fiber rolls, and straw bales) around the base of stockpiles to intercept runoff and sediment during storm events. If necessary, cover stockpiles with geotextile fabric to provide further protection against wind and water erosion.
- Install sediment barriers on graded or otherwise disturbed slopes as needed to prevent sediment from leaving the project site and entering nearby surface waters.
- Install plant materials to stabilize cut and fill slopes and other disturbed areas once construction is complete. Plant materials could include an erosion control seed mixture or shrub and tree container stock. Temporary structural BMPs, such as sediment barriers, erosion control blankets, mulch, and mulch tackifier, could be installed as needed to stabilize disturbed areas until vegetation becomes established.
- Conduct water quality tests specifically for increases in turbidity and sedimentation caused by construction activities.
- Water samples for determining background levels shall be collected in the adjacent water body for each erosion construction site. Testing to establish background levels shall be performed at least once a day when construction activity is in progress. Water samples for determining down current conditions shall be collected in the adjacent water body at a point 5 feet out from the shoreline and 300 feet down current of each erosion site. During periods when there are no in-water construction activities, random, weekly water monitoring will be performed. During periods of in-water construction, water monitoring will occur hourly.

- During working hours, the construction activity shall not cause the turbidity in the adjacent water body down current from the construction sites to exceed the Basin Plan turbidity objectives. Specifically, where natural turbidity is between 0 and 5 NTUs, increases shall not exceed 1 NTU; where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20%; where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs; and where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent (Central Valley RWQCB 2007). In determining compliance with these limits, appropriate averaging periods could be applied provided that beneficial uses will be fully protected.

An SPCCP is intended to prevent any discharge of oil into navigable water or adjoining shorelines. The contractor would develop and implement an SPCCP to minimize the potential for adverse effects from spills of hazardous, toxic, or petroleum substances during construction and operation activities. The SPCCP would be completed before any construction activities begin. Implementation of this measure would comply with state and Federal water quality regulations. The SPCCP would describe spill sources and spill pathways in addition to the actions that would be taken in the event of a spill (e.g., an oil spill from engine refueling would be immediately cleaned up with oil absorbents). The SPCCP would outline descriptions of containments facilities and practices such as doubled-walled tanks, containment berms, emergency shut-offs, drip pans, fueling procedures and spill response kits. It would also describe how and when employees are trained in proper handling procedure and spill prevention and response procedures.

Release of contaminants into adjacent water bodies could result in significant effects. Adherence to the environmental commitments and the implementation of the measures described in this section if spills were to occur would reduce or minimize this to a less than significant effect.

3.6 Vegetation and Wildlife

3.6.1 Environmental Setting

Regulatory Setting

- Fish and Wildlife Coordination Act of 1958, as amended (16 U.S.C. 661, et seq.)
- Federal Wild and Scenic Rivers Act (16 U.S.C. 1217, et seq.)
- State Wild and Scenic Rivers Act (PRC Section 5093.50-5093.70)
- American River Parkway Plan
- The Sacramento County Ordinance, Chapter 19.12, Tree Preservation and Protection (Tree Preservation Ordinance.

- The City of Sacramento Protection of Trees Ordinance (City of Sacramento Municipal Code 12.56.060).
- City of Sacramento Heritage Tree Ordinance (City of Sacramento Municipal Code 12.64.020).

Existing Conditions

This section describes the existing vegetation and wildlife resources in the project area. The primary focus of this section will be on areas within the potential construction footprint such as the American River Parkway, the Sacramento River, Robla Creek, Dry Creek, Natomas East Main Drain Canal, Magpie Creek, and Sacramento Bypass. These areas are where potential effects to vegetation and wildlife could occur.

In the summer of 2011, Corps biologists and a survey team tagged and identified trees along all levees within the study area. The identification included tree species, tree diameter, and the location of the tree. Surveys were done for the levee, 30 feet waterside, and 15 feet landside. Trees located on private property on the landside were identified for species and location; however, diameter was not obtained. This information was gathered in coordination with USFWS in accordance with the Fish and Wildlife Coordination Act. The Coordination Act Report (CAR) is included in Appendix A.

Appendix B includes existing habitat maps for the American and Sacramento Rivers. The American River maps were generated to support the Corps' Folsom Dam Water Control Manual Update project. The Sacramento River maps were generated by SAFCA to support their Levee Accreditation Program. The following section includes general descriptions of the habitat types that occur in the study area. The conditions in each segment of the study area follow the habitat discussion.

Habitat Types in the Study Area

Valley Foothill Riparian Habitat

Most valley foothill riparian habitat in the study area (hereafter referred to as "riparian habitat") occurs along the American and Sacramento Rivers, but smaller riparian areas are found at all of the levees in the study area (Appendix B). The overstory of the riparian habitat consists of mature, well-established trees: Fremont cottonwood (*Populus fremontii ssp. fremontii*), valley oak (*Quercus lobata*), black willow (*Salix gooddingii*), and box elder (*Acer negundo var. californicum*). During the surveys, Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*) were also observed. The shrub layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and Himalayan blackberry (*Rubus discolor*). Elderberry shrubs (*Sambucus mexicana*), the host plant of the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), which is Federally listed as threatened, were observed in the riparian habitat along the American and Sacramento Rivers.

Wildlife inhabiting the study area are dependent upon the trees associated with riparian habitats in the area for vegetation diversity, microclimate conditions, and the availability of water, food, and cover. Several species of raptors, including red-tailed hawks, red-shouldered hawks, Cooper's hawks, and great horned owls, build their nests in the crowns of cottonwood, valley oak, and other large trees that currently exist on both the landside and waterside of the levees in the study area. Natural cavities and woodpecker holes provide nesting sites for cavity-nesting species, including wood ducks, common mergansers, American kestrels, tree swallows, and western screech owls. Riparian scrub supports large numbers of insects and attracts passerine birds, including several species of warblers and hummingbirds. Additionally, a number of Federally listed species are reliant on riparian corridors, including the valley elderberry longhorn beetle and the western yellow-billed cuckoo.

On the habitat maps in Appendix B, riparian habitat is referred to as a number of different associated sub-habitats. The Sacramento River SAFCA maps refer to riparian habitat as Fremont Cottonwood Forest, Valley Oak Woodland/Trees, and Sandbar Willow Thickets. The American River habitat maps break riparian habitat down to the primary species in each area including Blue Oak Woodland, Cottonwood Woodland, Interior Live Oak Woodland, Mixed Riparian Woodland, Oak Woodland, Riparian Forest, Oak Forest, Black Walnut, and Alder Riparian. Riparian habitat is listed as a sensitive natural community by the CNDDB (2009).

Shaded Riverine Aquatic Habitat

Shaded Riverine Aquatic (SRA) habitat is defined as the near shore aquatic area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of this valuable cover type include: (1) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water; and (2) the water containing variable amounts of woody debris, such as leaves, logs, branches, and roots, as well as variable depths, velocities, and currents. On the habitat maps in Appendix B, SRA is not identified as a separate habitat type. SRA occurs throughout the study area along the riverbanks and levees and is contained within the other identified habitat types in these areas.

Oak Woodland

Valley oak woodland is dominated with valley oak, interior live oak, box elder, white alder, Oregon ash, and black walnut. Shrubs in this habitat type include California grape (*Vitis californica*), Himalayan blackberry (*Rubus armeniacus*), and blue elderberry (*Sambucus cerulea*). Oak woodlands are typically found on higher or upland portions of the study area than the riparian habitat discussed above. Oak woodland is considered to be a sensitive habitat under CEQA.

Ruderal Herbaceous

The ruderal herbaceous habitat type consists primarily of non-native annual grasses. The largest non-native annual grassland area occurs near the American River and the East Side Tributaries. The non-native annual grassland is dominated by naturalized annual grasses with intermixed perennial and annual forbs. Grasses commonly observed in the study area are foxtail barley (*Hordeum murinum ssp. leporinum*), ripgut brome (*Bromus diandrus*), Italian ryegrass (*Lolium multiflorum*), and soft chess (*Bromus hordeaceus*). Other grasses observed were wild oats (*Avena spp.*), Bermuda grass (*Cynodon dactylon*), and rattail fescue (*Vulpia myuros var. myuros*). Forbs commonly observed in annual grasslands in the study area are yellow star-thistle (*Centaurea solstitialis*), prickly lettuce (*Lactuca serriola*), bristly ox-tongue (*Picris echioides*), and sweet fennel (*Foeniculum vulgare*). Other forbs observed are perennial peppergrass (*Lepidium latifolium*), Italian thistle (*Carduus pycnocephalus*), horseweed (*Conyza canadensis*), black mustard (*Brassica nigra*), and fireweed (*Epilobium brachycarpum*).

The ruderal herbaceous habitat type is identified in SAFCA's maps for the Sacramento River as Wild Oats Grassland. On the American River habitat maps, this habitat type is identified as Prairie (Appendix B). Within the study area, this habitat type is typically found on and around the levee slopes and anticipated staging areas.

Wetlands

Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes1; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin, L.M. et al, 1979).

Representative species observed in seasonal wetlands include Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), Italian ryegrass (*Lolium multiflorum*), water pepper (*Persicaria hydropiperpoides*), and alkali mallow (*Malvella leprosa*). Wetlands in the study area represent potentially jurisdictional waters of the United States that may be subject to regulation under CWA Section 404. Within the study area, wetlands also include features such as drainage ditches and farm canals, vernal pools, and open water habitat such as rivers and creeks. Vernal pools are discussed further in Section 3.8. Wetlands and vernal pools are considered sensitive habitats under CEQA. Prior to construction, wetland delineations would be conducted at locations of potentially jurisdictional wetlands within the project area to confirm the presence of these sensitive habitats.

Invasive Plant Species

Within the ARCF study area, invasive non-native plant species occur in all plant communities found along the study area. Areas dominated by non-native vegetation are generally associated with recent human disturbance and include: abandoned, fallow, and active agricultural fields; borrow and staging areas; dredger mine tailings; levee slopes; and areas subject to fire, frequent flood inundation, or scour. Non- native weeds dominate some areas, especially along the side slopes of the levees, and the portions of the construction footprint that are immediately adjacent to the toes of the levees on the land and waterside where the area has been previously disturbed. To a lesser degree where there is low diversity of plants found growing on top of and on the slopes of the levees, invasive plants are also found in other nearby plant communities such as riparian, riparian forest, riparian scrub, oak woodland, agriculture and grassland, oak-grassland, and shrub grassland typically having greater plant diversity.

The areas dominated by invasive herbaceous plant species provide poor habitat quality for native wildlife such as voles, mice, garter snakes, jackrabbits, gophers, and for various native and non-native fish species found temporarily using the riparian zone during periods of inundation. The grassland areas also provide foraging habitat for raptors, coyotes, weasels, common king snakes, western rattlesnakes, ground squirrels, southern alligator lizards, and western fence lizards, as well as providing nesting and foraging habitat for migratory song birds. In the more upland areas of a flood plain and in areas extending upslope from it, blue elderberries (*Sambucus cerulea)* and other native shrubs and trees are associated with the grassland area.

Grasslands infested with yellow-star thistle (*Centaurea solstitialis*), pepperweed *(Lepidium latifolium*), and other non-native plants provide limited habitat value, but could be suitable sites for restoring native grasses. Native grasses provide higher value for wildlife. Approximately 548 acres of the Parkway, or 46 percent, are dominated by yellow star-thistle, especially in those agricultural areas with monotypic stands of pepperweed. Mature non-native species that are not invasive could hinder and prevent the natural regeneration of native plants in portions of the Parkway ecosystems and provide habitat of lesser value to native wildlife species.

Several weed populations such as red sesbania (*Sesbania punicea*) is expanding rapidly along the shorelines of streams and ponds. Chinese tallow tree (*Triadica sebifera)*, a recent invasive, is also expanding in riparian habitats, as are longer established invaders such as arundo (*Arundo donax*), Pampas grass (*Cortaderia selloana*), Spanish broom (*Spartium junceum*), French broom (*Genista monspessulana*), Himalayan blackberry (*Rubus armeniacus*), and tamarisk (*Tamarix ramosissima*). Tamarisk can rapidly colonize exposed bar surfaces and stream banks. Other common invasive weed plants include wild oats (*Avena fatua*), soft chess brome (*Bromus hordeaceus*), Italian ryegrass (*Lolium multiflorum*), rip-gut brome (*Bromus diandrus*), fennel (*Foeniculum vulgare*), mare's tail (*Conyza canadensis*), cocklebur (*Xanthium strumarium*), pyracantha (*Pyracantha sp.*), oleander (*Nerium oleander*), poison hemlock (*Conium maculatum*), mustard (*Brassica tournefortii*), and foxtail (*Hordeum*

jubatum). Chinese tallow tree, black locust (*Robinia pseudoacacia*), Siberian elm (*Ulmus pumila*), Chinese elm (*Ulmus parvifolia*), and tree-of-heaven (*Ailanthus altissima*) are common invasive tree species. These invasive species typically outcompete native plant species and have to be controlled aggressively including mitigation and restoration areas. Since 2001, Sacramento County and SAFCA have collaborated on invasive plant management planning efforts, which have guided local efforts towards eradication of all populations of arundo, tamarisk, French broom, Scotch broom (*Cytisus sp.*), Pampas grass, red sesbania, Chinese tallow tree, oleander, and pyracantha. Future phases could include eradication of pepperweed, and trees such as tree-of-heaven, black locust, and elm, and restore it as native grasslands (Sacramento County, 2008).

American River

The American River Parkway contains many vegetation types including: riparian, oak woodland, open water, ruderal herbaceous, wetlands, and limited agriculture. Along the river channel vegetation is primarily considered SRA habitat. Trees adjacent to the channel are mainly oaks and cottonwoods with a thick understory of vines, berry bushes, and willows. The Parkway Plan details how the vegetation in the Parkway should be protected, enhanced, and expanded, where appropriate. The Parkway Plan notes:

> *The American River Parkway is a unique regional asset that shall be managed to balance the goals of controlling flooding; preserving and enhancing native vegetation, native fish species, the naturalistic open space and environmental quality within the urban environment; maintaining and improving water flow and quality; providing adequate habitat connectivity and travel corridors to support migratory and resident wildlife; providing recreational opportunities; and ensuring public safety (Parkway Plan Section 1.1).*

Chapter 3 of the Parkway Plan sets up a framework for vegetation management in the Parkway. It establishes that development in the Parkway must be designed such that impacts to native vegetation are minimized and mitigation measures are incorporated. The framework establishes what types of vegetation are appropriate for development of mitigation and restoration areas within the Parkway. Additionally, it sets up a policy for managing invasive species within the Parkway.

Protected areas in the Parkway contain tracts of naturally occurring vegetation and wildlife that, although capable of sustaining light to moderate use with minimal alterations to the natural landscape, would be easily disturbed by heavy use. Protected areas allow general access and convenience-type facilities (i.e., restrooms, trash cans, and water fountains) to accommodate the anticipated increase in users. Facilities and other improvements are limited to those which are needed for public enjoyment of the natural environment. Emphasis is on protection and restoration of large portions of relatively natural areas which stand a better chance of preservation than smaller pieces and provide better support for wildlife.

Levee slopes along the American River are primarily covered with grasses and a few scattered trees within the levee structure. Several areas within the Parkway have been used as mitigation sites for Corps and other agency projects for endangered species. There are also some areas within the Parkway that have been used to compensate for loss of riparian habitat or oak woodlands from other projects. Landside generally includes ornamental and landscape plantings in private backyards and some individuals have migrated beyond the legal property line and fence line.

Habitats in the project area support various wildlife species. Mammal species include mule deer, coyote, black-tailed jackrabbit, striped skunk, and a variety of rodents. Common bird species in the project area include American robin, spotted towhee, Oregon junco, black phoebe, California towhee, ash-throated flycatcher, red-shafted flicker, mourning dove, California quail, house finch, goldfinch wren, mockingbird, magpie, blackbird, titmouse, and hummingbirds. Common raptors include red-tailed hawk, Cooper's hawk, red-shouldered hawk, American kestrel, and great horned owl. Reptile and amphibian species likely found in the project area include western fence lizard, gopher snake, western rattlesnake, common king snake, Pacific tree frog, and western toad.

The river and small backwater areas provide habitat for many water-associated species such as raccoon, beaver, Canada goose, wood duck, common merganser, mallard, black phoebe, great blue heron, belted kingfisher, and common yellowthroat. The levee slopes, dominated by annual grassland, provide foraging habitat and cover for California ground squirrel, pocket gopher, and western meadowlark.

Sacramento River

Habitat on the Sacramento River, within the project footprint, is mostly SRA/riparian habitat consisting of oaks and cottonwoods with berry and shrub understory. There are intermittent locations along the waterline with no trees due to rock revetment. The levees on the Sacramento River are immediately adjacent to the river channel with a few short stretches that have small benches.

The SRBPP has repaired some erosion sites along the river using rock revetment on the slope and created small benches. These sites have been planted with riparian vegetation and woody material has been placed in the rock to provide in-water habitat for fish species.

Due to the urban development adjacent to the levees in this area wildlife is limited to small mammals and various avian species. Domestic animals from residents are also often seen along the levees in this basin of the project.

East Side Tributaries

Natomas East Main Drainage Canal

The NEMDC flows into the American River just upstream of the confluence with the Sacramento River. This canal is a narrow channel with many trees in the lower portion. As the canal heads north the channel widens and becomes less vegetated. The levee slopes on the east side of the canal are grasses that are clear of trees and shrubby vegetation due to maintenance practices. The west side of the canal is not part of this project as it was completed as part of the NLIP Phase 4b project.

Arcade Creek

Arcade Creek flow into the NEMDC about 1.5 miles upstream of the confluence with the American River. The levees along this creek are maintained vegetation free; however, the channel does have some trees and understory. Between Norwood Avenue and Rio Linda Boulevard the channel contains a thick riparian area, but vegetation becomes sparse once it passes Rio Linda Boulevard. Due to the urban conditions in this area, wildlife is limited to those similar to the Parkway but in smaller numbers.

Dry and Robla Creeks

Dry and Robla Creeks flow into the NEMDC approximately 4 miles upstream of the confluence with the American River. The area is a wide open space floodplain with both creeks being contained between the two levees. The creeks maintain sufficient water throughout the year for trees to survive along the channel. Scattered wetlands are located in the floodplain with a higher concentration at the confluence with the NEMDC. The actual levee slopes in this floodplain contain very little vegetation due to maintenance practices. Wildlife in the floodplain is similar to that in the Parkway.

Magpie Creek

Magpie Creek is located about 4 miles north of Arcade Creek. The project area of the creek begins in an industrial area where the creek channel contains primary grasses. As the study moves upstream, the area becomes open space before it intersects with Raley Boulevard and additional industrial development. Primary wildlife in this area include jack rabbits, skunks, beavers, and coyotes that wander in from the surrounding undeveloped area. Avian species that utilize this habitat include herons and ducks, and amphibian and reptile species include tree frog and common garter snake.

Seasonal wetlands in the project area include several natural hardpan vernal pools and other areas that may or may not have hardpan, but form standing water and provide similar biological functions and values as the natural vernal pools (Corps 2004).

Sacramento Weir and Bypass

The Sacramento Bypass is used about every 5 to 10 years to convey water from the Sacramento River to the Yolo Bypass. The Sacramento Bypass is owned by the State of California and operated as the Sacramento Bypass Wildlife Area by CDFW. This 360 acre area is an important cover and feeding area for wildlife during late fall, winter, and early spring. Vegetation varies through the area from scattered trees such as mature cottonwoods, willows, and valley oaks to sparsely-covered sand soil area on the eastern end. Game birds, raptors, songbirds, and native mammals are all present in this area. Detailed surveys for wetlands in the bypass will be done prior to construction, however, visual surveys confirm that wetlands are present.

The footprint of the new weir contains about 8 acres of scattered trees along the road, railroad tracks, and levee slope. Primary wildlife in this area is avian species, beavers, skunks, and rabbits. The trees along the river provide shade for many native and non-native species along with some endangered fish species such as salmonids, sturgeon, and delta smelt. These trees are also used by avian species for nesting. Because it is unknown how soon the project would be constructed, bird surveys were not conducted. However, surveys will occur prior to construction.

3.6.2 Methodology and Basis of Significance

Methodology

Impacts to vegetation and wildlife within the project area are evaluated based on data collected from the tree surveys conducted in 2011, site visits, Google Earth, and the American River Parkway Plan. These resources provide a comprehensive overview of the vegetation that exists within the project area and were used to evaluate the impacts of the project alternatives. The goals and objectives of the American River Parkway Plan were also considered for the impact analysis, and how the construction of the alternatives would impact those goals and objectives. Impacts to wildlife were evaluated based on construction activities and changes in habitat types after construction of the project.

The ARCF GRR project description (Section 2.0) assumes that the Corps would receive a variance from addressing waterside vegetation under the requirements of ETL 1110-2-583. As discussed in Section 1.4.5, an engineering analysis was conducted to determine whether allowing the vegetation to remain would pose an unacceptable public safety risk. The analysis determined allowing vegetation on the lower waterside slope to remain would not pose an unacceptable risk and, therefore, that it is a reasonable assumption that a variance would be granted, therefore, this EIS/EIR assumes that most of the trees on the lower one half of the waterside slope to remain in place. If a vegetation variance is not granted, then further NEPA analysis would occur to address the impacts of compliance with ETL 1110-2-583.

Additionally, a SWIF agreement is being sought by the non-Federal sponsor, which would allow the LMA to defer ETL 1110-2-583 compliance of landside vegetation and encroachments, to be addressed by the LMA at a later time. Effects to vegetation and encroachments are assumed to occur in the footprint of all proposed construction activities, to include the upper waterside slope of the levee per the variance. Any landside vegetation and encroachments outside of the construction footprint would be addressed separately through the SWIF agreement during O&M of the completed project levees. More details about the SWIF and variance are included in Section 1.4.5 above.

Basis of Significance

Effects on vegetation and wildlife would be considered significant if the alternative would result in any of the following:

- Substantial loss, degradation, or fragmentation of any natural communities or wildlife habitat.
- Substantial effects on a sensitive natural community, including Federally protected wetlands and other waters of the U.S., as defined by Section 404 of the Clean Water Act.
- Substantial reduction in the quality or quantity of important habitat, or access to such habitat for wildlife species.
- Substantial conflict with the American River Parkway Plan, Sacramento County Tree Preservation Ordinance, or the City of Sacramento Protection of Trees Ordinance.
- Substantial adverse effects on native wood habitats in the American River Parkway, resulting in the loss of vegetation and wildlife.

3.6.3 No Action Alternative

Under the No Action Alternative, the Corps would not participate in construction of the proposed project. As a result, no vegetation variance would be acquired. The LMA would still address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. As a result, if a flood event were to occur, the Sacramento area would remain at risk of a possible levee failure.

Without some kind of erosion control measures, the Sacramento River levees would continue to erode during high flows. As the banks of the river erode vegetation would be lost and the levees could fail. It is likely that in order to save the levee structures, flood fight activities would occur during a high flow emergency response. Flood fighting is usually performed by placing large rock along the levee slope to stop erosion and prevent levee failure and loss of lives. The placement of rock would prevent or impede future growth of trees and vegetation on the levee slopes. In the event that flood fighting activities are not successful and a levee failure occurs all vegetation would be lost and any wildlife would be swept away in the flood waters. The loss of vegetation that could occur in a large flood event and the placement of rock along the banks are considered significant impacts to vegetation and wildlife.

Over time the berms within the American River Parkway would erode, and substantial vegetation would be lost. This lost habitat would include native wood habitats and sensitive natural communities, such as oak woodland. In addition, Federally protected wetlands could be disrupted or contaminated by polluted flood flows. Any trees removed by the flood flows would be lost and would likely required significant post-flood recovery mitigation in accordance with the local tree ordinances.

This loss would also cause any wildlife in the area to relocate to other areas where the habitat they need is present. As a result, this alternative would result in a substantial reduction in the quality and quantity of habitat for wildlife species. Because we cannot predict when and how large events will occur it is inappropriate to determine at which time the berms will erode. The No Action alternative also does not comply with the American River Parkway Plan which states “Bank scour and erosion shall be proactively managed to protect public levees and infrastructure, such as bridges, piers, power lines, habitat and recreational resources”. Additionally, flood fighting would occur as described above, and the Sacramento area would be in danger of a levee failure, as described above. The potential loss of the entire Parkway and its associated levees would be considered a significant impact.

3.6.4 Alternative 1 – Improve Levees

For both Alternatives 1 and 2 a vegetation variance would be obtained to reduce the impacts to vegetation and wildlife. This would allow most of the trees on the lower one half of the waterside slope to remain in place. In addition, a SWIF agreement with the non-Federal sponsor will allow vegetation and encroachment compliance on the landside of the levee to be deferred and addressed by the LMA at a later time. Vegetation impacts throughout the project area would occur in the proposed construction footprint. Further details on the SWIF and variance are included in Section 1.4.5 above.

Infestation of invasive weeds has an influence on hydraulic roughness during high-flow events, decreases the capacity of the floodway, and adversely affects bank erosion and sedimentation processes. The Corps would remove the noxious weeds from the various plant communities prior to construction. For each of the action alternatives, direct effects to stands of grassland habitat with invasive plants would result from clearing and grubbing and rock placement activities once levee improvements and construction begin. The total number of acres of grassland affected would be refined during the design phase. Existing vegetative mapping of the study area in included with this document in Appendix B.

After construction of flood management features are completed, the indirect effects to levee slopes and mitigation areas providing grassland habitat would occur during Operations and Maintenance (O&M) consisting of levee maintenance and minor repair activities where local construction work would repair a small erosion site. These post construction activities include mowing, herbicide application, hand weeding, or physical removal of the grassland. The direct and indirect effects from mowing and applying herbicide to control noxious weeds would occur during the 3-year plant establishment period and extending control methods afterwards by the non-Federal Sponsor and would result in short term effects to wildlife using the grassland areas.

A summary of the total vegetation impacts estimated for Alternative 1 are shown in Table 14 below.

Table 14. Vegetation Impacts for ARCF GRR – Alternative 1.

	GGS Upland ***	GGS Aquatic ***	Riparian **	SRA Habitat ***	Elderberry Shrubs **	Vernal Pools **	Shallow Water**	Green Sturgeon Benthic**	Oak Woodland*	Wetlands
American River North										
Reach A (American River)			22 acres	19,000 LF	284 stems					
Reach B (American River)			0.5 acre		183 stems					0.05 acre
Reach C (American River & NEMDC)									1 acre	
Reach D (Arcade Creek)			6 acres							
Reach E (Arcade Creek)			4.5 acres		42 stems					
Reach F (NEMDC)									1 acre	
Reach G (Dry/Robla Creek)	*No Measures Proposed*									
Reach H (Dry Robla Creek)	*No Measures Proposed*									
Reach I (Magpie Creek)						0.25 acre				
American River South										
Reach A (American River)			37 acres	6,850 LF	1,437 stems					0.35 acre
Reach B (American River)			2 acres	875 LF	1,144 stems					
Reach C (American River)				3,800 LF	81 stems					
Reach D (Sacramento River)			18.6 acres	9,200 LF	163 stems		5.67 acre			
Reach E (Sacramento River)			13.2 acres	8,850 LF			4.44 acre			
Reach F (Sacramento River)			54.7 acres	21,100 LF			3.88 acre			
Reach G (Sacramento River)			25.8 acres	11,150 LF			0.87 acre			
TOTAL (Alt 1)	**0**	**0**	**184.3 acres**	**80,825 LF**	**3,292 stems**	**0.25 acre**	**14.86 acre**	**20 acres**	**2 acre**	**0.40 acre**

*State Listed **Federal Listed ***State and Federal Listed

American River

Up to 11 miles of intermittent erosion repair work (a combination of bank protection and launchable rock trench) is proposed under Alternative 1 (Plate 7). This work would occur over a 7 year period likely from May through October when birds are likely to be nesting. Once the project is authorized and funded, site-specific surveys of the project areas would occur. These surveys would evaluate the baseline conditions of vegetation prior to the start of construction, refine what mitigation is required based on those conditions, and determine if birds or other potentially impacted wildlife are nesting in areas which may be impacted during construction. If nesting birds are located adjacent to the project area, coordination with the resource agencies would occur.

The estimated acreage of impacts shown in Table 14 above was determined by overlaying the largest possible footprint of the proposed erosion repair work onto aerial photographs of the study area and calculating the habitat within the footprint. Additionally, the habitat maps included in Appendix B were reviewed to determine what other habitat types such as wetlands might be present. Much of this habitat contains riparian and oak woodland trees that have been in the Parkway for 50 to 100 years or more. The Parkway is the largest remaining riparian corridor in Sacramento. However, the Parkway Plan allows for flood control activities to be conducted in order to pass 160,000 cfs through the system. Policy 4.10 of the Parkway Plan states:

> *Flood control projects, including levee protection projects and vegetation removal for flood control purposes, shall be designed to avoid or minimize adverse impacts on the Parkway, including impacts to wildlife and wildlife corridors. To the extent that adverse impacts are unavoidable, appropriate feasible compensatory mitigation shall be part of the project. Such mitigation should be close to the site of the adverse impact, unless such mitigation creates other undesirable impacts.*

The erosion protection work proposed under Alternative 1 would be consistent with the policies in the Parkway Plan. Policy 4.16 of the Parkway Plan, as described in the Existing Conditions discussion above, establishes that erosion control projects should be designed "to minimize damage to riparian vegetation and wildlife habitat, and should include a revegetation program that screens the project from public view, provides for a naturalistic appearance to the site, and restores affected habitat values." During the preconstruction engineering and design phase of the project, the Corps would evaluate each stretch of levee on a site-specific basis, including the potential environmental effects and the site's hydraulic conditions, in order to determine the appropriate measure (bank protection or launchable rock trench) to implement.

The Corps is proposing a combination of bank protection measures and launchable rock trench measures to address the need for erosion protection. Each of these measures would involve the removal of riparian vegetation during construction, however the habitat removed under each measure provides different types of habitat values; in areas where bank protection is constructed, SRA habitat would be impacted and proposed mitigation measures would focus on replacing this habitat. In areas where launchable rock trench is constructed, upland riparian forest, oak woodland, and ruderal herbaceous habitat could be impacted and the proposed mitigation measures would focus on replacing these habitat types. The impacts associated with each of these measures are discussed more in the subsections below.

Launchable Rock Trench

The construction of the launchable rock trenches would result in the removal of a maximum of 65 acres of riparian habitats within the American River Parkway. This acreage is based on areas where either a launchable rock trench or bank protection could occur; therefore based on site-specific design, it is likely to be refined to less acreage prior to construction. Most of the 65 acres of riparian habitats is located on land designated by the Parkway Plan as Protected Areas or Nature Study Area. The Corps would mitigate for the loss of this 65 acres of riparian habitat by planting the surface of the launchable rock trench with approved riparian vegetation, and by restoring other nearby habitat areas within the Parkway. Locations of other habitat restoration sites within the Parkway would be determined through coordination with County Parks. All on-site and off-site restoration work would be designed in coordination with County Parks.

Any trees planted would take many years to mature to the level where they provide the same value as those removed. Because there would be many years between when the trees are planted and when they mature to a value of those removed, this short term impact is considered significant for the temporal loss of riparian habitat. However, with the implementation of the proposed mitigation measures, the long-term impact would be less than significant, once newly planted vegetation is established.

In addition to the 65 acres of riparian habitat, construction would occur on an additional 135 acres of ruderal herbaceous habitats within the Parkway. These additional 135 acres are primarily the levees, patrol roads, and open lands with no trees. These disturbed areas would be restored following construction and would be reseeded with native grasses. As a result, the impacts to these areas would be less than significant, with mitigation.

Additionally, under the launchable rock trench scenario there is approximately 0.4 acre of wetland that could be removed by the project in ARN Reach B and ARS Reach A. However, if bank protection is the appropriate measure for these two locations, then these impacts would not occur. Prior to construction of a launchable rock trench at these locations, a wetland delineation would be conducted to confirm the potential impact. If the wetlands are removed for project construction, then appropriate compensation would occur through the purchase of credits at an approved mitigation bank. With the implementation of this mitigation, effects to wetlands would be less than significant.

Bank Protection

The construction of the bank protection measure would result in impacts to a maximum of 31,000 linear feet of SRA habitat. This estimate is based on areas where either bank protection or launchable rock trench could occur; therefore, based on site-specific designs, this is likely to be refined to a smaller impact prior to construction. The vegetation impacts from bank protection construction would primarily involve the removal of grasses and shrubby vegetation. Large trees would be protected in place during construction. Bank protection sites would be designed to be self mitigating through the installation of a waterside planting berm on the site.

The Corps conducted an analysis of potential bank habitat effects using the Standard Assessment Methodology (SAM) model. SAM results show that plantings in the berm would be expected to provide similar or better habitat values for salmonid species over time compared to the existing condition. More information on the methodology used for the SAM analysis and the results of the analysis are included in Section 3.8 and Appendix G.

Any trees planted would take many years to mature to the level when they provide the same value as those removed. Because there would be many years between when the trees are planted and when they mature to a value of those removed, this short term impact is considered significant for the temporal loss of riparian habitat. However, with the implementation of the proposed mitigation measures, the long-term impact would be less than significant, once newly planted vegetation is established.

Sacramento River

Under Alternative 1, the existing levee structure would be degraded by one half to create a working platform for slurry wall installation. As the levee is degraded, all vegetation located in the degraded area would be removed. The maximum degraded area (the upper one half of the levee) is approximately 110 acres and contains about 750 trees of various sizes and species. Because these trees are located on the top half of the levee, they provide a small amount of SRA habitat, as well as habitat for many avian species. On the waterside of the levee there is little understory vegetation on the top half of the levee due to maintenance activities.

Because a vegetation variance would be obtained approximately 930 large trees would be left in place on the lower one-half waterside slope, and rock will be placed around the base of the trees. The trees that would remain in place are scattered over approximately 50,000 linear feet and 50 acres. The rock protection around the trees would reduce the potential for erosion and anchor the trees in place to lower the risk of uprooting in high water events. The understory vegetation would be removed to provide a clean surface to place the rock. Excluding the large trees, vegetation in this area is primarily small shrubs, low growing plants of various species, and grasses. Once the rock protection is in place and a planting berm is constructed the area would be planted with small shrubs. Appropriate plants would be selected to maximize wildlife habitat and comply with Corps and State vegetation policies.

On the landside of the levee, where levee raises are required, all trees would be removed from the levee slope and within 15 feet of the levee toe to construct the levee raise. A landside maintenance easement would be required along the levee toe within the 8 miles of levee raise. This easement will be left in place after construction as access. There are approximately 1,300 trees of various species and size within this landside easement that once removed would not be replaced on-site. As discussed below in the Mitigation Measures Section, trees would be planted off-site to replace those removed for construction. The removal of these trees is considered a short term significant impact, because it would take many years for the replacement trees to establish to the value of those removed. However, once the replacement trees are established, the long term impact would be less than significant.

The landside slopes are primarily covered with a mix of trees and ornamental groundcovers installed over the years by adjacent private property owners. In some places landscaping has been extended beyond the fence or property lines and up the levee slopes. Degrading the levee will include removal of all vegetation on the upper half of the landside slope. All disturbed areas, including the levee slopes, would be planted with native grasses to prevent erosion. The 15 foot landside easement would be maintained vegetation free, except for the native grasses.

Because this area is very urbanized, the primary effects to wildlife would be to avian species. Surveys will be conducted to determine if any nesting birds are present prior to construction. If nesting birds are located adjacent to the project area, coordination with the resource agencies would occur. Trees where nesting birds are located would not be removed while they are actively nesting. However, once the young have fledged the trees may be removed to construct the project.

East Side Tributaries

There would be a maximum of 200 trees removed from both the landside and waterside to construct the project. These trees compose approximately 2 acres of oak woodland habitat on NEMDC, and approximately 10.5 acres of riparian on Arcade Creek. The trees are suitable nesting habitat for many avian species in the area. Surveys would be conducted to determine if any nesting birds are present prior to construction. If nesting birds are located adjacent to the project area, coordination with the resource agencies would occur. Trees where nesting birds are located would not be removed while

they are actively nesting. However, once the young have fledged the trees may be removed to construct the project. Trees would be replanted to replace those removed in accordance with the City of Sacramento tree ordinance. The loss of trees in this area would be considered a short term significant impact because new plantings would take many years to grow to the value of those removed. However, once the new plantings are established, the long term effect is expected to be less than significant. Effects to vernal pools at Magpie Creek are discussed in Section 3.8.

This alternative would result in temporary impact to approximately 4 acres of grasses along the creek channel and levee slopes. Once construction is complete the area would be planted with native grass seed mix to prevent erosion and replace the grasses removed for construction. The grasslands are likely to grow back in a single season, therefore, this impact is considered less than significant.

3.6.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Effects to vegetation and wildlife from construction of the levee repairs are the same for Alternative 1 on the American River and East Side Tributaries. Effects on the Sacramento River and Sacramento Weir and Bypass are discussed below.

Sacramento River

Because the amount of levee raising is significantly reduced under Alternative 2 due to the widening of the Sacramento Weir and Bypass, effects to the landside vegetation on the levees would be less than under implementation of Alternative 1. This would result in the removal of approximately 750 trees of various species compared to the 1,300 trees that would be removed under Alternative 1. However, even with the reduced impact, effects to vegetation and wildlife under Alternative 2 would remain significant due to the temporal loss of vegetation in the area during the growth and development period of the mitigation sites. A summary of the total vegetation impacts estimated for Alternative 2 are shown in Table 15 below.

Table 15. Vegetation Impacts for ARCF GRR – Alternative 2.

	GGS Upland ***	GGS Aquatic ***	Riparian **	SRA Habitat ***	Elderberry Shrubs**	Vernal Pools**	Shallow Water**	Green Sturgeon Benthic**	Oak Woodland*	Wetlands
American River North										
Reach A (American River)			22 acres	19,000 LF	284 stems					
Reach B (American River)			0.5 acre		183 stems					0.05 acre
Reach C (American River & NEMDC)									1 acre	
Reach D (Arcade Creek)			6 acres							
Reach E (Arcade Creek)			4.5 acres		42 stems					
Reach F (NEMDC)									1 acre	
Reach G (Dry/Robla Creek)	*No Measures Proposed*									
Reach H (Dry Robla Creek)	*No Measures Proposed*									
Reach I (Magpie Creek)						0.25 acre				
American River South										
Reach A (American River)			37 acres	6,850 LF	1,437 stems					0.35 acre
Reach B (American River)			2 acres	875 LF	1,144 stems					
Reach C (American River)			N/A	3,800 LF	81 stems					
Reach D (Sacramento River)			18.6 acres	9,200 LF	163 stems		5.67 acre			
Reach E (Sacramento River)			13.2 acres	8,850 LF	N/A		4.44 acre			
Reach F (Sacramento River)			54.7 acres	21,100 LF	N/A		3.88 acre			
Reach G (Sacramento River)			25.8 acres	11,150 LF	N/A		0.87 acre			
Sacramento Weir and Bypass	30 acres	15 acres	8 acres	1,500 LF						See GGS Aquatic
TOTAL (Alt 2)	**30 acres**	**15 acres**	**192.3 acres**	**82,325 LF**	**3,292 stems**	**0.25 acre**	**14.86 acre**	**20 acres**	**2 acre**	**0.40 acre**

*State Listed **Federal Listed ***State and Federal Listed

Sacramento Weir and Bypass

Habitat within the existing Bypass would remain the same as the existing conditions and would be expanded by about 300 acres. The additional land would become open space and would likely become similar habitat for wildlife as the existing Bypass. The land could also become an expansion of the Sacramento Bypass Wildlife Area. Long-term O&M of the expanded bypass is expected to be the same as the current Sacramento Bypass. No grading or altering of the lands within the existing bypass will occur as part of the alternative. The expanded bypass will be graded to ensure that water flows naturally with the existing drainage and continue to support existing vegetation and wildlife. Because of the natural flow of water in this area, wetlands in the existing bypass are not expected to be impacted by construction of the project. There is a potential for additional wetlands to develop in the additional 300 acres since this land will no longer be farmed.

There are approximately 8 acres of riparian vegetation that would be removed to construct the weir structure. Included within the 8 acres are 1,500 linear feet of vegetation along the Sacramento River that would be removed to allow the river to flow freely into the weir. Because the riparian habitat would be permanently lost in the footprint of the new weir, this would be considered a significant impact. Compensation for the loss of this vegetation is discussed in Section 3.6.6 below.

Construction activities would likely cause any wildlife within the bypass and adjacent areas to relocate to nearby rural lands and away from human activities. Once construction is complete the wildlife is expected to return to the area. Therefore, the impacts to wildlife in the Sacramento Bypass would be less than significant. Both native and non-native fish species, along with some endangered species, use this area of the river and are discussed in Fisheries (Section 3.7) and Special Status Species (Section 3.8). Impacts to GGS habitat from the removal of farm ditches and drainage canals are discussed in Section 3.8.

3.6.6 Mitigation Measures

Mitigation measures are similar for both Alternatives 1 and 2 since the impacts for these two alternatives are similar, with the exception of the Sacramento Bypass, which would only be required for Alternative 2. Compensation measures are based on the largest potential footprint and worst case scenario for the purposes of compliance with NEPA. If design refinements are made that result in reduced impacts to vegetation, compensation would be coordinated with the appropriate resource agencies and adjusted accordingly.

After construction of the flood risk management features is completed, the direct effects to non-native grasslands, shrubs, and trees providing poor habitat for wildlife would be compensated by planting/seeding a mixture of native grasses and forbs along the slopes of levees covered with rock only, in open areas next to the levees, and at borrow and staging areas. Soil inoculants contain important spores, mycelium, and mycorrhizal root fragments, which could be added to soils before seeding. Temporary irrigation for the planting installation and following three-year plant establishment period would be provided. The native mixture would provide good habitat for wildlife and their root masses controls erosion better than what non-native mixes would do. Native trees would be planted to replace the invasive ones in accordance with its plant community type. The mitigation seeding and plantings would be monitored during the plant establishment period for success. To the extent possible, mowing and other related levee O&M activities would be timed to avoid significant effects to fish and wildlife including Federally and State-listed species per the time frames stipulated in the Biological Opinions (Appendix J). Limited use of approved herbicides such as 2,4-D could be applied in non-wetland areas. A minimum of a 70-foot buffer to open water is recommended even for wetland-approved herbicides. Care would be taken to minimize drift and potential contamination of wetlands by applying spray treatments to calm, non-windy days.

Appendix I includes the project's Habitat Mitigation, Monitoring, and Adaptive Management Plan (HMMAMP). The purpose of this HMMAMP is to present conceptual mitigation proposals, establish performance standards, and outline adaptive management tasks and costs. Additionally, the project relied heavily on the Habitat Evaluation Procedures (HEP) for the *American River Watershed Investigation, Common Features Modifications, Mayhew Drain Site Project* in order to create a baseline condition for habitat quality within the study area. Using this HEP, the Corps conducted a cost effectiveness/incremental cost analysis (CE/ICA), which is also included in Appendix I. The CE/ICA evaluated five options for habitat mitigation to determine the most cost effective and government best buy options for habitat restoration. These options included conducting all mitigation on-site, conducting all mitigation at a mitigation bank, a combination of on-site and off-site (bank) mitigation (recommended plan), conducting all mitigation at a 1:1 ratio, and conducting all mitigation at a 3:1 ratio. The recommended mitigation plan is the Alternative 2 Combination Plan with a 2:1 ratio, because it is the smallest mitigation proposal that accomplishes the terms and conditions of the Biological Opinions, and the CE/ICA determined that it was a cost effective plan. Further information on proposed habitat mitigation can be found in Appendix I and in the subsections below.

American River

During the design refinement phase, plans will be evaluated to reduce the impact on vegetation and wildlife to the extent practicable. Refinements that could be implemented to reduce the loss of riparian habitat include: reduced footprint, constructing bank protection rather than launchable rock trench whenever feasible, and designing planting berms in areas where significant riparian habitat exists adjacent to the levee toe (when no hydraulic impacts would occur).

Trees would remain in locations where the bank protection and planting berm can be constructed, since this area is 15 feet from the levee toe and complies with the Corps vegetation policy. Trees would be protected in place along the natural channel during the placement of rock. The rock would anchor the trees in place and reduce the risk of them falling over during a high flow event. Additional plantings would be installed on the newly constructed berm to provided habitat for fish and avian species. The planting berm would be used to minimize impacts to fish and wildlife species; however, the impact to riparian habitat would still be significant.

To compensate for the removal of a maximum of 65 acres of riparian habitat, approximately 130 acres of replacement habitat would be created to account for the temporal loss of habitat while newly created habitat is growing. Species selected to compensate for the riparian corridor removal would be consistent with the approved list of trees, shrubs, and herbaceous plants native to the Parkway. The 130 acres would create habitat connectivity and wildlife migratory corridors that provide for the habitat needs of important native wildlife species, without compromising the integrity of the flood control facilities, the flood conveyance capacity of the Parkway, and Parkway management goals in the Parkway Plan. Some of the 130 acres of riparian would be planted on top of the rock trench. Corps vegetation policy allows for trees to be planted 15 feet from the levee toe. Additionally, to comply with the Parkway Plan, lands within the Parkway would be evaluated for compensation opportunities. The exact location of the compensation lands in the Parkway would be coordinated in the design phase of the project with County Parks and would comply with the Parkway Plan objectives and goals. It is assumed that sufficient lands would be available within the Parkway; however, if there is not sufficient land, other locations within Sacramento County would be identified and public coordination would occur.

Surveys would be conducted for several years prior to construction to determine if any birds are nesting within 0.5 miles of the construction activities. If nests are located within the vicinity of construction for any given year, coordination with the appropriate resource agencies would occur to determine what action should be taken. Trees would not be removed if an active nest is found; however, once the young have fledged, the tree can be removed for construction. If survey results determine that no nests are in the vicinity of construction scheduled for that year, construction may commence without further coordination on this issue.

Sacramento River

Avoidance and minimization measures incorporated as part of the Sacramento River design include: compliance with the Corps vegetation policy through a vegetation variance, installation of a planting berm where erosion protection is required, and narrowing of the levee footprint by construction of a retaining wall, when feasible.

The vegetation variance would allow waterside trees on the lower half of the slope to remain in place. This would allow approximately 930 trees along 10 miles of the Sacramento River to continue to provide habitat for fish and wildlife species. Along with retaining the trees, additional plantings of small vegetation would be done on the newly constructed berm. Species of plants would be coordinated with NMFS, USFWS, and State and local partners.

Compensation for the tree removal was evaluated based on other projects in the Sacramento area where riparian trees were removed, including the ARCF WRDA 1996 and 1999 authorized projects, coordination with USFWS under the Fish and Wildlife Coordination Act, and local plans and policies. Based on this evaluation and the lack of riparian habitat in the urban area, up to 95 acres could be required to compensate for the loss of these trees. There are pieces of land within a short distance that could be planted; however, further evaluation on availability of these lands and coordination with the resource agencies would be needed during site-specific designs. Lands within the extended Sacramento Bypass could be used to compensate for some of the landside trees being removed. Because it would take many years for the compensation sites to provide the value of those removed, both Alternatives 1 and 2 would cause a significant impact on vegetation and wildlife.

East Side Tributaries

Off-Site mitigation for the removal of 50 trees in the Arcade Creek area would be done in compliance with the Sacramento City tree ordinance. It is estimated that 2 acres would be required to accommodate the planting of approximately 450 trees. There are multiple locations that are suitable for planting the compensation trees within the City of Sacramento Parks land. Discussions with the City of Sacramento Parks Department identified the following locations as potential planting sites:

- **Sacramento Northern Bike Trail**: This trail runs from downtown Sacramento near C Street to Elverta Road. The trail has some open lands that run parallel to the trail, near Arcade Creek. Planting in this area would provide riparian habitat while also providing some beautification of the trail.
- **North Natomas Regional Park**: This Park is locate off Natomas Boulevard and contains 35 acres, including a lake, landscaping, dog park, bridges, walkways, and bikeways. Some of the land within this park could be used to compensate for the tree removal along Arcade Creek as it is within 5 miles of the tree removal area. Planting in this park would provide both riparian habitat and help complete the master plan for this land.
- **Johnston Park**: This Park is located on Eleanor Avenue in Sacramento. The park is approximately 25 acres with swimming pool, ball fields, picnic areas, and community center. The park has many acres of open land that could be used to plant trees. Again, this would provide the needed riparian compensation and benefit the overall quality of the park.

- **Dry/Robla Creek**: This area is a 420-acre open space located north of main Avenue and east of NEMDC. Any planting in this area would avoid existing woodland corridor along the Dry Creek channels, vernal pools, seasonal wetlands, and relatively permanent waters. If this area is used to plant compensation habitat, hydraulic modeling would occur to ensure that no impacts to hydraulics occur.

Sacramento Weir and Bypass

Impacts associated with the Sacramento Weir and Bypass are related to the construction of Alternative 2 only, therefore, mitigation measures discussed in this section would only be implemented if Alternative 2 is constructed.

As stated above, a maximum of 8 acres of riparian vegetation would be removed to construct the 1,500 foot long weir. Compensation was determined by evaluating other projects with similar impacts in the Central Valley, coordination with resource agencies, and evaluation of compensation plantings' ability to provide similar wildlife habitat. Because new plantings would take many years to establish, a temporal loss was considered in the calculation for compensation acreage. A total of 16 acres would be needed to compensate for the removal of the vegetation along the Sacramento River and within the new weir footprint, due to the temporal loss of habitat while the new habitat is establishing. Plantings could be accomplished within the expanded bypass, other nearby available lands, or through the purchase of credits at an approved mitigation bank. Specific lands for compensation have not been identified; however, lands considered would provide similar habitat to that being impacted. Although replacement trees would be planted off-site to compensate for the removal of 8 acres, the newly planted vegetation will take many years to mature to an equal value of those removed. Because the plantings would take a long time to provide the same value of habitat as those removed this impact would be significant on vegetation and wildlife.

3.7 Fisheries

3.7.1 Environmental Setting

Regulatory Setting

The following Federal and State laws and regulations apply to the resources covered in this chapter. Descriptions of the laws and regulations can be found in Section 5.0.

Federal

- Endangered Species Act
- Clean Water Act
- Magnuson-Stevens Fishery Conservation and Management Act
- Federal Wild and Scenic Rivers Act

State

- California Endangered Species Act
- California Fish and Game Code Section 1600: Streambed Alteration Agreements

Existing Conditions

Sacramento River and American River

Native species present in the Sacramento and American Rivers can be separated into anadromous species and resident species. Native anadromous species include four runs of Chinook salmon, steelhead trout, green and white sturgeon, and Pacific lamprey, which are discussed in detail in the Special Status Species Section of this EIS. Native resident species include Sacramento pikeminnow, Sacramento splittail, Sacramento sucker, hardhead, California roach, and rainbow trout and can be found throughout the study area in various habitats that include, but are not limited to, deep pools, riffles, side channels, swift moving cool water, and slow moving warm water habitats. A list of the species that can be found in the waterways within the study area can be seen on Table 16 below.

Table 16. Potential Central Valley Native and Nonnative Fish Species Present in the Study Area.

Common Name	Scientific Name	Origin
Lamprey (two species)	*Lampetra spp.*	native
Chinook Salmon (winter, spring, fall and late fall runs)	*Oncorhynchus tshawytscha*	native
Chum salmon (rare)	*Oncorhynchus keta*	native
Steelhead/rainbow trout	*Oncorhynchus mykiss*	native
White sturgeon	*Acipenser transmontanus*	native
Green sturgeon	*Acipenser medirostris*	native
Delta smelt	*Hypomesus transpacificus*	native
Wakasagi	*Hypomesus nipponensis*	nonnative
Sacramento sucker	*Catostomus occidentalis*	native
Sacramento pikeminnow	*Ptychocheilus grandis*	native

Common Name	Scientific Name	Origin
Sacramento splittail	*Pogonichthys macrolepidotus*	native
Sacramento blackfish	*Orthodon microlepidotus*	native
Hardhead	*Mylopharodon conocephalus*	native
Speckled dace	*Rhinichthys osculus*	native
California roach	*Lavinia symmetricus*	native
Hitch	*Lavina exilicauda*	native
Golden shiner	*Notemigonus crysoleucas*	nonnative
Fathead minnow	*Pimephales promelas*	nonnative
Goldfish	*Carassius auratus*	nonnative
Carp	*Cyprinus carpio*	nonnative
Threadfin shad	*Dorosoma petenense*	nonnative
American shad	*Alosa sapidissima*	nonnative
Black bullhead	*Ameiurus melas*	nonnative
Brown bullhead	*Ameiurus nebulosus*	nonnative
White catfish	*Ameiuruscatus*	nonnative
Channel catfish	*Ictalurus punctatus*	nonnative
Mosquito fish	*Gambusia affinis*	nonnative
Inland silverside	*Menidia audena*	nonnative
Threespine stickleback	*Gasterosteus aculaetus*	native
Striped bass	*Morone saxatilis*	nonnative
Bluegill	*Lepomis macrochirus*	nonnative
Green sunfish	*Lepomis cyanellus*	nonnative
Redear sunfish	*Lepomis microlophus*	nonnative
Warmouth	*Lepomis gulosus*	nonnative
White crappie	*Pomoxis annularis*	nonnative
Black crappie	*Pomoxis nigromaculatus*	nonnative
Largemouth bass	*Micropterus salmoides*	nonnative
Redeye bass	*Micropterus coosae*	nonnative
Spotted bass	*Micropterus punctulatus*	nonnative
Small mouth bass	*Micropterus dolomieu*	nonnative
Bigscale logperch	*Percina macrolepida*	nonnative
Prickly sculpin	*Cottus asper*	native
Tule perch	*Hysterocarpus traski*	native

Important attributes of the aquatic habitat within the American and Sacramento Rivers are aquatic vegetation and SRA habitat. Aquatic vegetation is represented by floating, submerged, and emergent vegetation. Aquatic vegetation serves as hiding cover and an invertebrate food production base for nearly all aquatic species. The percent of aquatic vegetation cover varies throughout the study area.

SRA is represented by overhead canopy cover. Overhanging SRA provides shade which is a form of cover important to the survival of many aquatic organisms, including fish. Overhanging vegetation moderates water temperatures, which is an important factor for various life stages of native fish species. The vegetation provides food and habitat for both terrestrial and aquatic invertebrates, which in turn serve as food for several fish species. Aquatic vegetation, or in-water cover, provides a diversity of microhabitats which allows for high species diversity, abundance, and a food source for instream invertebrates, which in turn are eaten by several native fish species. Thus, a broad food base and extensive cover and habitat niches are supported by in-water cover. These values in turn create high fish diversity and abundance (USFWS 1992a).

The existing overhead shade cover within the study area varies by location and along each waterway. The amount of SRA within the study area was calculated using aerial photography and determining which areas have overhanging vegetation and trees adjacent to the natural channel and which areas do not. Generally, greater shade cover occurs during summer when full tree canopies are present. Analysis of total linear feet (lf) of SRA was conducted using Google Earth Pro for the reaches associated with bank protection on the American and Sacramento Rivers in the ARCF study area (Table 17).

Table 17. Summary of Reach-Specific SRA Analysis.

American River		**Sacramento River**	
Reach	**Linear Feet (lf) of SRA**	**Reach**	**Linear Feet (lf) of SRA**
ARN A	19,000	D	9,200
ARS A	6,850	E	8,850
ARS B	875	F	21,100
ARS C	3,800	G	11,150
Total	30,525	Total	50,300

Note: Numbers were obtained using aerial photography and are estimates. Numbers are rounded.

Throughout the program area watersheds, altered flow regimes, flood control, and bank protection efforts have reduced sediment transport, channel migration, and instream woody material (IWM) recruitment, and have isolated the channel from its floodplain. Historically the floodplain provided areas for riparian vegetation recruitment and for rearing of native and special-status fish species. Levees and armored banks prevent fish from accessing productive floodplain habitats and limits nutrient exchange between the river and flooded riparian areas (Stillwater Sciences 2006).

The Lower American River is also a designated Wild and Scenic River under both the State and Federal Wild and Scenic Rivers Acts. The anadromous fisheries resources along the Lower American River are one of the designated extraordinary values of the river under this Act.

East Side Tributaries

The East Side Tributaries provide fish spawning, rearing, and/or migratory habitat for a diverse number of native, nonnative, and special status species (Table 16). Many of the nonnative resident fish species are more tolerant of warm water, low dissolved oxygen, and disturbed environments than native species as encountered in the East Side Tributaries during most of the year. In general, they are adapted to warm, slow-moving, and nutrient-rich waters (Moyle 2002).

Quality fish habitat for native fish species in the East Side Tributaries study area associated with SRA lies in the lower portion of NEMDC below Arcade Creek and in Arcade Creek between Norwood Avenue and the Sacramento Northern Bike Trail. Due to lack of quality SRA habitat in the Magpie Creek and Dry/Robla Creek project areas it would be considered of minimal quality for native fish species.

Analysis of total lf of SRA in the East Side Tributaries was not evaluated because no bank erosion protection is planned and there is minimal, if any, SRA associated with these reaches.

Sacramento Bypass

The Sacramento Bypass provides emigration and rearing habitat for juvenile anadromous fish and spawning and rearing habitat for native resident fish species. The occurrence of these life stages in the Sacramento Bypass is limited mainly to periods when flooding (via the Fremont and Sacramento Weirs) allows individuals to access the area from the Sacramento River. Juvenile Chinook salmon have been captured in the Sacramento Bypass (Jones & Stokes 2001). The area seasonally provides habitat for delta smelt, steelhead, and Chinook salmon, as well as numerous native resident fish species (Sommer et al. 2001). Most juveniles emigrate from the Sacramento Bypass during winter and spring before the floodplains become dry. Thus, the potential for these species' life stages to occur in these areas in any given year depends on the occurrence of flooding; the timing, magnitude, and duration of flooding; and the seasonal timing of specific life stages.

Recognition is growing that naturally functioning floodplains, such as the Yolo Bypass, provide many benefits, including direct economic benefits, ecosystem services, and habitat for a wide diversity of species (Bayley 1991; Tockner and Stanford 2002, as cited in Ahearn et al. 2006). Floodplains provide freshwater habitat for the migration, reproduction, and rearing of native fishes and mitigate flood damage to human settlements (Moyle et al. 2003; Crain et al. 2004; Sommer et al. 2001a).

Floodplains are highly productive habitats that flood during high flows in the winter and spring. Floodplains are important habitats for young native fish species (Moyle et al. 2005). Native resident species such as the Sacramento splittail, which spawn in inundated floodplains, produce the highest numbers of young when flows are high and floodplain habitat is inundated (Moyle 2002).

3.7.2 Methodology and Basis of Significance

Methodology

Existing resource information related to the study area was reviewed to evaluate whether sensitive habitats and native fish species are known from or could occur in the study area. The information reviewed included the following sources:

- Published and unpublished documents and reports pertaining to the study area.
- Analysis of total SRA in lf was conducted using Google Earth Pro for the reaches associated with bank erosion protection on the American and Sacramento Rivers in the ARCF project area.
- California Natural Diversity Data Base (CNDDB)

The key sources of data and information used in the preparation of this section are listed below.

- USFWS list (dated October 2, 2013) of endangered, threatened, and proposed species for the study area (Appendix G);
- Google Earth;
- Published and unpublished reports; and,
- A field survey on October 26, 2007.

Significance Criteria

In general, effects on fish populations are significant when the project causes or contributes to substantial short- or long-term reductions in abundance and distribution. An effect is found to be significant if it:

- Interferes substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites;
- Substantially reduces the habitat of a fish population; and/or
- Causes a fish population to drop below self-sustaining levels.

3.7.3 No Action Alternative

Under the No Action Alternative, the Corps would not participate in construction of the proposed project. As a result, no vegetation variance would be acquired and full compliance with ETL 1110-2-583 would be required, including the removal of all waterside vegetation, which would significantly impact fish species due to the lack of SRA habitat. The LMA would still address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. As a result, if a flood event were to occur, the Sacramento area would remain at risk of a possible levee failure.

There would be no construction related affects to fish habitat, however effects to fish associated with flood fighting could be significant. Flood fighting is usually performed by placing large rock along the levee slope to stop erosion and prevent levee failure and loss of lives and property. The placement of rock would prevent or impede future growth of trees and vegetation on the levee slopes, which would substantially reduce fish habitat. Emergency clean-up and earth-moving activities could also result in an increase in sediment and turbidity that adversely affect migration, spawning or rearing habitat. Given the nature of emergency clean-up activities, it is likely that implementation of BMPs and measures to reduce effects on fish would not be possible, and the populations may drop below self-sustaining levels.

High flows in the American River would have a large impact on the American River Parkway as the berms disappear from continued high flows against erodible material and eventually cause the levee to fail. The timeframe for which the berms would erode is unknown because it is impossible to determine how much water will pass through the system and potential flood events. The banks along the American River are very erosive and without some kind of erosion control measures would continue to erode during high flows. As the banks of the river erode, important SRA habitat would be lost and the levees could fail. It is likely that in order to save the levee structures, flood fight activities would occur during a high flow emergency response. All of these effects would be considered significant; however, given the uncertainty of the occurrence or magnitude of such an event, potential effects on fisheries cannot be quantified based on available information.

3.7.4 Alternative 1 – Improve Levees

The following subsections describe potential effects to fisheries associated with construction of Alternative 1. Under Alternative 1, long-term O&M is expected to continue similar to current practices, as described in Section 2.3.4. There would be no effects to fisheries associated with long-term project O&M.

American River

Rock placement would most likely disturb the native resident fish by increasing noise, water turbulence, and turbidity, causing them to move away from the area of placement. In some pelagic native juvenile species utilizing the near shore habitat for cover, moving away from that cover could put them at a slight risk of predation. Native benthic species would not be affected due to their location away from the levee slope where revetment placement would take place.

Nonnative species cause substantial predation mortality on native species. Studies at Clifton Court Forebay estimated predator-related mortality of hatchery-reared fall-run Chinook salmon from about 60% to more than 95%. Although the predation contribution to mortality is uncertain, the estimated mortality suggests that striped bass and other predatory fish, primarily nonnative, pose a threat to juvenile Chinook salmon moving downstream, especially where the stream channel has been altered from natural conditions including at rock revetment sites (DWR 1995). Predators such as striped bass, largemouth bass, and catfish also prey on delta smelt, splittail (USFWS 1996) and possibly longfin smelt. The extent that predation may affect delta smelt is unknown. Predation effects on green sturgeon are unknown.

In an ongoing SRBPP long-term aquatic monitoring fish sampling and habitat characterization report, boat electrofishing was used to document fish presence and estimated index abundance at three different site types: 1) Mitigated Repair Sites (i.e., post-2006 emergency levee repair sites that incorporate habitat mitigation features; n = 11 sites), 2) Unmitigated Repair Sites (i.e., Unmitigated type of levee repair sites that generally consist of rock revetment without additional habitat enhancement; n=4 sites), and 3) Naturalized Sites (i.e., natural bank sites that are not currently have no rock revetment, and are dominated by native riparian or emergent vegetation; n=7 sites) (Corps 2012). Monitoring at these sites allowed the Corps to compare the efficacy of the habitat improvements incorporated into Mitigated Repair Sites to that of non-mitigated repair designs associated with Unmitigated Repair Sites, as well as to non-engineered conditions at Naturalized Sites. Based on analysis of a combined dataset, predator abundance is higher at all Mitigated Repair Sites than at Naturalized Sites, yet among repair sites, predators abundance is lowest at 10:1 Slope/Bench sites, the design type occupied by higher abundances of juvenile Chinook salmon. Highest predator abundance, as documented previously based on single-year analysis in 2011 and 2012, was found at Wetland Trench sites, those locations where Chinook salmon juveniles were least likely to be observed during field sampling. It is unclear whether this is a result of predator-prey interaction or attributable to differences in habitat preference between juvenile Chinook salmon and piscivores. Intermediate predation risk (based on predator abundance) was found at No Bench Repair sites (Corps 2012).

Construction during the project may disturb soils and the nearshore environment, leading to increases in sediment in the nearshore aquatic habitat. This in turn may increase sedimentation (i.e., deposition of sediment on the substrate), suspended sediments, and turbidity. Increases in suspended solids and turbidity will generally be short-term in nature. Direct effects are less than significant to

resident native fish species because it was determined that existing conditions would not be worsened by project construction which includes the creation of planting berms to provide shade and instream woody material elements of SRA habitat. The natural bank element of SRA would be lost with the placement of rock along the levee slope. Over time sediment would settle into the rock voids and provide similar substrate characteristics as a natural bank. Because the long-term condition of the river is expected to recover and provide improved habitat for fish species, the project would not conflict with the extraordinary fisheries designation for the American River under the Federal Wild and Scenic Rivers Act.

The other proposed levee improvement measure for the American River involves construction of a launchable rock filled trench designed to deploy once erosion has removed the bank material beneath it. All launchable rock trenches would be constructed outside of the natural river channel with no significant direct effects to native fish species.

The erosion measures on the American River are not considered structural fixes, as these measures do not impact the structure of the levee, therefore the vegetation in this portion of the project would not be addressed under the ARCF project. Bank erosion measures therefore will allow the vegetation to remain. Indirect effects were not considered significant to resident native fish species because it was determined that existing conditions would not be worsened by project construction, and would not result in a substantial reduction in population abundance, movement, and distribution.

Construction of the proposed measures would require ground-disturbing activities that potentially cause erosion and soil disturbance, subsequently resulting in sediment transport and delivery to aquatic habitats. Increases in sedimentation and turbidity have been shown to affect fish physiology, behavior, and habitat. An increase in sedimentation and turbidity could occur in adjacent water bodies during earth-moving activities and could be considered significant.

Increased sedimentation and turbidity as a result of program construction activities may affect fish behavior by influencing spawning, feeding, or migratory behavior. The survival to emergence of fertilized salmonid eggs decreases with increased sedimentation (Shapovalov and Taft 1954, Cordone and Kelley 1961, Bjornn and Reiser 1991). Sedimentation could, therefore, reduce the quantity of available spawning habitat. However, little spawning habitat is located within the program area and is instead mostly upstream. The amount of habitat for juvenile fish (particularly salmonids) may decrease as sediment settles and fills in spaces between larger cobbles and boulders that are normally used for refuge (Cordone and Kelley 1961, Bjornn and Reiser 1991). Easily accessible invertebrate prey normally found on rocks may be replaced by burrowing organisms, reducing the amount of prey for juvenile salmonids (Bjornn and Reiser 1991). This effect is most relevant to areas upstream of the study area but, nevertheless, could be locally important within the study area.

Program construction may increase turbidity in the adjacent water bodies. Short-term periods of higher turbidity generally do not affect larger juveniles and adults (Cordone and Kelley 1961). For smaller juvenile salmonids, increased turbidity may result in decreased growth because of reduced visual foraging ability and earlier emigration from a water body (Sigler et al. 1984). Smaller size at emigration may increase vulnerability to predation. Migrating adult salmonids may avoid highly turbid water and may not be able to access suitable spawning habitat. For example, Cordone and Kelley (1961: 195) cite studies documenting avoidance of turbid Yuba River waters by migrating Chinook salmon adults; the movement of the salmon into a small tributary of the Yuba River led to considerable disturbance of previously constructed redds (nests) by subsequent spawners because the number of spawners exceeded the amount of habitat.

Increased construction-related suspended sediments may produce a variety of behavioral and physiological effects in salmonids. Newcombe and Jensen (1996) noted that concentration and duration of exposure were of importance in determining effects and modeled response exposure in terms of behavioral effects (ranging from an alarm reaction to avoidance), sublethal effects (ranging from short-term reductions in feeding success to long-term reductions in feeding success), and lethal or paralethal effects (ranging from reduced growth/feeding/density to 80–100% mortality). For adult and juvenile salmonids, Newcombe and Jensen calculated that for a very short-term exposure (1 hour), sublethal effects began at around 20 mg/l (milligrams per liter) of suspended solids and lethal/paralethal effects began at around 20,000 mg/l.

Direct and indirect effects related to increases in sedimentation, suspended solids, and turbidity would be significant, but would be adequately mitigated to a level that is less than significant with the implementation of BMPs discussed in Water Quality (Section 3.5). These BMPs include the Basin Plan turbidity thresholds, which provides that, where ambient turbidity is between 5 and 50 NTUs, projects would not increase turbidity on the Sacramento or American River by more than 20 percent above the ambient conditions.

Sacramento River

Direct effects on the Sacramento River in relation to rock placement would be the same as described above for the American River. The 9 miles of erosion protection planned under this alternative would include the creation of planting berms which would provide the shade and instream woody material elements of SRA habitat. The natural bank element of SRA habitat would be lost with the placement of rock along the levee slope. Over time sediment would settle into the rock voids and provide similar substrate characteristics as a natural bank. The other proposed levee improvements for the Sacramento River involve construction of cutoff walls to address seepage and stability measures and levee raises for overtopping measures. These measures would be constructed outside of the natural river channel with no direct effects to native fish species.

A vegetation variance would allow vegetation below the lower one-half of the slope to 15 feet waterward of the levee toe. Indirect effects were not considered significant to resident native fish species because it was determined that existing conditions would not be worsened by project construction. The planting berm would create additional cover habitat once it has matured. However, the loss of natural bank would still reduce the overall value of the SRA habitat.

Proposed measures would require ground-disturbing activities that potentially cause erosion and soil disturbance, subsequently resulting in sediment transport and delivery to aquatic habitats. Increases in sedimentation and turbidity have been shown to affect fish physiology, behavior, and habitat. An increase in sedimentation and turbidity could occur in adjacent water bodies during earth-moving activities and could be considered significant. These effects would be reduced to less than significant with the implementation of BMPs discussed in Water Quality (Section 3.5).

East Side Tributaries

Construction of cutoff walls and flood walls would take place above the waterline which would not have significant direct effects. The East Side Tributaries would be required to establish compliance with the Corps vegetation requirements. Due to SRA habitat located on the lower portion of NEMDC below Arcade Creek and between Norwood Avenue and the Sacramento Northern Bike Trail, there would be significant direct effects by reducing the available areas for shade and possible food sources available to the existing native and nonnative fish species present in the study area. Indirect effects to loss of SRA habitat would be reduced to less than significant with the implementation of compensation for the loss of vegetation. This compensation is discussed in detail in Vegetation and Wildlife (Section 3.6).

Proposed measures would require ground-disturbing activities that potentially cause erosion and soil disturbance, subsequently resulting in sediment transport and delivery to aquatic habitats. Increases in sedimentation and turbidity have been shown to affect fish physiology, behavior, and habitat. An increase in sedimentation and turbidity could occur in adjacent water bodies during earth-moving activities and could be considered significant. These effects would be reduced to less than significant with the implementation of BMPs discussed in Water Quality (Section 3.5).

3.7.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

The Alternative 2 direct and indirect effects for the American River, Sacramento River, and East Side Tributaries would be the same as described above in Alternative 1. Effects associated with construction of the Sacramento Weir and Bypass widening is discussed below.

Sacramento Weir and Bypass

Proposed construction in the Sacramento Bypass would take place during the dry season when no water would be flowing through the project area from the Sacramento River. There would be no significant direct effects to native fish populations because they would not be present in the construction footprint during the proposed construction.

Long-term O&M of the new weir and bypass is expected to be consistent with current O&M actions in the existing weir and bypass. However, as design and operation of the new weir and bypass are refined during PED, some changes could occur. If any changes to O&M requirements occur, they would be evaluated to determine if there would be an associated impact, and if those impacts different from what is disclosed in this EIS/EIR, then supplemental NEPA analysis may occur. Indirect effects associated with the Sacramento Weir and Bypass Widening are discussed below.

Winter floodplain habitat is a vital (and missing) link between upstream gravel beds where salmon spawn and the ocean where they spend the majority of their lives. Water management experts are beginning to recognize that floodplains and bypasses can serve multiple purposes. Floodplains give high flood flows a place to go, taking pressure off levees, and protecting people and property from flooding. Additionally, flood waters in these areas create seasonal habitat for fish and birds.

Currently, the primary input to the Yolo Bypass during storm events is through Fremont Weir in the north, which conveys floodwaters from the Sacramento and Feather Rivers (DWR 2010). The Fremont Weir discharges to the Yolo Bypass on average every two years. During intermittent major storm events additional water enters from the east via the Sacramento Weir and Bypass, adding flow from the American and Sacramento rivers. The last time this occurred was in 2006 and before that in 1997-1998 (USGS 2015). Very little, if anything, is known about the fish passage through the Sacramento Bypass during its infrequent inundation. Most, if not all, fish passage monitoring and research occurs on the Yolo Bypass adjacent to the Sacramento Bypass. When the Sacramento Bypass is operational, there is sufficient flow for fish passage through the Sacramento Bypass to the Yolo Bypass (Schlunegger, personal communication). Studies done on the Yolo Bypass suggest that fish would move into the floodplain during high-flow events and spread throughout the broad expanse of seasonally inundated habitat (Sommer et al. 2005). Similar if not equal habitat in the Sacramento Bypass exists which would suggest that during the infrequent times that the Sacramento Bypass is flooded fish would move through and into the Yolo Bypass. Existing sloping in the Sacramento Bypass is towards the southern levee toe drain. Sloping and grading of the bypass expansion will be determined in the preconstruction, engineering, and design (PED) phase with considerations for fish passage and elimination of stranding features.

Although results suggest that several measures of habitat quality may be better for young salmon in the Yolo Bypass, floodplain habitat carries risks from avian predation and stranding when water levels drop. Some predation occurs as a result of wading birds such as egrets and herons; however these birds are unlikely to have a major population effect as the densities of wading birds are typically low relative to the thousands of hectares of available fish rearing habitat (Sommer et al 2001). The relative importance of stranding mortality is difficult to evaluate because the number of salmon emigrating from the Sacramento River and its tributaries is unknown, despite substantial monitoring efforts by several agencies. After floodwaters recede, the basin empties through the Toe Drain. The floodplain is exceptionally well-drained because of grading for agriculture, which likely helps promote successful emigration of young salmon (Sommer et al. 2001).

The State of California has been conducting the Agricultural Floodplain Pilot Study to investigate the biological and physical parameters of fish habitat, as well as the relationships between habitat, growth, and survival. The goal of the project is to see if flooding agricultural land can create a seasonal wetland suitable for raising Chinook salmon, without disrupting agricultural operations. Such information is essential to the development of Bypass rearing habitat for Chinook at appropriate temporal and spatial scales (UC Davis and DWR 2012).

Knaggs Ranch, a research location involved in the Agricultural Floodplain Pilot Study, is located approximately five miles west of the city of Sacramento, in the Yolo Bypass. The initial pilot, completed in 2012, confirmed that juvenile salmon thrive on seasonally flooded agricultural fields, with the project documenting among the highest growth ever recorded in Central Valley salmon research. The second phase, launched in early 2013, will evaluate how different habitat variations might impact the salmon, with the goal of maximizing benefits for the fish without impacting farming operations or planting cycles. The salmon will be released on different types of land (such as post-harvest rice straw or bare ground) to see which makes for better habitat. Research will also determine if long-term survival rates of salmon are improved by increasing the time they spend on floodplains (CWF 2012).

By widening the Sacramento Weir and Bypass, the project would create additional floodplain habitat within the Sacramento Bypass, which could benefit native fish consistent with the results of the Knaggs Ranch Study. The increase of floodplain habitat could increase opportunities for successful rearing and feeding during seasonal flooding. As a result, indirect effects of the Sacramento Bypass and Weir widening for native fish species would be considered a benefit to the species.

3.3.6 Mitigation Measures

All mitigation measures associated with SRA and riparian habitat removal are addressed in Vegetation and Wildlife (Section 3.6). BMPs associated with construction related impacts such as dust, runoff, and spills are addressed in Water Quality (Section 3.5).

- In-water construction would be restricted to the general estimated work window of August 1 through November 30. For the purpose of this study however, during PED, the work window will be adjusted on a site specific basis taking into account periods of low fish abundance, and in-water construction outside the principal spawning and migration season. Typical construction season generally corresponds to the dry season, but construction may occur outside the limits of the dry season, only as allowed by applicable permit conditions.
- Due to the deleterious effects of numerous chemicals on native resident fish used in construction, if a hazardous materials spill does occur, a detailed analysis will be performed immediately by a registered environmental assessor or professional engineer to identify the likely cause and extent of contamination. This analysis will conform to American Society for Testing and Materials standards, and will include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, the Corps and its contractors will select and implement measures to control contamination, with a performance standard that surface water quality and groundwater quality must be returned to baseline conditions.
- If mitigation or compensation sites are planned within the Sacramento Bypass for the overall ARCF project, future results from the 2013 Knaggs Ranch Pilot Study would be reviewed for potential beneficial habitat for native fish species to be incorporated into the sites.

3.8 Special Status Species

This section describes special status species that either occur or have the potential to occur (existing habitat) in the project area. Special status species are protected by, or are otherwise of concern to, both the Federal and State Governments.

3.8.1 Environmental Setting

Regulatory Setting

Federal

- Endangered Species Act
- Migratory Bird Treaty Act
- Bald and Golden Eagle Protection Act

State

- California Endangered Species Act
- California Fish and Game Code
- California Native Plant Protection Act

Existing Conditions

A list of special status species was obtained from the USFWS website, and a search of the CNDDB was conducted in January 2015. The species lists from these data searches are included in Appendix G. Many of the listed species are not expected to occur in the study area due to lack of suitable habitat. Those species known to occur within or adjacent to the study area are discussed further in this chapter. In general, habitats within the entire study area are similar and so potential for listed species are described for the entire project and not broken out into the separate reaches of the project. Table 18 below summarizes the special status species that are addressed in this document, including their status, their general habitat requirements, and their potential to occur in the study area.

Table 18. Special Status Species with the Potential to Occur in the Study Area.

Common Name	Scientific Name	Status	Habitat	Potential for Occurrence
Invertebrates				
Valley Elderberry Longhorn Beetle	*Desmocerus californicus dimorphus*	Federal Threatened/ State Endangered	Riparian forest in the Central Valley. Elderberry shrubs are the host plant for this species.	Known to occur throughout the study area.
Vernal pool fairy shrimp	*Branchinecta lunchi*	Federal Threatened	Vernal pools in grass or mud-bottomed swales, earth sumps, or basalt flow depression pools in unplowed grasslands.	Occurs in vernal pool habitat near Magpie Creek.
Vernal pool tadpole shrimp	*Lepidurus packardii*	Federal Endangered	Vernal pools and swales containing clear to highly turbid water.	Occurs in vernal pool habitat near Magpie Creek.
Reptiles				
Giant Garter Snake	*Thamnophis gigas*	Federal/State Threatened	Rivers, Streams, Marshes, Ricefields	May occur in small canals adjacent to levees or in rice fields.
Birds				
Western Yellow-Billed Cuckoo	*Coccyzus americanus occidentalis*	Federal Threatened	Riparian forests with dense deciduous trees and shrubs	Unlikely to occur in the study area.
Swainson's Hawk	*Buteo swainsoni*	State Threatened	Open grasslands, prairies, farmlands, and deserts that have some trees for nesting.	Nesting sites have been observed recently within the study area.
Burrowing Owl	*Athene cunicularia*	State Species of Concern	Grasslands, rangelands, agricultural areas, deserts. Nest in burrows on levee slopes.	May occur in the study area.
White-tailed Kite	*Elanus leucurus*	State Fully Protected	Low foothills or valley areas with valley or live oaks, riparian areas, and marshes near open grasslands for foraging.	Known to occur in the study area.

Common Name	Scientific Name	Status	Habitat	Potential for Occurrence
Purple Martin	*Progne subis*	State Species of Concern	Nests in abandoned woodpecker holes in oaks, cottonwoods, and other deciduous trees in a variety of wooded and riparian habitats. Also nests in vertical drainage holes under elevated freeways and highway bridges.	May occur in the study area.
Fish				
Sacramento River winter-run Chinook salmon	*Oncorhynchus tshawytscha*	Federal/State Endangered	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, and tributaries, and in the Delta.	Occurs in the Sacramento River.
Central Valley spring-run Chinook salmon	*Oncorhynchus tshawytscha*	Federal/State Threatened	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, and tributaries, and in the Delta.	Occurs in the Sacramento and American Rivers.
Central Valley fall-/late fall–run Chinook salmon	*Oncorhynchus tshawytscha*	Federal/State Species of Concern	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, and tributaries, and in the Delta.	Occurs in the lower Sacramento and American Rivers, and NEMDC.
Central Valley Steelhead	*Oncorhynchus mykiss*	Federal Threatened	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, and tributaries, and in the Delta.	Occurs in the Sacramento and American Rivers, Dry/Robla Creek, and NEMDC.
North American Green sturgeon	*Acipenser medirostris*	Federal Threatened	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta.	Occurs in the lower Sacramento River.
Delta Smelt	*Hypomesus transpacificus*	Federal/State Endangered	Requires cold, freshwater-saltwater mixing zone, spawns in freshwater.	Occurs in the Sacramento River.

Common Name	Scientific Name	Status	Habitat	Potential for Occurrence
Longfin Smelt	*Spirinchus thaleichthys*	State Threatened	Requires cold, pure freshwater to pure seawater, spawns in freshwater.	Occurs in the Sacramento River below Isleton.
Sacramento splittail	*Pogonichthys macrolepidotus*	State species of special concern	Spawning takes place among submerged and flooded vegetation in sloughs and the lower reaches of rivers.	Occurs in the Yolo Bypass when flooded during spawning
Hardhead	*Mylopharodon conocephalus*	State species of special concern	Reside in low to mid-elevation streams and prefer clear, deep pools and runs with slow velocities.	Occurs in the Sacramento and American Rivers.
River lamprey	*Lampetra ayresi*	State species of special concern	Adults live in the ocean and migrate into fresh water to spawn. Juveniles rear in freshwater.	Occurs in the Sacramento and American Rivers.
Plants				
Sanford's Arrowhead	*Sagittaria sanfordii*	State Rare/Endangered	Assorted shallow freshwater marshes and swamps; generally occurs in standing or slow-moving freshwater ponds, marshes, ditches, and sloughs from 0 to 2,000 feet in elevation. Blooms May–October.	Known to occur in Arcade Creek
Wooly Rose-mallow	*Hibiscus lasiocarpos*	State Rare/Endangered	Freshwater marshes and swamps, generally found on wetted river banks and low peat islands in sloughs; known from the Delta watershed, also recorded in riprap on levee slopes, from 0 to 390 feet in elevation. Blooms June–November.	May occur in the study area.

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle (VELB) is Federally listed as threatened. These beetles are patchily distributed throughout the remaining riparian forests of the Central Valley. VELB require elderberry shrubs *(Sambucus sp.)* for reproduction and survival, and are rarely seen because they spend most of their life cycle as larvae within the stems of the shrubs. It appears that in order to function as habitat for the VELB, host elderberry shrubs must have stems that are 1.0 inch or greater in diameter at ground level. Use of the shrubs by the beetle is rarely apparent; often the only exterior evidence is an exit hole created by the larva just before the pupal stage.

Documented occurrences of VELB are present along both the American and Sacramento Rivers. The Corps conducted surveys in 2012 of the levee systems within the study area. The survey area consisted of the levee structures and 15 feet on both the waterside and landside; where access was available. The survey located elderberry clusters, however, actual shrubs, stem size, nor exit hole presence were not determined. The surveys found the greatest amount of clusters on the south side of the American River and determined that both basins contain shrubs. All shrubs are considered to be in a riparian zone except those located on the landside of the levees.

Vernal Pool Fairy Shrimp

The vernal pool fairy shrimp lives in vernal pools and swales containing clear to turbid water and grassy bottoms in unplowed grasslands. The shrimp is ecologically dependent on seasonal fluctuations in its habitat, such as presence or absence of water during specific times of the year, duration of water, temperature, and quantities of dissolved oxygen (USFWS 1992b).

Vernal pool habitat historically extended throughout the Central Valley. Vernal pools are in danger due to a variety of human-caused activities, including urban development, water supply and flood control activities, and conversion of land to agricultural use. Habitat loss occurs from direct destruction and modification of pools by filling, grading, discing, leveling, and other activities. Vernal pools can also be indirectly impacted when modifications of the surrounding uplands alter the vernal pool watershed (USFWS 1992b).

There are 32 known populations of the vernal pool fairy shrimp, extending from the Stillwater Plain in Shasta County through the Central Valley to Pixley in Tulare County. In addition, the shrimp occur along the central Coast Range from northern Solano County to Pinnacles National Monument in San Benito County. In the study area, vernal pools are known to occur near Magpie Creek, and there are recorded occurrences of vernal pool fairy shrimp in the CNDDB from 1995 (CNDDB 2015).

Vernal Pool Tadpole Shrimp

The vernal pool tadpole shrimp lives in vernal pools and swales containing clear to highly turbid water. The shrimp is ecologically dependent on seasonal fluctuations in its habitat, such as presence or absence of water during specific times of the year, duration of water, temperature, and quantities of dissolved oxygen (USFWS 1992b).

Vernal pool habitat historically extended throughout the Central Valley. Vernal pools are in danger due to a variety of human-caused activities, including urban development, water supply and flood control activities, and conversion of land to agricultural use. Habitat loss occurs from direct destruction and modification of pools by filling, grading, discing, leveling, and other activities. Vernal pools can also be indirectly impacted when modifications of the surrounding uplands alter the vernal pool watershed (USFWS 1992b).

There are 18 known populations of vernal pool tadpole shrimp in the Central Valley, ranging from east of Redding in Shasta County south to the San Luis National Wildlife Refuge in Merced County. In the study area, vernal pools are known to occur near Magpie Creek, and there are recorded occurrences of vernal pool tadpole shrimp in the CNDDB from 1998 (CNDDB 2015).

Giant Garter Snake

Giant garter snake (GGS) is Federally and State-listed as threatened. This species is endemic to the basins and flood plains of the Sacramento and San Joaquin Valleys. Generally, GGS inhabits rice fields, irrigation supply and drainage canals, freshwater marshes, sloughs, ponds, and other aquatic habitats. The primary cause of decline, loss, or degradation of aquatic habitat caused by agricultural development, has been compounded by the loss of upland refugia and bankside vegetation cover (Thelander 1994).

Rice fields and their adjacent irrigation and drainage canals and ditches serve an important role as aquatic habitat for the snakes. During the summer, some snakes use the flooded rice fields as long as their prey is present in sufficient densities. In late summer, rice fields provide important nursery areas for newborns. In late summer/fall, water is drained from the rice fields and the snakes prey items become concentrated in the remaining pockets of standing water, which allow the snakes to gorge before their period of winter inactivity (USFWS 1999). It appears that the majority of the snakes move back into the canals and ditches as the rice fields are drained, although a few may overwinter in the fallow fields, where they hibernate within burrows in the small berms separating the rice checks (Hansen 1998). The Sacramento Bypass widening area contains rice fields and adjacent irrigation canals which provide habitat for GGS.

The width of uplands used by the snake varies considerably. However, the USFWS considers 200 feet to be the width of upland vegetation needed to provide adequate habitat for giant garter snake along the borders of aquatic habitat (USFWS 1997).

The East Side Tributaries creeks (Arcade, Dry/Robla, and Magpie) have GGS habitat, however, there is no connectivity to rice fields which is a primary component of GGS habitat. The closest rice fields are in the Natomas Basin which connects to the East Side Tributaries via the NEMDC. Additionally, these creeks do not contain year round water, which is component for possible snake presence. The NEMDC could potentially contain GGS habitat as this waterway is adjacent to the rice fields within the Natomas Basin. Large waterways, such as the Sacramento and American Rivers, do not provide habitat for giant garter snakes.

Western Yellow-Billed Cuckoo

Western yellow-billed cuckoo is Federally listed as threatened. The cuckoo is typically found in riparian forests with dense deciduous trees and shrubs. Over the last 100 years, western cuckoo population declined dramatically due to extensive loss of suitable breeding habitat, primarily riparian forests and associated bottomlands dominated by willow (Salix spp.), cottonwood (Populus spp.), or mesquite (Prosopis spp.) (Gaines and Laymon 1984, Laymon and Halterman 1987, Hughes 1999, Halterman et al. 2001). Once considered a common breeder in California, by 1940 the Yellow-billed Cuckoo suffered severe population reduction and by 1987 was estimated to occupy only 30 percent of its historical range (Laymon and Halterman 1987).

Nesting usually occurs between late June and late July, but can begin as early as late May and continue until late September (Hughes 1999). Nests consist of a loose platform of twigs, which are built by both sexes and take one to two days to build (Hughes 1999), though occasionally the nest of another species is used (Jay 1911, Bent 1940, Payne 2005).

There are no recent CNDDB occurrences in the vicinity of the action area, but migrant individuals are likely to pass through the area in transit to breeding sites along the Sacramento River north of Colusa. Cuckoos are unlikely to occur in the study area, although potential dispersal and foraging habitat is present in the American River Parkway and along the Sacramento River.

Swainson's Hawk

Swainson's hawk is Federally listed as a species of concern protected under the Migratory Bird Treaty Act and State listed as threatened. As many as 17,000 Swainson's hawk pairs may have nested in California at one time (DFG 1994). According to the 2005 California Department of Fish and Game (CDFG) survey, an estimated 1,830 pairs of nesting hawks were found in the California Central Valley. Swainson's hawks typically occur in California only during the breeding season (March through

September) and winter in Mexico and South America. The Central Valley population migrates only as far south as central Mexico. Swainson's hawks begin to arrive in the Central Valley in March; nesting territories are usually established by April, with incubation and rearing of young occurring through June (Estep 2003).

Swainson's hawks are found most commonly in grasslands, low shrublands, and agricultural habitats that include large trees for nesting. Nests are found in riparian woodlands, roadside trees, trees along field borders, and isolated trees. Corridors of remnant riparian forest along drainages contain the majority of known nests in the Central Valley (England, Bechard, and Houston 1997; Estep 1984; Schlorff and Bloom 1984). Nesting pairs frequently return to the same nest site for multiple years and decades.

Prey abundance and accessibility are the most important features determining the suitability of Swainson's hawk foraging habitat. In addition, agricultural operations (*e.g.*, mowing, flood irrigation) have a substantial influence on the accessibility of prey and thus create important foraging opportunities for Swainson's hawk. Swainson's hawks feed primarily on small rodents, but also consume insects and birds. Although the most important foraging habitat for Swainson's hawks lies within a 1-mile radius of each nest (City of Sacramento, Sutter County, and TNBC 2003), Swainson's hawks have been recorded foraging up to 18.6 miles from nest sites (Estep 1989).

Within the study area, most of the nests are located along the Sacramento River, Sacramento Bypass, and Yolo Bypass, where foraging habitat is close to the levee system. Because of the urban development adjacent to both sides of the American River, hawks are less likely to nest in this area where foraging areas and food is not as abundant as it is abundant in undeveloped or farmland areas.

Burrowing Owl

Western burrowing owls are a California species of special concern and are protected under the MBTA. Western burrowing owls were formerly a common permanent resident throughout much of California, but population declines became noticeable by the 1940s and have continued to the present. Farming has taken a major toll on western burrowing owl populations and their habitat by destroying nesting burrows and exposing breeders and their young to the toxic effects of pesticides (Haug et al. 1993).

Western burrowing owls prefer open, dry, short grassland habitats with few trees and are often associated with burrowing mammals such as California ground squirrels. They occupy burrows, typically abandoned by ground squirrels or other burrowing mammals, but could also use artificial burrows such as abandoned pipes, culverts, and debris piles (CDFG 1995; Haug et al. 1993). Prey includes arthropods, amphibians, small reptiles, small mammals, and birds, particularly horned larks (Haug et al. 1993).

The breeding season usually extends from late February through August. Western burrowing owls often nest in roadside embankments, on levees, and along irrigation canals. This species is more diurnal than most owls and can often be observed during the day standing outside the entrance to its burrow (Haug et al. 1993).

There are numerous nesting occurrences within 10 miles of the study area. Within the study area, burrowing owls could nest in areas with non-native grasslands intermixed with barren ground, such as in some portions of the American River Parkway and the East Side Tributaries. The levees provide suitable nesting habitat where ground squirrel burrows are present and open areas near suitable nesting habitat provide suitable foraging habitat. All levee reaches within the study area have potential to support nesting and foraging of this species.

White-Tailed Kite

The white-tailed kite is protected under the MBTA and is a fully protected species under the California Fish and Game Code. White-tailed kites were threatened with extinction in North America during the early 20th century. Populations recovered throughout its range in the United States from small populations that survived in California, Texas, and Florida. However, since the 1980s, many white-tailed kite populations have been declining, apparently because of loss of habitat and increased disturbance of nests (Dunk 1995).

The breeding season generally extends from early February through early August. White-tailed kites usually nest in large native trees, although non-native trees also are occasionally used. Nest trees are generally at the edge of wooded habitat next to open fields. Large trees in areas that have been developed may also be used, although the trees need to be close to open fields for foraging (Dunk 1995). White-tailed kites feed primarily on small mammals including voles, pocket mice, and harvest mice.

CNDDB (2013) records indicate white-tailed kite nesting occurrences within 10 miles of the study area. Large trees in and adjacent to the study area provide suitable nesting habitat, and agricultural fields and other open areas provide suitable foraging habitat. All levee reaches in the study area provide suitable nesting and foraging habitat for this species.

Purple Martin

Purple martin is a California species of special concern. This species breeds locally along the eastern slopes of the Cascade Mountains of California south to extreme southwestern California. The species winters in South America in lowlands east of the Andes south to northern Argentina (rarely) and southern Brazil. Purple martin is the largest swallow in North America and among the largest in the world. These martins inhabit montane forest or Pacific lowlands, restricted to areas with dead snags containing woodpecker holes, generally patchy and local in occurrence. This species is reported to

typically avoid deserts and grasslands (Brown 1997).

Purple martins are diurnal, aerial feeder that feed on insects at higher elevations than other swallows, sometimes up to 490 feet. Because of the height of foraging, individuals are rarely observed foraging, with the exception being late afternoons and near dusk when birds feed low and close to nest sites. The species presumably ranges over areas immediately surrounding nest site, although there is no information on typical travel distance while foraging. Cold, rainy weather in spring forces purple martins, especially migrants, to feed low over ponds and lakes, apparently in pursuit of aquatic insects along water surface (Brown 1997).

Suitable nesting habitat for this species occurs in the riparian forest and woodland areas throughout the study area. The nearest CNDDB (2009) occurrence for this species is for a colony nesting in weep holes under the I-5 Freeway overpass at I Street within 1 mile of the Sacramento River. It is estimated that between 21 to 29 pairs of purple martins nest at this location. Numerous other occurrences are reported within a 10-mile radius for colonies nesting under freeway or street overpasses (CNDDB 2013).

Sacramento River Winter-Run Chinook Salmon

The Sacramento River winter-run Chinook salmon was listed as threatened under the Federal ESA on August 4, 1989 (NMFS 1989). NMFS subsequently upgraded the Federal listing to endangered on January 4, 1994 (NMFS 1994). NMFS designated critical habitat for Sacramento River winter-run Chinook salmon on June 16, 1993 (NMFS 1993a).

Winter-run Chinook salmon spend 1 to 3 years in the ocean. Adult winter-run Chinook salmon leave the ocean and migrate through the Delta into the Sacramento River from December through July with peak migration in March (Table 19). Adults spawn from mid-April through August (Moyle 2002). Egg incubation continues through October. The primary spawning habitat in the Sacramento River is above Red Bluff Diversion Dam at RM 243, although spawning has been observed downstream as far as RM 218 (NMFS 2001). Downstream movement of juvenile winter-run Chinook salmon begins in August, soon after fry emerge. The peak abundance of juveniles moving downstream at Red Bluff occurs in September and October (Vogel and Marine 1991). The peak period of juvenile emigration through the ARCF GRR study area into the Delta generally occurs between January and April (NMFS 1997) (Table 19). Differences in peak emigration periods between these two locations suggest that juvenile winter-run Chinook salmon may exhibit a sustained residence in the upper or middle reaches of the Sacramento River before entering the lower Sacramento River and the Delta. Juvenile Chinook salmon move downstream from spawning areas in response to many factors, which may include inherited behavior, habitat availability, flow, competition for space and food, and water temperature. The numbers of juveniles that move and the timing of movement are highly variable. Storm events and their resulting high flows and turbidity appear to trigger downstream movement of substantial numbers of juvenile Chinook salmon.

Juvenile emigration (downstream migration) past the Red Bluff Diversion Dam (RM 242) begins in late July, peaks during September, and may extend through mid-March (NMFS 1997). The peak period of juvenile emigration through the lower Sacramento River and the project area into the Delta generally occurs between January and April (NMFS 1997) (Table 19). Differences in peak emigration periods between these two locations suggest that juvenile winter-run Chinook salmon may exhibit a sustained residence in the upper or middle reaches of the Sacramento River before entering the lower Sacramento River and the Delta. Although the location and extent of rearing in these lower or middle reaches is unknown, it is believed that the duration of fry presence in an area is directly related to the magnitude of river flows during the rearing period (Stevens 1989). However, the Yolo Bypass also provides significant outmigration passage during higher flow events. During winter in the Sacramento–San Joaquin system, juveniles rear on seasonally inundated floodplains. Sommer et al. (2001) found higher growth and survival rates of juvenile Chinook salmon reared on the Yolo Bypass floodplain, than those that reared in the mainstem Sacramento River.

Within the study area, the Sacramento River is considered to be critical habitat for winter-run Chinook salmon. Critical habitat includes the water column, river bottom, and adjacent riparian zone which fry and juveniles use for rearing (NMFS 2006b). The conservation value of critical habitat in the study area is high because it supports both recruitment and survival of juveniles and adults (NMFS 2006a). The American River, Sacramento River, NEMDC, and Dry/Robla Creeks are also considered to be essential fish habitat (EFH) for winter-run Chinook salmon.

Table 19. Assumed Life Stage Timing and Distribution of Special Status Fish Species.

Life Stage	Distribution	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Late Fall–Run Chinook Salmon													
Adult Migration	SF Bay to Upper Sac River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement and Rearing	Upper Sacramento River and Tributaries												
Fall-Run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River and Tributaries												
Spawning[1]	Upper Sacramento River and Tributaries												
Egg Incubation[1]	Upper Sacramento River and Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Spring-Run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Winter-Run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River												
Spawning	Upper Sacramento River												
Egg Incubation	Upper Sacramento River												
Juvenile Rearing (Natal Stream)	Upper Sacramento River to SF Bay												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement and Rearing	Upper Sacramento River to SF Bay												

Life Stage	Distribution	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Central Valley Steelhead													
Adult Migration	SF Bay to Upper Sacramento River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Rearing	Upper Sacramento River and Tributaries to SF Bay												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Delta Smelt													
Adult Migration	Delta												
Spawning]	Delta, Suisun Marsh												
Larval and Early Juvenile Rearing	Delta, Suisun Marsh												
Estuarine Rearing: Juveniles/Adults	Lower Delta, Suisun Bay												
Green Sturgeon													
Adult Migration	Delta to Upper Sacramento River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Movement and Rearing	Sacramento River and Tributaries to SF Bay												

Notes: SF Bay = San Francisco Bay.

[1] Spawning and incubation occurs from October to February in the Feather, American, and Mokelumne Rivers

Sources: Brown 1991; Wang and Brown 1993; U.S. Fish and Wildlife Service 1996; McEwan 2001; Moyle 2002; Hallock 1989; U.S. Army Corps of Engineers 2006.

Central Valley Spring-Run Chinook Salmon

The Central Valley spring-run Chinook salmon was Federally listed as threatened on September 16, 1999 (NMFS 1999). Their threatened status was reaffirmed in NMFS's final listing determination issued on June 28, 2005 (NMFS 2005a). Critical habitat for Central Valley spring-run Chinook salmon was designated by NMFS on September 2, 2005 (NMFS 2005b).

Adult spring-run Chinook salmon enter the mainstem Sacramento River from March through September, with the peak upstream migration occurring from May through June through the ARCF GRR study area (Yoshiyama et al. 1998). Adults generally enter tributaries from the Sacramento River between mid-April and mid-June (Lindley et al. 2006 as cited in NMFS 2006b). Spring-run Chinook salmon are sexually immature during upstream migration, and adults hold in deep, cold pools near spawning habitat until spawning commences in late summer and fall. Spring-run Chinook salmon spawn in the upper reaches of the mainstem Sacramento River and tributary streams (USFWS 1995), with the largest tributary runs occurring in Butte, Deer, and Mill Creek's (Yoshiyama et al. 1998). Spawning typically begins in late August and may continue through October. Juveniles emerge in November and December in most locations but may emerge later when water temperature is cooler. Newly emerged fry remain in shallow, low-velocity edgewater (CDFG 1998).

A small portion of an annual year-class of juvenile spring-run Chinook salmon may emigrate as post-emergent fry (less than 1.8 inches long) and reside in the Delta undergoing smoltification. However, most are believed to rear in the upper river and tributaries during winter and spring, emigrating as juveniles (more than 1.8 inches long). The timing of juvenile emigration from the spawning and rearing reaches can vary depending on tributary of origin and can occur from November through June through the ARCF GRR study area (Table 19). Rearing takes place in their natal streams, the mainstem of the Sacramento River, inundated floodplains (including the Sutter and Yolo bypasses), and the Delta. Downstream migration of yearlings typically coincides with the onset of the winter storm season, and migration may continue through March (CDFG 1998).

Critical habitat for spring-run Chinook salmon in the study area Sacramento River, American River, NEMDC, and Dry/Robla Creeks (NMFS 2006b). Critical habitat includes the stream channels and the lateral extent as defined by the ordinary high-water line or bank-full elevation. All reaches within the ARCF study area are considered to be EFH for spring-run Chinook salmon.

Central Valley Fall-/Late Fall–Run Chinook Salmon

Central Valley fall-/late fall–run Chinook salmon are currently the most abundant and widespread salmon runs in California (Mills et al. 1997), representing about 80% of the total Chinook salmon produced in the Sacramento River drainage (Kjelson et al. 1982). This species is not listed under the Federal ESA. On March 9, 1998, NMFS issued a proposed rule to list fall-run Chinook salmon as threatened (NMFS 1998a). However, on September 16, 1999, NMFS determined that the species did

not warrant listing (NMFS 1999). On April 15, 2004, NMFS classified Central Valley fall-/late fall–run Chinook salmon as a species of concern (NMFS 2004). However, EFH is designated for this species.

Adult fall-run Chinook salmon migrate into the Sacramento River and its tributaries through the ARCF GRR study area from June through December in mature condition and spawn from late September through December, soon after arriving at their spawning grounds (Yoshiyama et al. 1998). The spawning peak occurs in October and November. Emergence occurs from December through March, and juveniles migrate downstream to the ocean soon after emerging, rearing in fresh water for only a few months. Smolt outmigration typically occurs from March through July (Yoshiyama et al. 1998) (Table 19).

Late fall–run Chinook salmon migrate upstream before they are sexually mature, and hold near spawning grounds for 1 to 3 months before spawning. Upstream migration takes place from October through April through the ARCF GRR study area and spawning occurs from late January through April, with peak spawning in February and March (Yoshiyama et al. 1998). Fry emerge from April through June. Juvenile late fall–run Chinook salmon rear in their natal streams during the summer, and in some streams they remain throughout the year. Smolt outmigration can occur from November through May (Yoshiyama et al. 1998) (Table 19).

Critical habitat is not designated for fall-/late fall–run Chinook salmon, however EFH is designated for this species. EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All reaches within the ARCF GRR study area are considered to be EFH for fall-/late fall-run Chinook salmon.

Central Valley Steelhead

The Central Valley steelhead was Federally listed as threatened on March 19, 1998 (NMFS 1998b). The threatened status of Central Valley steelhead was reaffirmed in NMFS's final listing determination on January 5, 2006 (NMFS 2006a). Critical habitat for Central Valley steelhead was designated by NMFS on September 2, 2005 (NMFS 2005b).

Central Valley steelhead occur in the ARCF GRR study area, either as adults migrating upstream to their spawning habitat, or as juveniles rearing and migrating toward the ocean. Juvenile steelhead tend to use bank habitat more frequently than the main channel, because bank habitat provides increased protection, shade, and food.

Steelhead exhibit highly variable life history patterns throughout their range but are broadly categorized into winter and summer reproductive ecotypes. Winter steelhead are the most widespread reproductive ecotype and the only type currently present in Central Valley streams (McEwan and Jackson 1996). Winter steelhead become sexually mature in the ocean, enter spawning streams in summer, fall or winter, and spawn a few months later in winter or late spring (Meehan and Bjornn 1991; Behnke 1992). In the Sacramento River, adult winter steelhead migrate upstream during most months

of the year, beginning in July, peaking in September, and continuing through February or March (Hallock 1987). Spawning occurs primarily from January through March, but may begin as early as late December and may extend through April (Hallock 1987) (Table 19). Individual steelhead may spawn more than once, returning to the ocean between each spawning migration.

Juvenile steelhead rear a minimum of one and typically two or more years in fresh water before migrating to the ocean as smolts. Juvenile migration to the ocean generally occurs from December through August. The peak months of juvenile migration are January to May (McEwan 2001). The importance of main channel and floodplain habitats to steelhead in the lower Sacramento River and upper Delta is not well understood. Steelhead smolts have been found in the Yolo Bypass during the period of winter and spring inundation (Sommer 2002), but the importance of this and other floodplain areas in the lower Sacramento River and upper Delta is not yet clear.

Critical habitat for Central Valley steelhead includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-waterline or bank-full elevation (NMFS 2006b). There is no EFH designated for Central Valley steelhead.

Delta Smelt

Delta smelt was Federally listed as threatened on March 5, 1993 (USFWS 1993) and critical habitat was designated on December 19, 1994 (USFWS 1994). Delta smelt are endemic to the Sacramento–San Joaquin estuary and are found seasonally in Suisun Bay and Suisun Marsh. They typically are found in shallow water (less than 10 feet) where salinity ranges from 2 to 7 parts per thousand (ppt), although they have been observed at salinities between 0 and 18.4 ppt. Delta smelt have relatively low fecundity and most live for 1 year. They feed on planktonic copepods, cladocerans, amphipods, and insect larva (Moyle 2002).

Delta smelt are semi-anadromous. During their spawning migration, adults move into the freshwater channels and sloughs of the Delta between December and January. Spawning occurs between January and July, with peak spawning and potential presence in the ARCF GRR study area from April through mid-May (Moyle 2002) (Table 19). Spawning locations in the Delta have not been identified and are inferred from larval catches (Bennett 2005). Larval fish have been observed in Montezuma Slough; Suisun Slough in Suisun Marsh; the Napa River estuary; the Sacramento River above Rio Vista; and Cache, Lindsey, Georgiana, Prospect, Beaver, Hog, Sycamore, and Barker sloughs (Wang 1986, Moyle 2002, Stillwater Sciences 2006, and USFWS 1996). Spawning was also observed in the Sacramento River up to Garcia Bend (RM 51) during drought conditions, as a result of increased saltwater intrusion that moved delta smelt spawning and rearing farther inland (Wang and Brown 1993).

There is no EFH designated for delta smelt. Critical habitat for delta smelt consists of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the contiguous waters in the Delta (USFWS 1994). Critical habitat for delta smelt is designated in the following California counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo (USFWS 2003). Critical habitat in the ARCF GRR study area includes the Sacramento River up to the I Street Bridge and the Yolo Bypass just above Interstate 80 at the railroad tracks. Primary constituent elements of critical habitat determined to be essential to the conservation of the species include: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (USFWS 2006a).

Green Sturgeon

The Sacramento River supports the southernmost spawning population of green sturgeon (Moyle 2002). On April 7, 2006, NMFS determined that the southern distinct population segment (DPS) of green sturgeon was threatened under the Federal ESA (NMFS 2006c). On October 9, 2009, NMFS (74 CFR 52300) designated critical habitat for the green sturgeon southern DPS throughout most of its occupied range. Green sturgeon were classified as a Class 1 Species of Special Concern by CDFG in 1995 (Moyle et al. 1995). Class 1 Species of Special Concern are those that conform to the state definitions of threatened or endangered and could qualify for addition to the official list. On March 20, 2006, emergency green sturgeon regulations were put into effect by CDFG requiring a year-round zero bag limit of green sturgeon in all areas of the state (CDFG 2006).

The southern DPS has a single spawning population in the Sacramento River (NMFS 2005d). Adults typically migrate upstream into rivers between late February and late July. Spawning occurs from March to July, with peak spawning from mid-April to mid-June in the upper Sacramento River and lower Feather River outside of the ARCF GRR study area (Table 19). Green sturgeon are believed to spawn every 3 to 5 years, although recent evidence indicates that spawning may be as frequent as every 2 years (NMFS 2005c). Little is known about the specific spawning habitat preferences of green sturgeon. Adult green sturgeon are believed to broadcast their eggs in deep, fast water over large cobble substrate, where the eggs settle into the interstitial spaces (Moyle 2002). Spawning is generally associated with water temperatures from 46 to 57 degrees Fahrenheit (°F). In the Central Valley, spawning occurs in the Sacramento River upstream of Hamilton City, perhaps as far upstream as Keswick Dam (Adams et al. 2002).

Little is known about movements, habitat use, and feeding habits of juvenile rearing green sturgeon. Green sturgeon juveniles have been salvaged at the State and Federal fish collection facilities in every month, indicating that they are present in the Delta and possibly in the lower Sacramento River within the project area year-round (Table 19). Juveniles and adults are reported to feed on benthic invertebrates, including shrimp and amphipods, and small fish (NMFS 2005c).

There is no EFH designated for green sturgeon. Designated critical habitat for the southern DPS of green sturgeon includes the Sacramento River downstream of Keswick Dam, including through the ARCF GRR study area; portions of the Yolo Bypass; the legal Delta, excluding Five Mile Slough, Seven Mile Slough, Snodgrass Slough, Tom Paine Slough and Trapper Slough; and San Francisco, San Pablo, and Suisun bays.

Sanford's Arrowhead

Sanford's Arrowhead is listed on the California Native Plant Society's rare plants list. It occurs in shallow, standing, fresh water and sluggish waterways within marshes, swamps, ponds, vernal pools and lakes, reservoirs, sloughs, ditches, canals, streams and rivers at elevations from 10 to 2,000 feet. It typically flowers from late May to October.

There is one documented occurrence of Sanford's arrowhead in the Arcade Creek channel, between Norwood Avenue and the railroad bridge to the west (CNDDB 2015). This species was also observed in a seasonal wetland located along the waterside of the east NEMDC levee.

Wooly Rose-Mallow

Wooly rose-mallow is listed on the California Native Plant Society's rare plants list. Wooly Rose Mallow is an upright, hairy perennial. Its preferred habitat is moist roadside ditches, wet fields and moist disturbed sites from 0 to 390 feet in elevation. It typically flowers from June to November. This species is known to occur in the Delta watershed, and has been previously recorded growing in riprap on levee slopes south of the study area.

3.8.2 Methodology and Basis of Significance

Methodology

The evaluation of potential effects on special-status species from each project alternative is based on the results of field surveys, review of existing documentation, coordination with USFWS and NMFS, and the use of the Standard Assessment Methodology (SAM) model. Surveys of the study area were conducted in 2011 by Corps staff. The surveys included the levees slopes, landside levee toe and out 15 feet, and waterside levee toe and out 30 feet. Surveys included tree size, species, health, location, elderberry shrubs general size and location. For this analysis, the project alternatives were determined to have a significant impact on special-status species if project activities would have a substantial adverse effect, either directly or through habitat modification, on any species identified as candidate, sensitive, or special species in local or regional plans or policies, or regulations, or by DFW, USFWS, or NOAA Fisheries.

The SAM analysis was conducted at a feasibility level of design; specific project designs will be developed under a future PED phase. In the absence of more specific designs, this SAM analysis was developed using a set of "reasonable worst-case" parameters. The parameters were developed by evaluating the applicability of past levee repair designs to the project reaches. Past levee repairs were conducted under the SRBPP within each of the sub-reaches (Corps 2008, Corps 2013). A Vegetation Variance Request (VVR) was assumed to be in place for the Sacramento and American River reaches. The Corps will attempt to obtain an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The Corps will be complying with the ETL on the American River via a SWIF. The VVR is not assumed to apply to the Sacramento Bypass. Appendix B of the ARCF GRR BA includes the SAM report and the results from the SAM modeling.

Basis of Significance

Effects on special status-species were considered significant if an alternative would result in any of the following:

- Substantial direct or indirect reduction in growth, survival, or reproductive success of species listed or proposed for listing as threatened or endangered under the Federal or State ESA.
- Substantial direct mortality, long-term habitat loss, or lowered reproductive success of Federally or State-listed threatened or endangered animal or plant species or candidates for Federal listing.
- Direct or indirect reduction in the growth, survival, or reproductive success of substantial populations of Federal species of concern, State-listed endangered or threatened species, plant species listed by the California Native Plant Society (CNPS), or species of special concern or regionally important commercial or game species.
- Have an adverse effect on a species' designated critical habitat.

3.8.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. There would be no construction related affects to special status species, however effects to these species associated with flood fighting could be significant. Flood fighting is usually performed by placing large rock along the levee slope to stop erosion and prevent levee failure and loss of lives and property.

The placement of rock would prevent or impede future growth of trees and vegetation on the levee slopes, which would impact special status fish species from the loss of SRA habitat. Emergency clean-up and earth-moving activities could also result in an increase in sediment and turbidity that adversely affect migration, spawning or rearing habitat for special status fish species. Given the unpredictable nature of emergency clean-up activities, it is likely that implementation of BMPs and measures to reduce effects on fish would not be possible.

High flows in the American River would have a large impact on the American River Parkway as the berms disappear from continued high flows against erodible material, which could eventually cause a levee break. The timeframe for which the berms would erode is unknown because it is impossible to determine how much water will pass through the system or predict potential future flood events. The banks along the American River are very erosive and without some kind of erosion control measures would continue to erode during high flows. As the banks of the river erode, critical habitat would be lost, including SRA habitat, and the levees could fail. It is likely that in order to save the levee structures, flood fight activities would occur during a high flow emergency response. All of these effects could result in significant direct effects to listed species, including mortality, long-term habitat loss, or lack of reproductive success.

All of these effects would be considered significant; however, given the uncertainty of the occurrence or magnitude of such an event, potential effects on special status species cannot be quantified based on available information.

3.8.4 Alternative 1 – Improve Levees

Valley Elderberry Longhorn Beetle

Within the surveyed study area, approximately 250 shrubs were located along the American River Parkway and 50 shrubs were located along the Sacramento River. Prior to project construction, a qualified biologist would conduct focused surveys of elderberry shrubs within 100 feet of the project area for construction in accordance with the USFWS guidelines. All elderberry shrubs with potential to be affected by project activities would be mapped and surveyed to determine the size of the stems on each shrub, location of shrubs to riparian habitat, and presence of exit holes.

Direct effects to valley elderberry longhorn beetle may occur if elderberry shrubs are incidentally damaged by construction personnel or equipment. Since the project would occur over a 10 year period and construction would occur during beetle flight season, there could be direct mortality caused by construction activities. Elderberry shrubs that cannot be avoided would be transplanted between November and mid-February when the plants are dormant. Transplanting procedures will comply with the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle, USFWS, 9 July 1999*.

Potential impacts due to damage or transplantation include direct mortality of beetles and/or disruption of their lifecycle.

Temporal loss of habitat may occur due to transplantation of elderberry shrubs. Although compensation measures include restoration and creation of habitat, mitigation plantings would likely require one or more years to become large enough to provide supporting habitat. Furthermore, associated riparian habitats may take several decades to reach their full value.

As a result, under Section 7 of the ESA, Alternative 1 may affect, and is likely to adversely affect the VELB. Compensation for affects to these shrubs and the beetle are discussed below in Section 3.8.6. With the implementation of the avoidance, minimization, and compensation measures discussed below, impacts to VELB would be less than significant.

Operation and Maintenance

As part of long-term O&M, elderberry shrubs will be trimmed by the three levee maintenance districts. Table 20 describes the maximum amount of elderberry acreage that will be trimmed each year as a result of O&M. Trimming consists of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. Up to a third of a shrub will be trimmed in a single season. Trimming will occur between November 1 and March 15. Loss of habitat will be offset through the development of a conservation area designed in accordance with the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle, USFWS, 9 July 1999*. Each year the local maintaining authority will document the amount of valley elderberry longhorn beetle habitat that they have trimmed and report that number to the Corps to ensure compliance with the Biological Opinion (Appendix J). If the local maintaining agency has a need to exceed the amount of valley elderberry longhorn beetle habitat which needs to be trimmed or affected due to routine maintenance then they will request the Corps reinitiate consultation on this biological opinion for those actions. With the implementation of the mitigation discussed above, O&M activities would result in less than significant impacts to VELB.

Table 20. O&M Elderberry Shrub Effects and Compensation.

O&M Agency	Annual Acreage Trimmed[1]	Life of Project Acreage[2]
American River Flood Control District	0.5 acre	25 acres
Maintenance Area 9	0.2 acre	10 acres
City of Sacramento	0.1 acre	5 acres

[1] Acreage was estimated based on a measurement of 0.009-acre per every 1/3rd of a shrub trimmed.

[2] Life of project is estimated to be 50 years.

Vernal Pool Fairy Shrimp

CNDDB records include historical occurrences of vernal pools and fairy shrimp in the vicinity of the Magpie Creek area. There is approximately 0.25 acre of land within the construction footprint of the new levee and floodwall that could potentially include vernal pool habitat. This 0.25 acre could be adversely affected from ground disturbing activities, operation of construction vehicles, by construction of the new levee and maintenance road, or due to the alteration of the natural flows of the area due to construction of the new levee.

Prior to initiation of any construction activities, field surveys and a wetland delineation would occur to verify the occurrence of vernal pools in the construction footprint and to determine if any nearby vernal pools could be indirectly affected by construction. If any additional vernal pools were to be impacted, consultation would be reinitiated at that time to determine appropriate mitigation measures.

The land being acquired on the east side of Raley Boulevard to create a permanent flood basin is in an area with historical occurrences of vernal pools and fairy shrimp. While this land is being acquired as a part of project construction, no construction would occur on the site, and the land would be protected in perpetuity. Indirectly, acquisition of this property would allow for the protection of the vernal pool habitat on this land, and the maintenance of the land to allow for vernal pools to thrive. As a result, creation of the flood basin would have positive impacts to the vernal pool fairy shrimp by allowing for long-term protection of vernal pool habitat. As a result, it is anticipated that effects to vernal pool fairy shrimp would be less than significant, with the implementation of the mitigation discussed below. The proposed project may affect, but is not likely to adversely affect vernal pool fairy shrimp.

Vernal Pool Tadpole Shrimp

Impacts to vernal pool tadpole shrimp under Alternative 1 would be consistent with what was described above for vernal pool fairy shrimp. These impacts would be less than significant, with the implementation of the mitigation discussed below. The proposed project may affect, but is not likely to adversely affect vernal pool fairy shrimp.

Giant Garter Snake

Effects to GGS under Alternative 1 are not likely to result from construction activities along the East Side Tributaries. The East Side Tributaries (NEMDC, Magpie Creek, and Arcade Creek) have some potential GGS habitat, however, the creeks in this area lack year round water and connectivity to rice fields, a major component of GGS habitat. The closest rice fields are about 5 miles away above a pump plant located on the NEMDC just above Dry/Robla Creek. Additionally, Arcade Creek and NEMDC both have segments that include large cover vegetation that would make them undesirable for GGS.

As such, the project actions are unlikely to result in long-term habitat losses to the giant garter snake, as long as the applicable mitigation and compensation measures are implemented. With the implementation of the avoidance and minimization measures, and post construction site restoration, the project actions may affect but are unlikely to adversely affect giant garter snakes. Additionally, construction would occur between May 1 and October 1 during the snake's active season, which minimizes impacts to the species due to activities occurring at a time when the snakes are capable of moving away from construction on their own, rather than during their hibernation period. With the implementation of the avoidance, minimization, and compensation measures discussed below, impacts to GGS would be reduced to less than significant. Compensation for effects to GGS habitat is discussed below in Section 3.8.6.

Western Yellow-Billed Cuckoo

The project area is unlikely to support western yellow-billed cuckoo nesting habitat due to the narrow riparian corridors along the waterways, with the exception of the American River Parkway. However, migrant individuals are likely to pass through the area in transit to breeding sites along the Sacramento River north of Colusa. Overall, cuckoos are unlikely to occur in the action area, although potential dispersal and foraging habitat is present.

Prior to construction, surveys would be conducted to determine the presence of cuckoos within the project area in accordance with any required USFWS survey protocols and permits at the time of construction. If cuckoos are determined to be present, there is the potential for short term, temporary impacts during construction from dust, noise, and vibration. However, since construction would occur in the summer months when the cuckoo is nesting (June 1 through September 30), and cuckoos are unlikely to be nesting in the study area, these activities would not adversely effect the species.

Potential long-term effects to the cuckoo could result from the loss of 65 acres of riparian habitat in the footprint of the rock trench sites within the American River Parkway. For the American River, impacts to trees would be the width of the launchable rock trenches (currently proposed at approximately 40-feet wide) for a total of approximately 65 acres. This habitat is suitable nesting habitat for the yellow-billed cuckoo due to the significant width of the riparian corridor along the American River Parkway, ranging from approximately 75 feet in some of the more narrow stretches to over 1,000 feet in other locations, however there are no records of the cuckoo nesting in this area. The Corps would compensate for riparian vegetation removed as a result of construction within the Parkway and on-site to the maximum extent practicable. There would remain a significant temporal loss of riparian habitat for the cuckoo during their migration, however in time it is anticipated that with the implementation of the compensation proposed by the Corps, the riparian corridor would recover and would provide a suitable level of habitat for the cuckoo long-term.

Additionally, approximately 110 acres of riparian habitat would be impacted along the Sacramento River; however the Sacramento River's riparian corridor is very narrow (approximately 100 feet wide in most locations) and would not likely provide quality habitat for the cuckoo, who require a minimum of 20 hectares of riparian corridor to nest. However, they are expected to use this area as a migration corridor.

Short term effects to Western yellow-billed cuckoo under Alternative 1 would be significant, due to the temporal loss of nesting habitat along the waterways while the new trees grow at the mitigation sites. However, with the implementation of compensation for the loss of nesting trees, when the new plantings reach the same habitat values as the trees removed as part of construction, the long term effects would be less than significant.

Swainson's Hawks

It is estimated that approximately 175 acres of riparian habitat used by Swainson's hawk for roosting and nesting could be affected by project construction, consistent with the discussion for Western yellow-billed cuckoo above,. Any trees removed would be mitigated, however, there would be a significant impact due to the temporal loss of habitat while the new trees grow. Additionally, approximately 2.5 acres of non-native grassland intermixed with barren ground would be removed or disturbed as a result of construction activities at levees. Much of this habitat is within the Sacramento urban area, where Swainson's hawks nest and forage along the American and Sacramento Rivers. Prior to construction activities, hawk surveys would be conducted within the study area to determine where potential nest sites. The surveys would be conducted annually in close proximity to construction locations and within one-half mile of any anticipated construction. If any hawks are found, coordination with the resource agencies would occur and appropriate avoidance and minimization measures would be established prior to the start of construction. The potential measures that could be implemented are discussed in Section 3.8.6 below. Short term effects to Swainson's hawks under Alternative 1 would be significant, due to the temporal loss of nesting habitat along the waterways while the new trees grow at the mitigation sites. However, with the implementation of compensation for the loss of nesting trees, when the new plantings reach the same habitat values as the trees removed as part of construction, the long term effects would be less than significant.

Burrowing Owl

Construction activities, including grading and clearing activities within or adjacent to potential burrowing owl habitat, could result in nesting failure, death of nestlings, or loss of eggs. In addition, the short-term loss of approximately 175 acres of riparian habitat on the landside of the levees that could support burrowing owl nesting and foraging could result in significant effects to this species. However, with the implementation of the mitigation measures discussed in Section 3.8.6 below, construction activities would result in less than significant impacts to burrowing owls.

During post-construction levee maintenance activities and maintenance of mitigation plantings, there could be indirect effects to burrowing owls. Driving on dirt roads in close proximity to habitat could disturb the owl due to vibration and dust. However, O&M activities following construction are expected to be consistent with existing O&M practices, so any impacts would likely be consistent with the existing condition. Additionally, these activities would be short-term and the resulting impacts would be temporary and less than significant.

White-Tailed Kite

Construction activities conducted during nesting season, including vegetation removal, could significantly impact the white-tailed kite by removing nesting habitat or causing the species to abandon any active nests. In addition, the short-term loss of approximately 175 acres of riparian habitat on the landside of the levees that could support white-tailed kite nesting and foraging could result in significant effects to this species. With the implementation of the mitigation measures discussed in Section 3.8.6 below, construction activities would result in less than significant impacts to white-tailed kites.

O&M activities following construction could cause noise and physical disturbance to white-tailed kites. However, O&M activities following construction are expected to be consistent with existing O&M practices, so any impacts would likely be consistent with the existing condition. Additionally, these activities would be short-term and the resulting impacts would be temporary and less than significant.

Purple Martin

Construction activities conducted during nesting season, including vegetation removal, could significantly impact the purple martin by removing nesting habitat or causing the species to abandon any active nests. In addition, the short-term loss of approximately 175 acres of riparian habitat on the landside of the levees that could support purple martin nesting and foraging could result in significant effects to this species. With the implementation of the mitigation measures discussed in Section 3.8.6 below, construction activities would result in less than significant impacts to purple martins.

O&M activities following construction could cause noise disturbance and physical disturbance to purple martins. However, O&M activities following construction are expected to be consistent with existing O&M practices, so any impacts would likely be consistent with the existing condition. Additionally, these activities would be short-term and the resulting impacts would be temporary and less than significant.

Winter-Run Chinook Salmon

Construction would occur on approximately 80,000 linear feet of waterside habitat; however, a vegetation variance is included as part of the alternatives and large vegetation would remain in place. Also included is a planting berm which would be planted with species that provide additional habitat for fish species once established (see Figures 11 through 13). Construction activities are not likely to affect winter-run adults because construction will avoid the primary migration period (December through July), will be restricted to the channel edge, and will include implementation of the avoidance and minimization measures described in Section 3.8.6. Winter-run Chinook salmon do not spawn in the study area. Therefore, no construction-related effects on winter-run Chinook salmon spawning or spawning habitat will occur.

Implementation of the bank erosion protection measures may result in adverse effects to juvenile and smolt winter-run Chinook salmon, their critical habitat, and EFH. Construction activities that increase noise, turbidity, and suspended sediment may disrupt feeding or temporarily displace fish from preferred habitat. Physical damage or harassment to listed fish species would be low during the months of construction. Adults will not sustain any physical damage due to construction because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance that occurs during typical daylight construction hours. For the purpose of this study restricting in-water activities to an August 1 through November 30 work window (beginning on July 1 for sites upstream of RM 60) and implementing the avoidance and minimization measures described below will minimize, but not avoid, potential construction-related effects on juveniles and smolts. For the purpose of this study however, during PED the work window will be adjusted on a site specific basis taking into account presence of juvenile and adult winter-run Chinook salmon as well as any other condition that could impact rearing and migration.

Winter-run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River and American River SAM analysis reaches over the lifetime of the project when both IWM and planted benches are incorporated into the with-project conditions. Chinook salmon should exhibit a positive response by year 5 in the winter-spring when most juvenile Chinook salmon are expected in the ARCF GRR project area. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. Winter-run Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Winter-run Chinook salmon should exhibit a negative response by year 1. Short term and long term negative values will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir (See Appendix B of the ARCF GRR BA for a more detailed analysis).

The study area does not support spawning habitat for winter-run Chinook salmon and no long-term effects on spawning habitat will occur. For juvenile winter-run Chinook salmon, the bank protection measures will generally provide long-term increases in bank shading at project sites. The plantings of native grasses and willows are designed to benefit juvenile Chinook salmon by increasing the availability (habitat area) and quality (shallow water and instream cover) of nearshore aquatic habitat and SRA relative to current conditions. Figures 11 through 13 are an example of long-term habitat replacement under Alternative 1. As a result, construction of Alternative 1 would result in less than significant effects to winter-run Chinook salmon, and their critical habitat, with the implementation of the mitigation measures discussed below. Under the ESA, due to the short-term effects during construction, project activities may affect and are likely to adversely effect winter-run Chinook salmon.

Figure 11. Planting Site 4L on the American River after Bank Protection in 2001.

Figure 12. Planting Site 4L on the American River after Bank Protection in 2005.

Figure 13. Planting Site 4L on the American River after Bank Protection in 2010.

Spring-run Chinook Salmon

Adult spring-run Chinook salmon migrate up the Sacramento River from March through September although most individuals have entered tributary streams by mid-June and will not be affected by construction activities. Therefore, potential for construction-related ARCF GRR project effects will be similar to that described for winter-run Chinook salmon. Similar to winter-run Chinook salmon, spring-run Chinook salmon typically spend up to 1 year rearing in fresh water before migrating to sea. Therefore, potential for construction-related effects will be similar to that described for winter-run Chinook salmon above.

With respect to Spring-run Chinook salmon, the SAM analysis is expected to show a long term positive response to project actions in the Sacramento River and American River SAM analysis reaches over the lifetime of the project when both IWM and planted benches are incorporated into the with-project conditions. Chinook salmon should exhibit a positive response by year 5 in the winter-spring when most juvenile Chinook salmon are expected in the ARCF GRR project area. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. Spring-run Chinook salmon are expected to show a minor long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Spring-run Chinook salmon should exhibit a negative response by year 1. Short term and long term negative values will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir (See Appendix B of the ARCF GRR BA for a more detailed analysis).

Restricting in-water activities to the August 1 through November 30 work window and implementing the avoidance and minimization measures described below will minimize potential construction-related effects on juveniles and smolts to less than significant. For the purpose of this study however, during PED the work window will be adjusted on a site specific basis taking into account presence of juvenile and adult spring-run Chinook salmon as well as any other condition that could impact rearing and migration. Under Section 7 of the ESA, effects from Alternative 1 may affect and is likely to adversely affect spring-run Chinook salmon.

Central Valley Fall-/Late Fall–Run Chinook Salmon

Fall-/Late Fall-Run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River and American River SAM analysis reaches over the lifetime of the project when both IWM and planted benches are incorporated into the with-project conditions. Chinook salmon should exhibit a positive response by year 5 in the winter-spring when most juvenile Chinook salmon are expected in the ARCF GRR project area. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. (See Appendix B of the ARCF GRR BA for

detailed analysis). Fall-/Late-Fall-run Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Fall-/Late Fall-run Chinook salmon should exhibit a negative response by year 1. Short term and long term negative values will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir (See Appendix B of the ARCF GRR BA for a more detailed analysis).

Fall-/late fall–run Chinook salmon migrate into the Sacramento River and its tributaries from June through December; therefore, construction activities will coincide with most of the migration period. Construction activities that increase noise, turbidity, and suspended sediment may disrupt adult passage through the study area and may displace these fish as a result of effects on their preferred habitat and spawning habitat. However, because construction activities will be restricted to the channel edge and will include implementing avoidance and minimization measures described below, adverse effects on habitat will be minimized to below the significance thresholds.

Long-term changes on nearshore habitat are expected to have adverse effects on habitat that is important to all life stages of fall-/late fall–run Chinook salmon. The project could represent a long-term loss of a small amount of potential spawning habitat because repairs will require covering bottom substrates with revetment. However, the potential spawning area that might be affected is very small. In general, it is expected that channel areas immediately adjacent to erosion sites do not support spawning riffles. As a result, effects to fall-/late fall-run Chinook salmon from Alternative 1 would be less than significant, with the implementation of the mitigation measures discussed below.

Central Valley Steelhead

In the Sacramento River, adult steelhead migrate upstream during most months of the year, beginning in July, peaking in September, and continuing through February or March. Adults use the river channel in the study area as a migration pathway to upstream spawning habitat, and may also use deep pools with instream cover as resting and holding habitat. The potential for construction-related effects on migrating adult steelhead would be similar to that described above for adult winter-run Chinook salmon.

Steelhead are expected to show a long term positive response to project actions in the Sacramento River and American River SAM analysis reaches over the lifetime of the project. Steelhead should exhibit a positive response by year 4 in the winter-spring when most juvenile steelhead will be migrating and rearing through the project area. Short term habitat deficits are expected within the recommended recovery period for steelhead. Steelhead are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Steelhead should exhibit a negative response by year 1. Short term and long term negative SAM values will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the

Sacramento Bypass Weir (See Appendix B of the ARCF GRR BA for a more detailed analysis). Construction-related activities may affect but are not likely to adversely affect adult migration.

Within the ARCF GRR study area, potential spawning habitat is present in the American River, NEMDC, and Dry/Robla Creek. Steelhead spawn in late winter and late spring, which will be taken into consideration when determining a general estimated time of a August 1 through November 30 work window. For the purpose of this study however, during PED the work window will be adjusted on a site specific basis taking into account presence of juvenile and adult steelhead as well as any other condition that could impact steelhead spawning, rearing, and migration; therefore, construction-related effects may affect but are not likely to adversely affect steelhead spawning or their spawning habitat.

Central Valley steelhead rear year-round in the cool upstream reaches of the mainstem Sacramento River and its major tributaries. Juveniles and smolts are most likely to be present in the study area during their downstream migration to the ocean, which may begin as early as December and peaks from January to May. For purposes of this analysis, rearing juvenile steelhead are assumed to use nearshore and off-channel habitat in the study area. The potential for construction-related effects on steelhead juveniles and smolts and their habitat will therefore be similar to that described above for winter-run Chinook salmon. Under Section 7 of the ESA, Alternative 1 may affect and is likely to adversely affect Central Valley steelhead. However, with the implementation of the minimization and mitigation measures discussed below, these effects will be reduced to less than significant.

Green Sturgeon

Potential project effects that may affect, and are likely to adversely affect are described below for each life stage of green sturgeon and its habitat. An accurate assessment of potential project effects on green sturgeon and its habitat is difficult due to the limited information available on distribution, seasonal abundance, habitat preferences, and other life history requirements of this species.

Adult green sturgeon are believed to move upstream in the Sacramento River in the study area from February through late July (NMFS 2005c). Construction activities occurring outside of these time periods are not likely to affect migrating green sturgeon adults. Construction activities during July, however, may have adverse impacts on any adult green sturgeon that are still migrating upstream. Because construction activities will largely avoid the peak migration period, will be restricted to the channel edge, and will implement the avoidance and minimization measures described in Sections below, adverse effects to adult green sturgeon would be minimized during construction.

Spawning migrations of Green Sturgeon typically occur during the months of March through June (Thomas et al. 2013). The Sacramento River downstream of Knights Landing (RM 90) is not believed to have suitable spawning habitat for green sturgeon, primarily due to lack of suitable coarse bottom substrate such as large cobbles (Corps 2012). Therefore, the ARCF project is not likely to affect spawning green sturgeon or their habitat.

SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species. SAM values for green sturgeon generally indicate a negative response or no response to typical onsite mitigative features. Green sturgeon are expected to show long term negative response to project actions in the Sacramento River SAM analysis reach for several life stages at all seasonal habitat conditions over the lifetime of the project because the construction of these features would remove benthic feeding habitat for sturgeon. SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species; green sturgeon will exhibit a negative response for juvenile rearing in the summer/fall to these onsite mitigative features. However, during the winter/spring green sturgeon juvenile rearing life stages will exhibit a positive response to these onsite mitigative features (See Appendix B of the ARCF GRR BA for a more detailed analysis).

If larvae or juveniles are present during construction, in-water activities could result in localized displacement and possible injury or mortality to individuals that do not readily move away from the channel or nearshore areas. Project actions associated with bank protection measures may increase sediment, silt, and pollutants, which could adversely affect rearing habitat or reduce food production, such as aquatic invertebrates, for larval and juvenile green sturgeon.

Due to these adverse effects to juvenile green sturgeon, the Corps is proposing to adaptively manage the project in a number of ways in order to minimize impacts to this species. In particular, preconstruction physical modeling is proposed to assist in determining potential methods of implementing the proposed measures to minimize impacts to salmon. Additionally, new habitat modeling is proposed to better define what those impacts may be. Monitoring would be conducted during and post-construction in order to confirm the impacts estimated to result from the project, and to allow for improvement in minimizing impacts for future construction throughout the estimated 10 year construction period. With the implementation of this process, which is described in more detail in the Habitat Mitigation and Monitoring Plan (Appendix I), the direct and indirect effects to green sturgeon would be reduced to less than significant with mitigation.

Delta Smelt

Delta smelt in the Sacramento River have been documented upstream as far as the city of Sacramento (RM 60) (Moyle 2002), and may be present throughout their life cycle. Adult delta smelt migrate upstream between December and January and spawn between January and July, with a peak in spawning activity between April and mid-May (Moyle 2002). Potential effects on delta smelt will be avoided or minimized by restricting in water construction activities on the Sacramento River to a general estimated work window between August 1 and November 30. During PED, the work window will be adjusted on a site specific basis taking into account presence of juvenile and adult delta smelt as well as any other condition that could impact delta smelt rearing and migration..

Potential spawning habitat includes shallow channel edge waters in the Delta and Sacramento River. Construction-related effects include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, and alteration of spawning and incubation habitat. As a result, potential construction-related effects to delta smelt physical habitat would include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, alteration of spawning and incubation habitat, and loss of shallow water habitat for spawning.

The Corps conducted an analysis of existing shallow water habitat in the ARCF GRR project area, and the effect of the proposed project on that habitat. The results of this analysis are included as Appendix C to the Biological Assessment (AppendixG). This analysis was based on a cross section geometry with the assumption that the sediment or sand will be converted to rock revetment. The conclusion of the analysis was that approximately 14 acres of shallow water habitat would be permanently lost as a result of implementation of the ARCF GRR with 32 acres of spawning habitat being affected by a long-term change in substrate from sand to rock. The footprint could be minimized as site-specific designs are developed during the PED phase of the project.

The erosion repair is likely to somewhat reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment prospective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems. All of the available sediment in the American River watershed is being contained behind Folsom Dam. The site specific designs will be constrained from allowing any velocity increases outside the erosion repair site (Schlunegger 2014).

Juvenile delta smelt may be subject to disturbance or displacement caused by construction activities that increase noise, turbidity, and suspended sediment. Delta smelt may not be readily able to move away from channel or nearshore areas that are directly affected by construction activities (i.e., placement of rock revetment). Larvae may be disrupted during summer months as they migrate downstream to rear in the Delta. Incidental take of delta smelt may occur from direct mortality or injury during a construction activity, or by the impairment of essential behavior patterns (i.e., feeding, escape from predators). In addition, physiological impairment could be caused by toxic substances (i.e., gasoline, lubricants, oil) entering the water. Construction related effects on delta smelt rearing and migration will be minimized by restricting in-water construction activities on the Sacramento River to a general estimated work window betweenAugust 1 and November 30. For the purpose of this study however, during PED, the work window will be adjusted on a site specific basis taking into account presence of juvenile and adult delta smelt as well as any other condition that could impact delta smelt rearing and migration.

Non-native species may exploit the warmer water temperature in the shallow bench habitat created as an on-site mitigation feature and prey on delta smelt eggs and larvae; however, it is expected that despite the risk of predation, construction of shallow benches will result in a net benefit to delta smelt. Proposed planting of emergent vegetation will enhance habitat complexity by providing cover, incubation habitat, and possibly spawning habitat, especially during high winter and spring flows.

Due to the potential impacts during construction, the proposed alternative may affect, and is likely to adversely effect the Delta smelt during construction. However, with the implementation of appropriate mitigation and compensation measures, as discussed below, these impacts would be less than significant.

Sanford's Arrowhead

Sanford's arrowhead is known to occur in the Arcade Creek and NEMDC channels. Levee work in these reaches is proposed to remain within the levee prism and would not encroach into the channel; therefore, construction activities in this reach would not result in direct impacts to Sanford's arrowhead. Indirect effects to Sanford's arrowhead could occur during construction due to dust disturbance. However, the mitigation measures proposed in the air quality section (Section 3.11.6) would reduce this impact to less than significant. Long-term O&M activities would likely be confined to the levees and would not encroach on any wetlands or the creek channels. As a result, no effects are expected to occur to Sanford's arrowhead from long-term O&M of the proposed measures. Additional avoidance and minimization measures to reduce any potential impacts to this species are described in Section 3.8.6 below. With the implementation of these measures, effects to Sanford's arrowhead would be less than significant.

Wooly Rose-Mallow

There are no known populations of wooly rose-mallow in the study area, however since they are known to occur on levee banks with riprap, they could potentially be adversely impacted by construction of the proposed project. Clearing and grubbing of the levee slopes, and some long-term O&M activities, such as mowing of the levees, could also remove populations of this plant, if present. Avoidance and minimization measures to reduce the potentially significant effects to this species are described in Section 3.8.6 below. With the implementation of these measures, effects to wooly rose-mallow would be less than significant.

3.8.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Effects to special status species under Alternative 2 would be consistent with those described for Alternative 1, with the addition of any effects associated with the widening of the Sacramento Weir and Bypass. Additionally, this alternative would have the added footprint of widening the Sacramento Weir and Bypass which reduces the raises along the Sacramento River from 9 miles to 1 mile. Listed species that would have reduced affects by the implementation of Alternative 2 include VELB, purple martin, white-tailed kite, and Swainson's hawk. Approximately 33 elderberry shrubs would not need to be transplanted under Alternative 2 with the reduced amount of raise along the Sacramento River. Additionally, there would be fewer sites that require levee raises under Alternative 2 resulting in fewer trees being removed along the Sacramento River. Affects to purple martins, white-tailed kites, and Swainson's hawks would be reduced from 123 acres of riparian habitat lost under Alternative 1 to 71 acres of riparian habitat lost under Alternative 2. Therefore, effects to special status wildlife (i.e., VELB, Swainson's hawks, burrowing owl) and various runs of special status Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon) and their riparian or wetland habitat and/or upland or aquatic habitats are less than significant to all species with the implementation of avoidance, minimization, and compensation measures.

Sacramento Bypass and Weir

A maximum of 15 acres of aquatic GGS habitat (drainage ditches and farm canals) would be permanently removed and incorporated into the Sacramento Bypass. Existing riparian and wetland habitat within the existing bypass would remain, but could be expanded by about 300 acres once the bypass widening is complete. The additional land would become open space and would likely become similar riparian and wetland habitat supporting listed wildlife and fish (when there is water in it) as the existing vegetation in the bypass. If on-site restoration is not possible, then credits would be purchased at a Service-approved mitigation bank.

Assumptions regarding operation of the new weir and bypass for the purposes of this study are discussed in Section 2.3.4, but would likely be refined during the design phase of the project. No grading or altering of the lands within the existing bypass will occur as part of the alternative. The southern side of the bypass is at a lowest elevation so water will naturally flow to the existing area and continue to support existing vegetation and wildlife. Because of the natural flow of water in this area, wetlands in the existing bypass are not expected to be impacted by construction of the project. There is a potential for additional wetlands to actually develop in the added 300 acres of bypass, since the land will no longer be farmed. While the loss of the existing irrigation canals has a short term negative effect on GGS, the conversion of this land back to its natural state would have long term ecological benefits to the GGS and other wildlife and could become an expansion of the Sacramento Bypass Wildlife Area. As a result, impacts to GGS associated with the bypass widening would be less than significant, with the implementation of the mitigation and compensation discussed below.

To the east of the bypass, there are approximately 8 acres of riparian vegetation growing along the Sacramento River that would be removed to construct the new weir structure. The 8-acre area contains both the Old River Road and Union Pacific Railroad (UPRR) tracks. Prior to construction this area would be surveyed to determine if any avian species have nested in the area. If there is nesting Swainson's Hawks construction would be delayed until fledglings have left the nest. Fish in the area would likely disperse with the disturbance to the water. The expansion of the Sacramento Weir and Bypass could have a positive beneficial effect on special status wildlife such as the giant garter snake and its riparian vegetation once construction is complete and lands are converted from farming activities to open space where wetlands and shrubby riparian habitat is expected to naturally regenerate with the increased area that is periodically inundated from flooding during the rainy season. The operation of the weir is not expected to adversely affect any species currently listed under the Endangered Species Act, because the intermittent flooding of the bypass would support the natural processes associated with floodplain habitat. Effects to special status species associated with the bypass widening would be less than significant, with the implementation of the mitigation measures discussed below.

Widening of the weir and bypass will increase the entrainment and stranding exposure and rates of juvenile green sturgeon. When the weir is overtopping and water is flowing down the bypass, adult fish are attracted to the flow and follow it upstream in an attempt to reach their holding and spawning habitat. Widening the weir and bypass would increase the amount of water going over the weir and increase the attraction rate of sturgeon, salmon and steelhead. Without fish passage in place, the stranding rates of these fish would increase. This is significant, especially for sturgeon. Population viability modeling, funded in part by the Corps, concluded that without the fish rescue that took place, the loss of the green sturgeon stranded behind the Fremont and Tisdale weirs in 2012 would have significantly reduced the viability the species and increased their extinction risk. The Sacramento Weir poses a similar risk and widening the weir would add to the effect. Given that green sturgeon are long-lived species that have the strongest upstream migration and cohort replacement rates during wet water years and especially after high river flow conditions, the effect of the stranding occurring only two to three times over a 50 year period could be significant. Implementation of the mitigation measures discussed below, including ensuring fish passage and positive drainage in the Sacramento Bypass, would reduce these adverse effects to less than significant. However, the widening of the Sacramento Weir and Bypass may affect, and is likely to adversely effect the green sturgeon.

3.8.6 Mitigation Measures

Mitigation measures are similar for both Alternatives 1 and 2 since the footprint does not change for these two alternatives with the exception of impacts associated with widening the Sacramento Bypass. Compensation to mitigate for the loss of riparian habitat supporting special status species is based on the largest potential footprint for the purposes of compliance with NEPA. If design refinements are made at a later time that result in reduced impacts, compensation for the permanent loss of habitat will be coordinated with the appropriate resource agencies and adjusted accordingly.

Appendix I includes the project's Habitat Mitigation, Monitoring, and Adaptive Management Plan. The purpose of this HMMAMP is to present conceptual mitigation proposals, establish performance standards, and outline adaptive management tasks and costs. Additionally, the project relied heavily on the Habitat Evaluation Procedures (HEP) for the *American River Watershed Investigation, Common Features Modifications, Mayhew Drain Site Project* in order to create a baseline condition for habitat quality within the study area. Using this HEP, the Corps conducted a cost effectiveness/incremental cost analysis (CE/ICA), which is also included in Appendix I. The CE/ICA evaluated five options for habitat mitigation to determine the most cost effective and government best buy options for habitat restoration. These options included conducting all mitigation on-site, conducting all mitigation at a mitigation bank, a combination of on-site and off-site (bank) mitigation (recommended plan), conducting all mitigation at a 1:1 ratio, and conducting all mitigation at a 3:1 ratio. The recommended mitigation plan is the Alternative 2 Combination Plan with a 2:1 ratio, because it is the smallest mitigation proposal that accomplishes the terms and conditions of the Biological Opinions, and the CE/ICA determined that it was a cost effective plan. Further information on proposed habitat mitigation can be found in Appendix I and in the subsections below.

Valley Elderberry Longhorn Beetle

In accordance with the USFWS 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* adverse effects to the VELB would be compensated by transplanting the affected elderberries with stems greater than 1 inch in diameter and by planting a mix of native riparian/or upland vegetation at a 2:1 and 6:1 ratios depending on the diameter size of the stems. The amount of compensation for VELB is based on preliminary surveys done in 2011 within the construction footprint. At that time approximately 265 shrubs were located along the levees and within the 15 foot landside and 30 feet on waterside toes. All shrubs that can be transplanted would be transplanted.

Along the American River, shrubs would be transplanted and additional compensation would be installed on top of the newly constructed trench when possible. On-site elderberry compensation would be planted on the trench outside of the vegetation free zone. Sufficient lands are expected to be available to plant the shrubs and associated natives in these on-site areas. If additional lands are needed, off-site plantings could occur at the existing Cal Expo mitigation site or adjacent to the existing River Bend Park mitigation site.

Table 21. American River Elderberry Shrub Effects and Proposed Compensation.

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios[1,2]	Elderberry Plantings	Associated Native Planting	Associated Native Ratios
non-riparian	greater than or = 1" & less than or = 3"	No	0	1	0	0	1
		yes	0	2	0	0	2
non-riparian	greater than 3" & less than 5"	No	0	2	0	0	1
		yes	0	4	0	0	2
non-riparian	greater than or = 5"	No	0	3	0	0	1
		yes	0	6	0	0	2
riparian	greater than or = 1" & less than or = 3"	No	1,998	2	3,996	3,996	1
		yes	0	4	0	0	2
riparian	greater than 3" & less than 5"	No	790	3	2,370	2,370	1
		yes	16	6	96	192	2
riparian	greater than or = 5"	No	312	4	1,248	1,248	1
		yes	23	8	184	368	2
TOTAL			**3,139**		**7,894**	**8,174**	
				Calculations:	natives-elderberries	280	
				basins or credits	1,578.8	28	
				total basins or credits=	1,606.8		
					2,892,240		
				total acres need for compensation	66.39669421		

1 Affected elderberry plant minimization ratios based on location, stem diameter, and presence of exit holes

2 Multiply No. of stems by this for planting counts

Table 22. Sacramento River Elderberry Shrub Effects and Proposed Compensation.

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios[1,2]	Elderberry Plantings	Associated Native Plantings	Associated Native ratios
non-riparian	greater than or = 1" & less than or = 3"	No	0	1	0	0	1
		yes	0	2	0	0	2
non-riparian	greater than 3" & less than 5"	No	0	2	0	0	1
		yes	0	4	0	0	2
non-riparian	greater than or = 5"	No	0	3	0	0	1
		yes	0	6	0	0	2
riparian	greater than or = 1" & less than or = 3"	No	104	2	208	208	1
		yes	0	4	0	0	2
riparian	greater than 3" & less than 5"	No	40	3	120	120	1
		yes	1	6	6	12	2
riparian	greater than or = 5"	No	16	4	64	64	1
		yes	2	8	16	32	2
TOTAL			**163**		**414**	**436**	
				Calculations:	natives-elderberries	22	
				basins or credits	82.8	2.2	
				total basins or credits=	85		
					153000		
				total acres need for compensation	3.512396694		

1 Affected elderberry plant minimization ratios based on location, stem diameter, and presence of exit holes

2 Multiply No. of stems by this for planting counts

Because elderberry shrubs are fast growing and the size and amount of shrubs could significantly change between the time of the surveys and the construction of the project the exact amount of compensation is unknown. Using the numbers from the 2011 survey an assumption was made that each shrub contained 13 stems measures greater than 1 inch to greater than 3 inches, 5 stems measuring greater than 3 inches to greater than 5 inches, and 2 stems measuring less than 5 inches, and all are within riparian habitat. This would require the compensation as shown in Tables 21 and 22 below Using this assumption a total of approximately 108 acres of elderberry compensation would be required. There are likely many additional shrubs outside the 30 foot waterside survey area that would be impacted by the project. These would also be compensated for in accordance with the 1999 Guidelines.

The following is a summary of measures that would be implemented during construction based on the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (USFWS 1999a). These measures will be implemented to minimize any potential effects on valley elderberry longhorn beetles or their habitat, including restoration and maintenance activities, long-term, protection, and compensation if shrubs cannot be avoided as shown in Tables 21 and 22.

- When a 100-foot (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed.
- Where encroachment on the 100-foot buffer has been approved by the USFWS, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.
- During construction activities, all areas to be avoided will be fenced and flagged.
- Contractors will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs will be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area will be restored.
- Buffer areas will continue to be protected after construction.
- No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Trimming of elderberry plants will be subject to mitigation measures.
- Elderberry compensation would be planted in the American River Parkway. The Corps has six existing sites which are offsetting previous Corps flood control projects along the lower American River and near Folsom Dam. The Corps will find areas within the lower American River parkway which will either expand existing compensation areas or provide for connectivity between conserved valley elderberry longhorn beetle habitat. Sites within the Parkway will be coordinated with County Parks and the Service during the design phase of

the project. Sites will be designed and developed prior to any effects to valley elderberry longhorn beetle habitat. The Corps will create 69.91 acres of riparian habitat which supports valley elderberry longhorn beetle within the lower American River parkway.

- If possible, elderberry shrubs would be transplanted during their dormant season (approximately November, after they have lost their leaves, through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation ratios will apply.
- Any areas that receive transplanted elderberry shrubs and elderberry cuttings will be protected in perpetuity.
- The Corps will work to develop off-site compensation areas prior to or concurrent with any take of valley elderberry longhorn beetle habitat.
- Management of these lands will include all measures specified in USFWS's conservation guidelines (1999a) related to weed and litter control, fencing, and the placement of signs.
- Monitoring will occur for ten consecutive years or for seven non-consecutive years over a 15-year period. Annual monitoring reports will be submitted to USFWS.

Vernal Pool Fairy Shrimp and Tadpole Shrimp

The following measures from the 2004 Biological Opinion from the Magpie Creek Flood Control Project would be implemented to avoid and minimize impacts to potential vernal pools in the vicinity of the Magpie Creek construction area:

- Preservation component: For every acre of habitat directly or indirectly affected, at least two vernal pool credits will be dedicated within a Service-approved ecosystem preservation bank or, based on Service evaluation of site-specific conservation values, three acres of vernal pool habitat may be preserved on the project site or another nonbank site as approved by the Service.
- Creation component: For every acre of habitat directly affected, at least one vernal pool creation credit will be dedicated within a Service-approved habitat creation bank or, based on Service evaluation of site-specific conservation values, two acres of vernal pool habitat will be created and monitored on the project site or another non-bank site as approved by the Service.
- Listed vernal pool crustacean habitat and associated uplands utilized as on-site compensation will be protected from adverse effects and managed in perpetuity or until the Corps, the applicant, and the Service agree on a process to exchange such areas for credits within a Service-approved conservation banking system. Off-site conservation at a Service-approved non-bank location will be protected and managed in perpetuity through a Service-

approved conservation easement, Service-approved management plan, and a sufficient endowment fund to manage the site in perpetuity in accordance with the management plan.

- If habitat is avoided (preserved) on site, then a Service-approved biologist (monitor) will inspect any construction-related activities at the proposed project site to ensure that no unnecessary take of listed species or destruction of their habitat occurs. The biologist will have the authority to stop all activities that may result in such take or destruction until appropriate corrective measures have been completed. The biologist also will be required to immediately report any unauthorized impacts to the Service and the California Department of Fish and Game.
- Adequate fencing will be placed and maintained around any avoided (preserved) vernal pool habitat to prevent impacts from vehicles.
- All on-site construction personnel will receive instruction regarding the presence of listed species and the importance of avoiding impacts to these species and their habitat.
- The applicant will ensure that activities that are inconsistent with the maintenance of the suitability of remaining habitat and associated on-site watershed are prohibited. This includes, but is not limited to: (i) alteration of existing topography or any other alteration or uses for any purposes, including the exploration for or development of mineral extraction; (ii) placement of any new structures on these parcels; (iii) dumping, burning, and/or burying of rubbish, garbage, or any other wastes or fill materials; (iv) building of any new roads or trails; (v) killing, removal, alteration, or replacement of any existing native vegetation; (vi) placement of storm water drains; (vii) fire protection activities not required to protect existing structures at the project site; and (viii) use of pesticides or other toxic chemicals.

The proposed project will result in 0.25 acre of indirect effects to vernal pools/swales of potentially suitable vernal pool shrimp and vernal pool tadpole shrimp habitat. The applicant has identified and agreed to purchase 0.5 vernal pool preservation credits at a Service-approved conservation bank or Service-approved fund. Credits will be purchased prior to the effect on any vernal pool habitat. The agreed upon conservation responsibilities of the applicant are as follows:

- Prior to any earth-moving activities at the proposed project site, the applicant shall purchase at least 0.5 vernal pool preservation credits within a Service-approved ecosystem preservation bank or fund account.

Giant Garter Snake

The following measures will be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity. These measures are based on USFWS guidelines for restoration and standard avoidance measures included as appendices in USFWS (1997).

- Unless approved otherwise by USFWS, construction will be initiated only during the giant garter snakes' active period (May 1 to October 1, when they are able to move away from disturbance).
- Construction personnel will participate in USFWS-approved worker environmental awareness program.
- A giant garter snake survey would be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than two weeks, a biologist would survey the project area again no later than 24 hours prior to the restart of work.
- Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from giant garter snake aquatic habitat.
- Giant garter snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.
- Habitat temporarily affected for more than three or more seasons will be restored and twice as much habitat will be created.
- The Corps has estimated that approximately 15 acres of aquatic habitat (drainage ditches and irrigation canals) and 30 acres of associated upland habitat would be permanently affected due to the widening of the Sacramento Weir and Bypass. Habitat permanently affected in the Sacramento Bypass will be compensated for through the purchase of 135 acres of credits at a USFWS-approved conservation bank. Due to the spatial and temporal loss of habitat, and the lack of permanent on-site replacement, the ecological value associated with doing all mitigation at an off-site location was reduced to an overall 70% habitat value. This reduction is offset by the increase of mitigation credits at ratios specified by USFWS in the Biological Opinion included as Appendix J.
- One year of monitoring will be conducted for the 80.5 acres that are temporarily affected.
- The Corps will purchase credits at a conservation bank prior to any permanent disturbance of giant garter snake habitat.

Western Yellow-Billed Cuckoo, Swainson's Hawk, White-Tailed Kite, and Purple Martin

To avoid and minimize effects to migratory birds, the Corps would implement the following BMP measures:

- Before ground disturbance, all construction personnel would participate in a CDFW-approved worker environmental awareness program. A qualified biologist would inform all construction personnel about the life history of Swainson's hawk and the importance of nest sites and foraging habitat.
- A breeding season survey for nesting birds would be conducted for all trees and shrubs that would be removed or disturbed which are located within 500 feet (0.5 mile for Swainson's hawk) of construction activities, including grading. Swainson's hawk surveys would be completed during at least two of the following survey periods: January 1 to March 20, March 20 to April 5, April 5 to April 20, and June 10 to July 30 with no fewer than three surveys completed in at least two survey periods, and with at least one of these surveys occurring immediately prior to project initiation (Swainson's Hawk Technical Advisory Committee 2000). Other migratory bird nest surveys could be conducted concurrent with Swainson's hawk surveys with at least one survey to be conducted no more than 48 hours from the initiation of project activities to confirm the absence of nesting. If the biologist determines that the area surveyed does not contain any active nests, construction activities, including removal or pruning of trees and shrubs, could commence without any further mitigation.
- If active nests are found, the Corps would maintain a 0.25-mile buffer between construction activities and the active nest(s). In addition, a qualified biologist would be present on-site during construction activities to ensure the buffer distance is adequate and the birds are not showing any signs of stress. If signs of stress that could cause nest abandonment are noted, construction activities would cease until a qualified biologist determines that fledglings have left an active nest.
- Tree and shrub removal, and other areas scheduled for vegetation clearing, grading, or other construction activities would not be conducted during the nesting season (generally February 15 through August 31 depending on the species and environmental conditions for any given year) . These construction activities could affect them by removing or causing abandonment of active nests of migratory birds protected under the Migratory Bird Treaty Act and California Fish and Game Code. Implementation of mitigation measures described below, would avoid, reduce, or minimize the significant effect.

To reduce the impact on migratory birds habitat the Corps will seek a vegetation variance on lower half of the waterside levee slope. Additionally, where bank protection work is performed the sites would be planted with vegetation and trees that over time will provide habitat for the hawks.

To compensate for the removal of 134 acres of riparian habitat supporting Western yellow-billed cuckoos, Swainson's hawks, and other migratory birds approximately 268 acres of replacement habitat will be created, as discussed in the vegetation and wildlife section (Section 3.6.6). Due to the temporal loss of habitat while new on site habitat is growing, the ecological value associated with onsite mitigation was reduced to an overall 80% habitat value. This reduction is offset by the increase of mitigation credits at ratios specified by USFWS and NMFS in the Biological Opinions.

Some areas that may be considered for riparian mitigation include Cal Expo and Woodlake. For those mitigation lands within the American River Parkway species selected to compensate for the riparian corridor removal will be consistent with the approved list of trees, shrubs, and herbaceous plants native to the Parkway. Mitigation within the Parkway will prove to be contiguous and create habitat connectivity with wildlife migratory corridors that supports the needs of important native wildlife species, without compromising the integrity of the flood control facilities, the flood conveyance capacity of the Parkway, and Parkway management goals in the Parkway Plan. To comply with the Parkway Plan, lands within the Parkway will be evaluated for compensation opportunities for any riparian habitat removed from Parkway. The exact location of the compensation lands in the Parkway would be coordinated in the design phase of the project with County Parks and would comply with the Parkway Plan objectives and goals. It is assumed that sufficient lands will be available within the Parkway, however, if there is not sufficient land, other locations within Sacramento County will be identified and pubic coordination will occur. Additional mitigation may be planted in the expanded Sacramento Bypass or on other lands within the Sacramento area that provide similar value to those removed.

Burrowing Owl

The following avoidance and minimization measures would be implemented to reduce the potential for adverse effects to burrowing owl:

- Prior to the implementation of construction, surveys will be conducted to determine the presence of burrows or signs of burrowing owl presence within the project area. The survey would be conducted in accordance with Appendix D of CDFW's Staff Report on Burrowing Owl Mitigation (CDFG 2012).
- If burrowing owls are observed, coordination would occur with CDFW to determine the appropriate actions to take or any additional avoidance and minimization measures that may need to occur. These measures may include creating a protective buffer around occupied burrows during the duration of the breeding season and biological monitoring of active burrows to ensure that construction activities do not result in adverse effects on nesting burrowing owls.

- If potential burrows are present, all on-site construction personnel shall be instructed regarded the potential presence of burrowing owls, identification of these owls and their habitat, and the importance of minimizing impacts on burrowing owls and their habitat.

Listed Fish Species

The Corps proposes to develop a green sturgeon habitat, mitigation, and monitoring plan (HMMP) in the design phase of the project to address the long-term negative impacts to green sturgeon designated critical habitat with the specific elements that are described below:

- The green sturgeon HMMP shall be developed in coordination with the Interagency Ecological Program (IEP) green sturgeon project work team and consulted on with NMFS prior to the construction of any work within the designated critical habitat of sDPS green sturgeon related to the ARCF GRR.
- The Corps shall either refine the SAM or develop an alternative green sturgeon survival and growth response model based on using and updating the existing Hydrologic Engineering Center Ecosystem Function Model (HEC-EFM) that reflects green sturgeon's preference for benthic habitat.
- The green sturgeon HMMP shall also be developed with measurable objectives for completely offsetting all adverse impacts to all life stages of sDPS green sturgeon (as modeled using refined approaches described above and considering design refinements that occur in the PED phase of project implementation.
- The HMMP shall also, restore or compensate for the number of acres of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This mitigation shall be coordinated with the Interagency Working Group (IWG) or a Bank Protection Working Group (BPWG) and must be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat.
- Mitigation actions shall be initiated prior to the construction activities affecting sDPS green sturgeon and their critical habitat.
- The sDPS green sturgeon HMMP will include measurable performance standards at agreed upon intervals and will be monitored for a period of at least ten years following construction.

The following additional conservation measures would be implemented to reduce the adverse effects to listed Chinook, steelhead, delta smelt, and green sturgeon:

- In-water construction activities (e.g., placement of rock revetment) will be limited to the work window of August 1 through November 30. If the Corps wants to work outside of this

window they will consult with USFWS and NMFS.

- The Corps will purchase delta smelt credits from a USFWS-approved conservation bank to off-set the loss of 14 acres of shallow water habitat, and 13 acres of spawning habitat. This mitigation is assumed to occur through the purchase of credits at a mitigation bank due to the lack of available real estate in the study area for on-site mitigation. Due to the spatial and temporal loss of habitat, the ecological value associated with doing all mitigation at an off site location was reduced to an overall 70% habitat value. This reduction is offset by the increase of mitigation credits at ratios specified by USFWS and NMFS in the Biological Opinions. The Corps proposes to purchase a total of 72 credits to ensure that impacts to Delta smelt are fully mitigated.
- Erosion control measures (BMPs), including Storm Water Pollution Prevention Program and Water Pollution Control Program, that minimize soil or sediment from entering the river. BMPs shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to Federally listed fish and their designated critical habitat.
- Screen any water pump intakes, as specified by NMFS and USFWS screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.
- No grading or altering of the lands within the existing Sacramento Bypass will occur as part of the project.
- The Corps shall participate in an existing IWG or work with other agencies to participate in a new BPWG to coordinate stakeholder input into future flood risk reduction actions associated with the ARCF GRR.
- The Corps shall coordinate with NMFS during PED as future flood risk reduction actions are designed to ensure conservation measures are incorporated to the extent practicable and feasible and projects are designed to maximize ecological benefits.
- The Corps shall include as part of the Project, a Riparian Corridor Improvement Plan with the overall goal of maximizing the ecological function and value of the existing levee system within the Sacramento Metropolitan Area.
- The Corps shall develop a HMMP with an overall goal of ensuring the conservation measures achieve a high level of ecological function and value. The HMMP shall include:
    - Specific goals and objectives and a clear strategy for maintaining all of the project conservation elements for the life of the project.

  - Measures to be monitored by the Corps for 10 years following construction and shall update their O&M manual to ensure the HMMP is adopted by the local sponsor to ensure the goals and objectives of the conservation measures are met for the life of the project.
  - Include specific goals and objectives and a clear strategy for achieving full compensation for all project-related impacts to listed fish species.
  - The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP.
  - The Corps shall host an annual meeting and issue annual reports for five years following completion of project construction.

- The Corps shall ensure that, for salmon and steelhead, the maximum SAM WRI deficits for each seasonal water surface elevation as determined appropriate with input from the IWG or the BPWG are fully offset through the purchase of credits at a NMFS approved conservation bank (as described in this BA).
- The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.
- The Corps shall ensure that the planting of native vegetation will occur as described in the HMMP. All plantings must be provided with the appropriate amount of water to ensure successful establishment.
- The Corps shall provide a copy of the BO, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in the documents and to educate and inform all other contractors involved in the project as to the requirements of the BO.
- A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. Written documentation of the training will be submitted to NMFS within 30 days of the completion of training.
- The Corps shall consider installing IWM along future flood risk reduction projects associated with the ARCF GRR at 40 to 80 percent shoreline coverage at all seasonal water surface elevations in coordination with the IWG or the BPWG. The purpose is to maximize the refugia and rearing habitats for juvenile fish.
- The Corps shall protect in place all riparian vegetation on the lower waterside slope of any levee unless removal is specifically approved by NMFS.

- The Corps shall develop a Vegetation Variance for all elements of the ARCF GRR that are adjacent to habitat that is occupied by federally listed salmon, steelhead and green sturgeon, including the main channel of the Sacramento River (as proposed) and the Sacramento Bypass.
- The Corps shall ensure the widening of the Sacramento Bypass is designed and constructed to minimize stranding of fish in the depressions wound within the bypass though grading or construction of drainage channels.
- The Corps, in coordination with the local sponsor, shall ensure that the Habitat Mitigation and Monitoring Plan for the Sacramento Bypass includes baseline post-project monitoring of fish stranding. The monitoring plan shall be developed in coordination with NMFS.
- The Corps shall update the O&M manual to incorporate without detrimental effects to flood operations 1) operations of the Sacramento Weir include a plan that allows for ramp down flows in a manner that minimize juvenile fish stranding in the Sacramento Bypass, (2) integration of Sacramento Weir operations with the Yolo Bypass.
- During Preconstruction Engineering and Design, the Corps, in coordination with the local sponsor, shall coordinate with NMFS to provide an operation of the Sacramento Weir to allow without detrimental effects to flood management operations, for controlled ramp down rates of water into the Sacramento Bypass following peak flows.
- Additional mitigative concerns, not considered in a SAM analysis, will be included in the MMP (See Appendix I) along the Sacramento Bypass reach, including potential adult and juvenile passage issues, loss of shoreline riparian vs. gain in floodplain, and contradicting ESA species habitat requirements. These issues will be considered and appropriate actions will be taken where possible in coordination with other agencies.

For SRA habitat impacted by construction, the following measures would be implemented to compensate for the habitat loss:

- Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to protected species from designated compensation sites. In general, compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] §§ 2201–2330).

- For identified designated critical habitat, where feasible all efforts will be made to compensate for impacts where they have occurred or in close proximity. Impacts to designated critical habitat, SRA and instream components combined and the compensation value of replacement habitat will be based on the interagency approved Standard Assessment Model (SAM) used throughout the Sacramento River basin and Delta flood control system.
- Compensation sites would be monitored and vegetation would be replaced as necessary based on performance standards in the Mitigation Monitoring Plan (MMP) as detailed in Appendix I of the EIS/EIR.

Depending on the species of interest (e.g., delta smelt), the severity of the short- term habitat losses due to bank erosion repair actions may not be compensated by long-term gains, whereas longer lived species (e.g., steelhead, Chinook) have longer periods for compensation to be provided. The following compensation time periods (based loosely on life expectancy) should be considered as guidelines for compensation:

- Green sturgeon, 15 years;
- Chinook salmon, 5 years;
- Central Valley steelhead, 4 years; and
- Delta smelt, 1 year.

Special Status Plant Species

The following avoidance and minimization measures would be implemented during construction to reduce potentially significant effects to Sanford's arrowhead and wooly rose-mallow to less than significant. Additionally, the avoidance and minimization measures to address invasive plant species in Section 3.6.6 would also reduce potential impacts to special status plant species.

- Preconstruction surveys would be conducted by a qualified botanist in suitable habitat to determine the presence of any special status plants. Surveys would be conducted at an appropriate time of year during which the species are likely to be detected, which would likely be during the blooming period.
- If special status plant species are found during preconstruction surveys, the habitat would be marked or fenced as an avoidance area during construction. A buffer of 25 feet would be established. If a buffer of 25 feet is not possible, the next maximum possible distance would be fenced off as a buffer.

- If special status plant species cannot be avoided during construction, the Corps would coordinate with the resource agencies to determine additional appropriate mitigation measures.

3.9 Cultural Resources

The following section addresses cultural resource impacts that could result from implementation of one of the proposed alternatives for the ARCF study.

3.9.1 Environmental Setting

Regulatory Setting

Federal

- National Historic Preservation Act of 1966, as amended (NHPA)

State

- CEQA (Public Resources Code § 21000 et seq.)and CEQA Guidelines (14 California Code of Regulations § 15000 et seq.).

Existing Conditions

"Cultural resources" describe several different types of properties: prehistoric and historic archaeological sites; architectural properties such as buildings, bridges, and infrastructure; and resources of importance to Native Americans (traditional cultural properties and sacred sites). "Artifacts" include any objects manufactured or altered by humans.

Prehistoric archaeological sites date to the time before recorded history, and in this area of the U.S., sites are primarily associated with Native American use before the arrival of European explorers and settlers. Archaeological sites dating to the time when these initial Native American-European contacts occurred are referred to as protohistoric. Historic archaeological sites can be associated with Native Americans, Europeans, or any other ethnic group. In the project area and surrounding area, these sites include the remains of historic structures and buildings.

Structures and buildings are considered historic when they are more than 50 years old or when they are exceptionally significant. Exceptional significance can be attributed if the properties are integral parts of districts that meet the criteria for eligibility for listing in the National Register of Historic Places (NRHP) or if they meet special criteria considerations.

National Register of Historic Places Evaluation Criteria

The criteria applied to evaluate properties for listing in the NRHP (36 C.F.R. § 60.4) are outlined below:

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and

(a) That are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) That are associated with the lives of persons significant in our past; or

(c) That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) That have yielded, or may be likely to yield, information important in prehistory or history.

Meeting one or more of the criteria for eligibility is not enough to determine a resource as eligible for listing in the NRHP. In order to meet eligibility, a resource must have also retained historic integrity of those features necessary to convey its significance (U.S. Department of the Interior 1997). There are seven aspects of integrity: Location, Design, Setting, Materials, Workmanship, Feeling, and Association. Not all aspects of integrity may be relevant to a particular resource.

Area of Potential Effects

For purposes of complying with Section 106 of the NHPA, 54 U.S.C. § 306108, a Federal agency will make a determination of the area of potential effects (APE) for the project or undertaking. The APE is defined as "the geographic areas or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." Additionally, the APE "is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking." 36 C.F.R. § 800.16(d).

The APE for an undertaking may extend beyond the physical impacts associated with a project. Depending on the scale and nature of the undertaking and the known and anticipated types of cultural resources, the direct or indirect effects may include, but are not limited to: physical modification; intrusion to the visual or esthetic characteristics of landscapes or features; or access to a historic property.

The Programmatic Agreement for this undertaking is covers the ARCF GRR project, as well as NLIP Phase 4b EIS/EIR. As a result, the APE identified in the PA covers a different geographic area than is described as the study area in this EIS/EIR. The ARCF Project APE includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; the Sacramento Bypass and Sacramento Weir; an expansion area 1,500 feet north of the Sacramento Bypass and Sacramento Weir; approximately 4 miles of the Pleasant Grove Creek Canal; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal. The APE for the overall ARCF Project is shown in Figure 14 and further described in Appendix C. The APE for the ARCF includes areas within the American River Parkway and along Dry Creek and Robla Creek, because it is anticipated that there may be visual or landscape impacts to potential historic properties in those areas.

The Corps has determined and defined the APE in consultation with the State Historic Preservation Officer (SHPO), in letters dated February 1, 2012 and June 12, 2014.

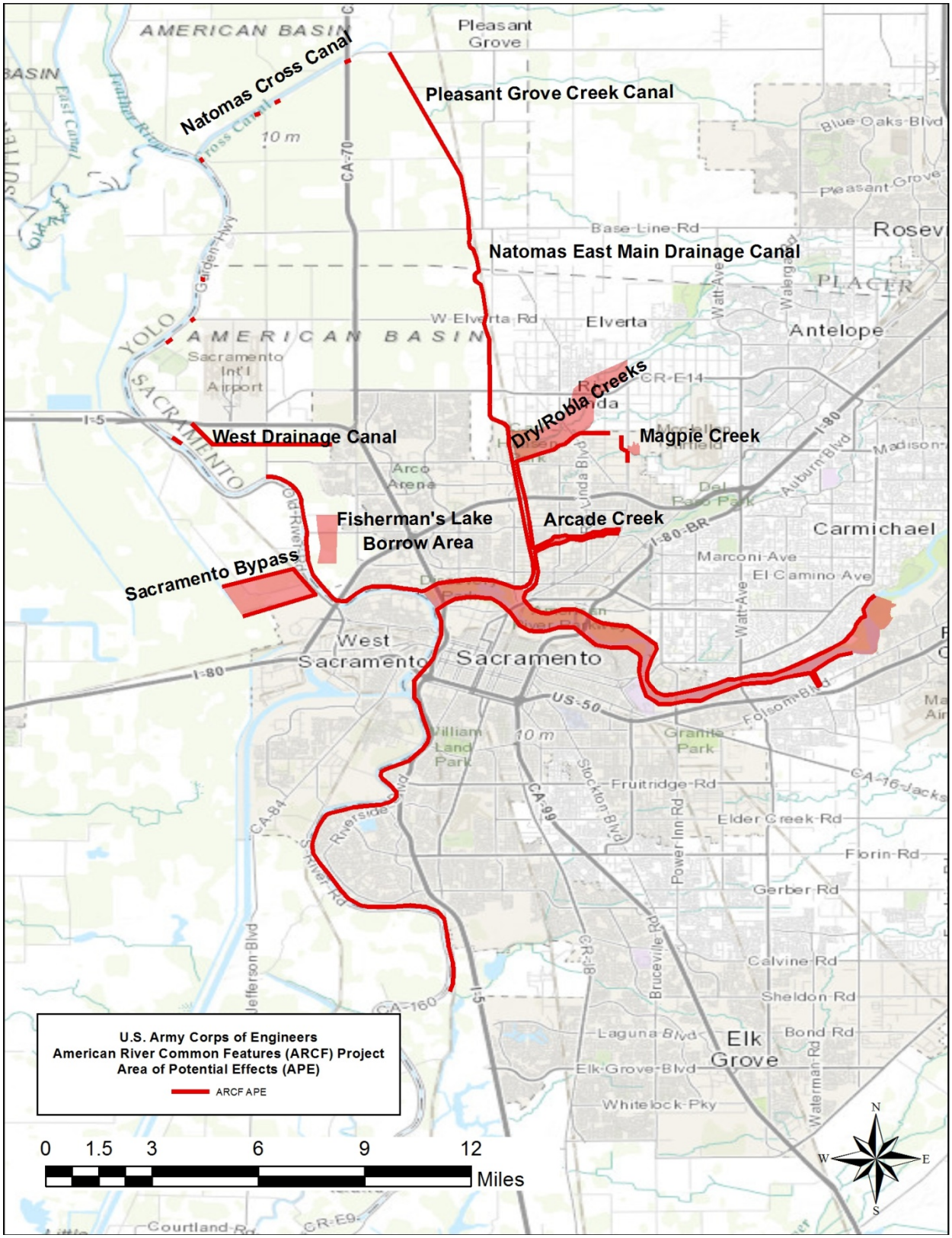

Figure 14. ARCF APE for Compliance with Section 106 of the NHPA.

Environment and Landscape

The ARCF study area is located in the Southern Sacramento River Valley. The Sacramento Valley is a broad, generally flat plane situated between the low mountains of California's Coast Range and the peaks of the Sierra Nevada and Cascade Ranges. The Sacramento Valley comprises the northern half of California's Great Central Valley which includes the San Joaquin River Valley to the south. As the delta formed during the early Holocene, the hydrology of the Sacramento River changed; stream channels filled with sediment and shifted around. By approximately 5000 years before present (BP), the current meander belt of the river was established. Subsequent episodes of erosion, deposition, and stability continued however, with evidence of significant soil deposition associated with large scale floods occurring between 1500 to 1100 BP and 750 to 650 BP.

Historically, the western half of the ARCF study area was dominated by wetlands surrounding patchy riparian habitat along the Sacramento River. To the east, the wetlands gave way to foothill grasslands and limited stands of valley hardwoods, especially oaks. A considerably wider band of riparian habitat bounded the American River, located in much closer proximity to the hardwood forests and groves.

These vegetative zones would have produced varied suites of technological and subsistence resources, plants and game, useful to indigenous populations. In addition, access to permanent sources of water was obviously important to the prehistoric occupants of California. Apart from the basic human need of water for drinking, easy access to fresh water facilitates cooking, the processing of some foods (esp. acorns), and access to aquatic resources including plants, fish, and some birds.

More recently, hydraulic mining during the Gold Rush deposited tremendous volumes of sediment in foothill stream channels. Winter storms in 1861-1862 washed large quantities of these materials into the Sacramento and American Rivers, raising channel beds and causing immense flooding. Subsequent erosion and dredging has deposited much of these mine tailings throughout the floodplain. Modern agricultural practices have also significantly affected the study area. Leveling land for agricultural work destroyed countless mound sites along the river courses, and the native vegetation has been replaced almost entirely by agricultural crops.

Prehistoric and Ethnographic Setting

Well documented prehistoric sites dating from approximately 3,800 to 2,700 BP are commonly characterized by archaeologists as belonging to the Windmiller Pattern (Ragir 1972; Rosenthal et al 2007). Windmiller sites appear to reflect a wide-spread cultural phenomenon marked by distinctive burial patterns, as well as charmstones, shell pendants, and a variety of chipped and ground stone tools.

The Windmiller Pattern gave way to the Berkeley Pattern which remained the common cultural expression until approximately 1,000 BP (Fredrickson 1973). Berkeley Pattern sites reflect period a demographic, political, and subsistence intensification marked by the occupation of larger villages and the onset of a dependence on acorns and other stored food resources for consumption during the leaner parts of the year.

The most recent cultural phase is termed the Augustine Pattern (Bennyhoff 1994; Fredrickson 1973). Augustine Pattern sites reflect the apogee of cultural complexity in Central California. Large villages and towns grew along rivers and tributaries (Rosenthal et al 2007) while the variety of items of material culture expanded to include a broad variety of stone, bone, and shell artifacts. Immediately south of the study area, at site CA-SAC-267, Cosumnes Brown Ware, a type of coiled pottery was developed (Johnson et al 1976). This is the only known ceramic pottery tradition to have ever developed in the area.

The study area is situated within the lands traditionally occupied by the Nisenan, or Southern Maidu. The language of the Nisenan, which includes several dialects, is classified within the Maiduan family of the Penutian linguistic stock (Kroeber 1925). The name “Nisenan” was a self-designation by the native groups occupying the Yuba and American River drainages. The western boundary of Nisenan territory was the western bank of the Sacramento River and the area between present-day Sacramento and Marysville, covering a significant portion of the Central Valley and reaching into the Sierra Nevada Mountains.

The local Nisenan occupation occurred within the broader context of Central Valley prehistory. California archaeological sites outside the Central Valley suggest that humans may have first occupied the area by 9,000 to 11,000 BP or earlier (Erlandson et al 2008; Harrington 1948; Mills et al 2005; Simons et al 1985; Zimmerman et al 1989), however, there is little direct evidence of this kind of antiquity in the valley itself. Sites older than 6,000 BP are known from the southern Central Valley (Hartzell 1992), as well as the Sierran foothills and the Coast Range mountains on either side of the valley.

Nisenan occupation of the area appears to date back to at least 3,300 years BP. Most of the scientific data about the Nisenan was recovered at archaeological site CA-PLA-101A, also known as the Spring Garden Ravine site in the Auburn Reservoir area (Table 23). This site helped to define late prehistoric chronology of the Nisenan and native occupation over three millennia (Moratto 1984).

Table 23. CA-PLA-101A – Spring Garden Ravine.

	Time Period	Artifacts or Information Gathered
Upper (A) Stratum	Less than 1000 years	Arrow points and numerous retouched flakes of silicates, hopper mortars, bedrock mortars, core tools, milling stones. Thought to be Nisenan.
Middle (B) Stratum	1039 to 976 A.D.	Strategically and culturally intermediate.
Lower (C) Stratum	1400 B.C.	Large projectile points of basalt and slate, atlatl weights, bowl mortars, core tools and milling stones.

At the Spring Garden Ravine site, pollen data suggests stability of vegetation for 3,000 years up to the last 500 years as savanna habitat and oak grassland gave way to pine-oak woodland. This shift has been attributed to the halting of historic burning by native groups. The climate of the area occupied by the Nisenan was characterized by mild weather with wet winters and warm, dry summers. The Nisenan often inhabited areas near rivers and some major areas of significance included sites on the American, Sacramento, Bear, Feather, and Yuba Rivers (Moratto 1984). The basic political unit was a village community or tribelet with one primary village and a few satellite villages under one head authority.

Valley Nisenan territory was divided into three tribelet areas, each populated with several large villages (Wilson and Towne 1978), generally located on low, natural rises along streams and rivers or on slopes with a southern exposure. One important village, *Pusune*, near Discovery Park, appears to have been recorded as CA-SAC-26. Other villages—*Wollok*, *Leuchi*, *Wishuna*, *Totola*, and *Nawrean*—were located east of the confluence of the Feather and Sacramento Rivers, near the northwestern portion of the Natomas Basin. Villages within the valley were aware of one another and these varying groups of Nisenan had shared political and cultural connections. Generally, villages consisted of 15 to 20 people and as many as several hundred in one group. House structures were conical, dome shaped, and covered with earth, tule mats, grass thatch, and occasionally bark. These structures, along with the ceremonial lodges or chief's residences were large and circular or elliptical and situated on low knolls near streams and above marshy floodplains.

The Nisenan mostly settled in permanent or winter settlements and followed a yearly gathering cycle that led them away from the lowlands and into the hill country each summer. During the annual gathering cycle, the Nisenan harvested acorns, nutmeg, pine nuts, buckeyes, and sunflower seeds and often stored these for long periods. Other vegetation such as greens, tule and cattail roots, brodiaea bulbs, Manzanita berries, black berries, and California grapes was harvested and eaten as it ripened. All valley groups, including the Nisenan, fished trout, perch, chub, sucker, hardhead, eels, sturgeon, and Chinook salmon. Fishing methods included hook, net, harpoon, trap, weir, and poison (Moratto 1984).

Euro-American contact with the Nisenan began with infrequent excursions by Spanish explorers and Hudson Bay Company trappers traveling through the Sacramento and San Joaquin Valleys in the early 1800s. In general, Nisenan lifeways remained stable for centuries until the early to middle decades of the 19th century. With the coming of Russian trappers and Spanish missionaries, cultural patterns began to be disrupted as social structures were stressed. An estimated 75% of the Valley Nisenan population died in the malaria epidemic of 1833. With the influx of Europeans during the Gold Rush era, the population was further reduced as a result of disease and violent relations with the miners.

Historic Setting

The following section is drawn from the Historical Overview of Dames & Moore's 1995 report: *Archeological Inventory Report, Lower American River Locality.* The historic period in interior central California began relatively late by comparison to much of North America, with little or no Euroamerican activity occurring until early in the nineteenth century. Although occasional Spanish exploring expeditions toured the California coast as early as the middle sixteenth century, for over 200 years most Spanish activity in the New World concentrated on colonizing and missionizing in Sonora, the Southwest, and Baja California. The California missions were never supported with adequate resources or personnel for full colonization of the area. Explorations in northern and central California eventually brought European settlers. First the Spanish, then the shift in government replaced New Spain with the republic of Mexico.

Americans and British soon followed, following the call of rich resources and land. Europeans and Americans soon began to establish more permanent settlements, acquiring land grants from the Mexican governors of California. John Marshall's discovery of gold at John Sutter's mill in 1848 brought on the Gold Rush which brought on a population boom for California and statehood. The relative isolation and sparse settlement of the Sacramento Valley ended with the discovery of gold. Because of its location near the mining areas, and its location at the farthest point upstream that ocean-going vessels could reasonable navigate, Sacramento soon became a central trading and market city. Mining continued to shape the region and levee systems were built up to protect the burgeoning population from the frequent flooding experienced in the area.

The history of the region is strongly tied to the mining industry and railroads to support mining activities. Throughout the years of development as Sacramento grew, gold remained an important focus of activities along the American River. After the initial Gold Rush, when gold became more difficult to collect, interest shifted to the exploitation of river beds, deep gravels, and quartz veins. River mining in particular was a far more complex technique, requiring the use of dams, ditches, and flumes to divert streams from their natural beds. The Chinese worked along bars, banks, and gulches and remnants of their camps and activities may still be found on the American River.

Dredging operations continued on the American River until quite recently. The peak of this activity appears to have occurred during World War I, declining thereafter. From 1927 to 1952, several operators dredged the Folsom District. Capital Dredge operated four dredges from 1927 to 1952; Gold Hill Dredging Company operated one dredge from 1933 to 1937; and General Hill Dredging Company operated three dredges from 1938 to 1951. Dredging activities dwindled along the American River until ending altogether in 1962.

Agriculture and ranching were the primary industries in the Sacramento County region during the historic period. Regional ranching originated on Sutter's New Helvetia rancho near modern day Sacramento in the early 1840s. The Gold Rush precipitated growth in agriculture and ranching, as ranchers and farmers realized handsome returns from supplying food and other goods to miners.

Results of the Records Search for the Study Area

Records searches of pertinent cultural resource information were conducted by the Corps in 2006 and 2007, and updated in 2010 and 2013 for the overall study area. Most of the searches were conducted at the North Central Information Center (NCIC) of the California Historical Resources Information System, located at California State University, Sacramento (CSUS). The NCIC records search covered portions of the study area in Sacramento and Yolo Counties. The northern portion of the Natomas area is within Sutter County so records searches for that area were also conducted at the Northeast Information Center (NEIC) located at California State University, Chico. The NEIC reported seven previous cultural resource studies in the study area within Sutter County, and the NCIC reported 278 previous studies in the Sacramento and Yolo County portions of the study area; thus a total of 285 studies have been conducted in the study area.

From those previous studies, a total of 175 cultural resources (archaeological and historical sites) were identified within the overall study area. Numerous archaeological investigations have covered large portions of the study area. These have generally focused on areas closest to the rivers and levees. There has been very little archaeological inventory of lands more than 100 feet from the levee toes, and ground surface visibility has frequently been poor even in surveyed areas. The most comprehensive of these investigations were completed by Far Western Anthropological Group (Far Western) in 1990 and Dames & Moore in 1994 as a broad survey in the Natomas Basin and American River, and more recently between 2007 and 2013 by AECOM Technology Corporation (AECOM).

Previously, in 1990, Far Western conducted surveys of areas along the same route later surveyed by Dames & Moore in 1994 (Dames & Moore 1994), as well as of additional areas (Bouey and Herbert 1990). Far Western (Bouey, Berg, and Hunter 1991) also performed limited test excavations at two sites south of Sacramento International Airport. Numerous cultural resources were identified in the course of previous survey efforts, including ranches and farms; agricultural, transportation, and reclamation features; and debris scatters, as well as prehistoric occupation and burial sites, frequently seen as mounds or the disturbed remnants of mounds.

Recent Related Cultural Resources Identification and Treatment in the Project Area

Fieldwork undertaken between 2007 and 2013 by AECOM (formerly EDAW) focused on the areas that would be affected by the Natomas Levee Improvements Project (NLIP) construction conducted by SAFCA: the Natomas Cross Canal south levee, Sacramento River east levee, the Elkhorn Canal and the new Giant Garter Snake/Drainage Canal, Sacramento County–owned Airport bufferlands, and most of the potential borrow sites.

The AECOM archaeologists first conducted a survey and shovel testing program within the project area to locate cultural resources. This program originally identified a total of 55 cultural resources including 21 historic sites, ten multi-component sites, ten prehistoric sites, ten isolates, and four resources that were later determined to not be cultural. Sites were then evaluated for eligibility for listing in the National Register of Historic Places (NRHP). Of the 51 remaining cultural resources, the prehistoric components of seven sites were determined to be eligible, 43 resources were determined not eligible, and one multi-component site was only evaluated for the historic component-which was determined not eligible for listing in the NRHP. Historic components of the seven eligible sites were determined not eligible for listing in the NRHP. The seven eligible sites and their treatment and/or mitigation is further described in Table 24. Sites determined eligible for the register that are not completely avoided are subject to Historic Property Treatment Plans (HPTP) that stipulate avoidance, data recovery, or some other form of mitigation to resolve adverse effects.

Table 24. NLIP Eligible Sites and Treatment and/or Mitigation.

Site Number	Type of Site	Treatment and/or Mitigation
CA-SAC-15/H	Multi Component – Historic Farm and Prehistoric Mound	Data Recovery of a portion of the site and special construction conditions in the HPTP.
CA-SAC-16/H	Multi Component – Historic Artifact Scatter and Prehistoric Mound	Cataloguing and analysis of existing museum collections, special construction conditions in the HPTP.
CA-SAC-1148	Prehistoric Mound	Avoidance with special construction conditions in the HPTP.
CA-SAC-485/H	Multi Component – Historic Farm and Prehistoric Mound	Avoidance/Special construction conditions in the HPTP.
CA-SAC-1112	Prehistoric Mound	Data Recovery-special construction conditions in the HPTP.
CA-SAC-1130/H	Multi Component – Historic Levee and Prehistoric Mound	Avoidance.
CA-SAC-1142	Prehistoric Mound	Avoidance.

Field Surveys

Due to the large geographic scope of the study area, limitations in access, the alluvial nature of the watershed, because levees and other structures have been built on top of much of the original native soil of the study area, and due to the high potential for buried cultural resources that will not be discovered until during construction, a 100% pedestrian survey of the entire study area could not be completed at this time. The portions of the study area that have been previously surveyed for cultural resources are shown on Figure 15.

To date, no new surveys have been undertaken for this project. However, surveys will be undertaken as part of the identification efforts, pursuant to a a Programmatic Agreement (PA), which is further described below and in Appendix C. The nature of those surveys will vary and have yet to be determined, but may include intensive pedestrian surveys, subsurface reconnaissance, geoarchaeological studies, and other survey methodologies.

Consultation with Native American Tribes and Identification of Resources

Through consultation with Native American Tribes, several locations within the study area that have been identified as sensitive for the presence of resources and sites that are important to the Tribes. Additional identification efforts, to include continual and ongoing consultation with Native American Tribes, will be conducted as part of compliance with Section 106 of the NHPA, in accordance with the PA (Appendix C).

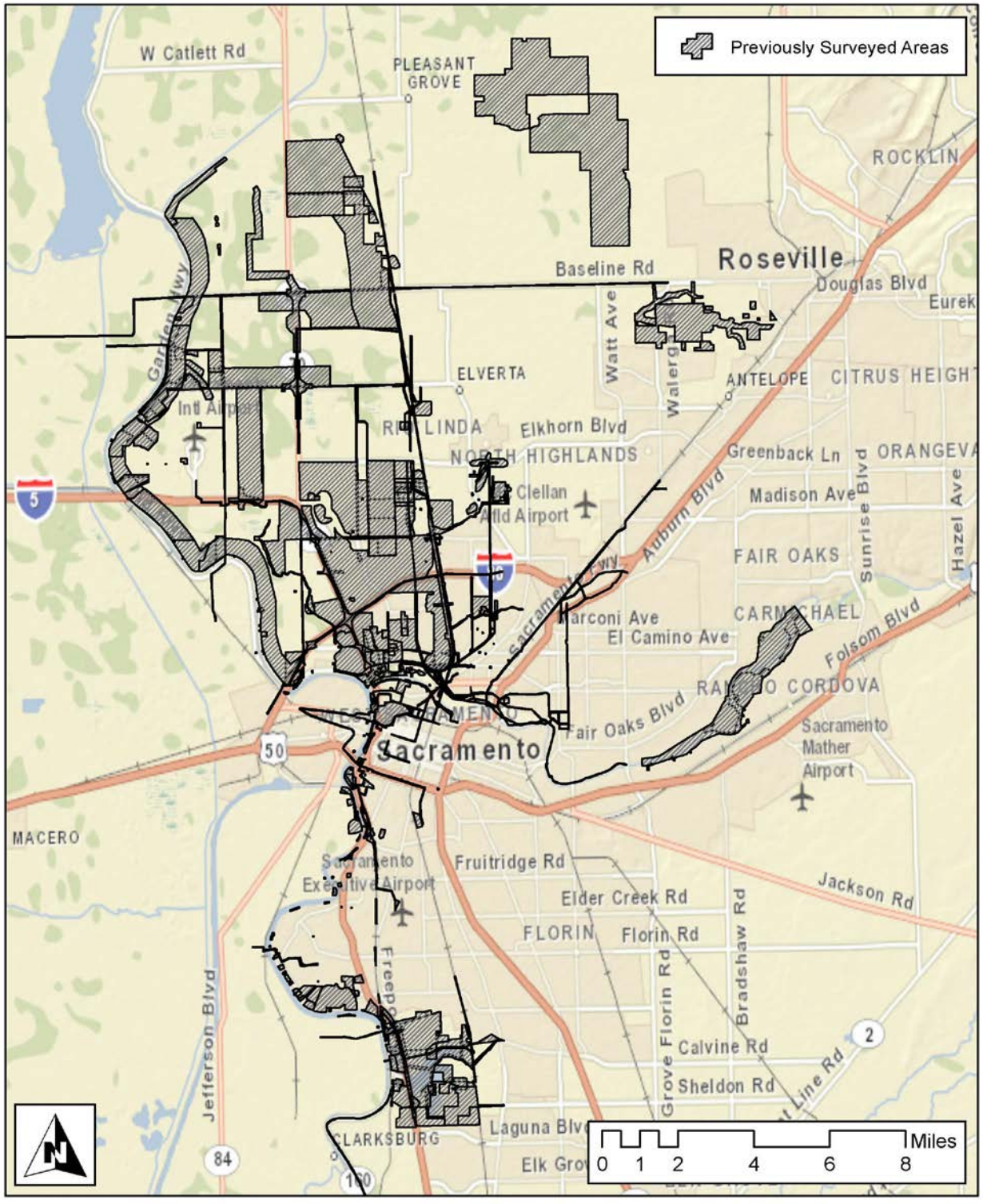

Figure 15. American River Common Features Study Area and Previous Cultural Resource Surveys.

Cultural Resources Site Types

Data from the records and literature search, concerns expressed by Native American Tribes during ongoing consultation efforts, knowledge of the prehistory and history of the study area, and recent archaeological surveys conducted as part of NLIP provide information on the types of cultural resource sites that may be found within the study areas. The known cultural resources within the study area can be categorized as the following general types within the Sacramento Valley:

- **Mounds** – Refers to relatively low natural rises or anthropogenic soil buildup occupied by Native Americans as habitation sites and burial locations. Discarded refuse and numerous fires frequently generated significant accumulations of midden soil on these features.
- **Midden** – Refers to prehistoric or proto-historic trash deposits containing food refuse, such as discarded bone, shell, and other organic matter; along with broken, discarded or lost artifacts made of various raw materials, including stone, wood, bone, antler, etc. The organic nature of middens tends to produce softer, darker, and greasier soils in contrast to the natural soils on which they rest. Deposition of midden often expanded the size of natural knolls or mounds both horizontally and vertically. Because of the softer soils in middens, they were also used as locations for human and/or animal burials. Middens generally include the full suite of artifacts, materials, and remains that would be encountered in a lithic scatter.
- **Lithics/Lithic Scatter** – The term "lithic scatter" refers to scatters of lithic (stone) debris (or debitage) resulting primarily from manufacture of chipped stone tools such as knives, dart points, arrow points, scrapers, adzes, and other tools. The process of manufacture by chipping or "knapping" resulted in percussion and pressure flakes removed from the raw natural resources of chert, obsidian, basalt, felsite and any other stone raw materials. Lithic scatters often contain fire-cracked rock distinguished by its fire reddened colors and sharp fracture patterns. Such rocks were often used for cooking by dropping heated rocks into baskets full of water and food. The sudden temperature change would commonly cause the rocks to fracture in a distinctive way. Ground stone tools used for processing foods and pigments are also common in lithic scatters. Finally, broken fragments of tools used for lithic manufacture such as hammerstones may also be associated with lithic scatters.
- **Traditional Cultural Properties** – Often referred to as "TCPs," Traditional Cultural Properties may be geographic features, locations, rural communities, urban neighborhoods, or other areas associated with cultural practices or beliefs of a living community that are rooted in that community's history, and are important in maintaining the continuing cultural identity of the community. TCPs may include locations associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world; may include buildings and structures, objects or landscapes; and may be associated with religious or cultural practices of Native Americans. Identification efforts may include background

research, oral history interviews, scientific analysis, and field investigations.

- **Traditional Cultural Landscapes –** As described by the Advisory Council on Historic Preservation (ACHP), the term "traditional cultural landscape" has not been formally defined by the National Park Service. Although there is no single defining feature or set of features that comprise a traditional cultural landscape, such places could be comprised of natural features such as mountains, caves, plateaus, and outcroppings; water courses and bodies such as rivers, streams, lakes, bays, and inlets; views and view sheds from them, including the overlook or similar locations; vegetation that contributes to significance; and manmade features including archeological sites, buildings and structures, circulation features such as trails, land use patterns, evidence of cultural traditions, such as petroglyphs, evidence of burial practices, and markers or monuments, such as cairns, sleeping circles, and geoglyphs.
- **Historic Debris** – This term may refer to a number of different artifacts 50 years of age or older that may be considered historical in nature. Cans, metal fragments, nails, glass fragments, glass bottles, and a variety of remnant material may be considered historic debris. In the Sacramento Valley this occasionally includes material thrown from railroad cars as passengers passed through the area, as well as abandoned machinery and equipment. Historic debris may be linked to a number of different historic subsistence activities such as farming, irrigation, infrastructure construction, mining, and homesteading.
- **Water Related** – The history of the Sacramento Valley is intertwined with that of flood control, reclamation, farming, and irrigation in the city of Sacramento and the surrounding areas. Much of the flood control infrastructure of the area dates back to the turn of the twentieth century. Water-related features may include levees, canals, weirs, bypass channels, drainage ditches, pump houses, wells, pipes, and farm-related structures and equipment.
- **Transportation** – A great number of roads, bridges, railroad tracks, and railroad trestles appear within the study area. These may include dirt or paved roads; bridges over canals, culverts, or other topographic features; and a variety of railroad features. Railroad features may include portions of the Transcontinental Railroad, the Walnut Grove Branch Line Railroad, raised berms that supported railroad rights-of-way, railroad trestle bridges, and lengths of railroad alignments. Within Sacramento, a number of historic railroad features are still in use today, both for the transport of goods, and recreationally and educationally associated with the California Railroad Museum in Old Town Sacramento just east of the Sacramento River.
- **Structures** – This refers to a variety of buildings or structures 50 years of age or older that shelter human activity. Within the project area these may include government offices, farmsteads, homesteads, residential structures, barns, ranches, power plants, and sheds. These structures may be made from materials such as wood, concrete, brick, masonry, stucco, and corrugated metal.

Human Remains

Human remains may be encountered within the study area. In the event that human remains are discovered, the CVFPB and landowner shall ensure that Native American human remains and grave goods that are located on state or private land are treated in accordance with the requirements of California State Health and Safety Code, Section 7050.5 and Public Resources Code 5097.98.

Archaeological Sensitivity Assessment

In addition to the conclusions regarding the various cultural resources site types that may be found within the study area, an archaeological sensitivity assessment for prehistoric resources was conducted. The sensitivity assessment was built using existing survey data to identify correlations between the occurrence of archaeological sites and environmental variables including proximity to water, historic vegetation, and lithology. This was accomplished in GIS using environmental data and information from the records search indicating where archaeological sites do and do not exist in areas that had been previously surveyed.

Programmatic Agreement

As a result of the various efforts (records and literature searches, archaeological sensitivity assessment, consultation with Native American Tribes, consultation with the interested public, review of existing and recent archaeological inventories and discoveries) to identify cultural resources within the study area, the Corps has determined that the project will likely have an adverse effect on properties that are either included in, or are eligible for inclusion, in the NRHP. Due to the large geographic scope of the project, the lack of detailed designs to determine construction specific APEs, and limitations in available funding to complete full identification of potential historic properties prior to approval of the project, the Corps has also determined that it cannot fully determine the effects of the project on NRHP eligible properties for all phases and segments of the project at this time.

In order to provide a framework for the Corps to identify cultural resources, evaluate cultural resources for their eligibility for inclusion in the NRHP, determine possible effects to historic properties, and mitigate effects to historic properties as a result of the project, a PA has been developed by the Corps in consultation with the SHPO, the ACHP, and Native American tribes with concerns in the area as potential Concurring Parties. The PA covers the ARCF Project, as well as segments of NLIP not previously completed. The PA provides a process for the identification and evaluation of historic properties and, if necessary, the resolution of adverse effects to identified historic properties. The PA also provides a process for handling post-review discoveries. Per the PA, all Corps construction activities will avoid archaeological sites/historic properties, both eligible and non-eligible, to the maximum extent practicable. Per the PA, all Corps construction activities will avoid historic properties to the maximum extent practicable.

The draft PA was provided to the California Department of Water Resources (DWR) and the CVFPB on April 11, 2012 and February 22, 2013, and to SAFCA on February 12, 2013, and potentially interested Native Americans on April 5, 2013, June 6, 2013, June 12, 2014, and June 25, 2014 for review and comment as part of the development of the PA. The final PA, executed by signature by the Corps and the SHPO on September 10, 2015, is appended to this EIS/EIR (Appendix C).

3.9.2 Methodology and Basis of Significance

Methodology

Analysis of impacts was based on evaluation of the potential changes to the existing historic properties that would result from implementation of the project. The term "historic property" refers to any cultural resource that has been found eligible for listing, or is listed, in the NRHP. Section 106 of the NHPA requires that Federal agencies evaluate and consider the effects of their undertakings on historic properties. It is only when a cultural resource is determined to be a historic property that the Federal agency is required to make a determination of effect for the undertaking. In making a determination of the effects to historic properties, consideration was given to:

- Specific changes in the characteristics of historic properties in the study area.
- The temporary or permanent nature of changes to historic properties and the visual study area around the historic properties.
- The existing integrity considerations of historic properties in the study area and how the integrity was related to the specific criterion that makes a historic property eligible for listing in the NRHP.

For the ARCF Project, the PA is the means by which the Corps will comply with Section 106. The PA includes stipulations that outline the process to identify cultural resources, evaluate cultural resources for their eligibility for inclusion in the NRHP, determine possible effects to historic properties, and, if necessary, mitigate effects to historic properties resulting from implementation of the project.

Application of Archaeological Sensitivity Assessment

The Archaeological Sensitivity Assessment covers all areas where the Corps may implement construction for the ARCF. The description below is an abbreviated version of the function and structure of the assessment procedure.

The model is designed to produce an approximate value reflecting the probability of an archaeological site existing, visible on the surface of the ground, within 70 meters of any given point in the study area. Units of analysis in the model are an array of points spaced 100 meters apart across the footprint of the ARCF study area. Environmental variables including lithology, historic water courses, and historic vegetation are mapped in the GIS. Those layers are then queried and each data point is associated with a set of these variables.

A calibration data-set is established using those points located within the footprints of previous archaeological surveys where it can be known with some certainty whether a given point is, or is not, located within 70 meters (roughly half the diagonal distance between points on a 100 meter grid) of an archaeological site. Figure 14 illustrates the footprints of previous surveys that have taken place in the study area. For each point in the calibration data set, the following attributes were populated: whether or not the point exists within 70 meters of an archaeological site, the distance to a source of permanent water, the historic vegetative community, and the lithologic unit in which the point is located.

Correlations between the occurrences of each environmental attribute were described mathematically using a regression function. Using the equation generated by the regression for each of the environmental attributes, the probability of site location is extrapolated across a larger 100 meter grid superimposed over un-surveyed portions of the study area using the environmental variables that characterize each of these data points.

This produced three separate maps which individually estimate archaeological sensitivity based on one environmental attribute. The selected environmental attributes are closely related to one another, and typically predict archaeological sensitivity in broadly similar ways. The results produced by the three approaches can be compared by mapping sensitivity predicted by one variable normalized (i.e. divided by) the sensitivity predicted by another. In the case of data points where the two variables predict similar levels of sensitivity, the normalized value is very close to 1.0. However, if the two variables predict significantly different levels of sensitivity, the normalized value will be either well below or above 1.0.

The model was used to generate a predicted number of archaeological sites that would be impacted by each alternative. These results are presented along with a brief sensitivity discussion based on the environmental variables present within the footprints of each alternative.

Basis of Significance

Any adverse effects on cultural resources that are listed or eligible for listing in the NRHP (i.e., historic properties) are considered to be significant. Effects are considered to be adverse if they:

- Alter, directly or indirectly, any of the characteristics of a cultural resource that qualify that resource for the NRHP so that the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association is diminished.
- Cause a substantial adverse change in the significance of a historic property through the physical demolition, destruction, relocation, or alteration of the historic property of its immediate surroundings such that the significance of the resource would be materially impaired.

Under California law, effects to a historical resource or unique archaeological resource are considered to be adverse if they:

- Materially impair the significance of a historical resource or unique archaeological resource.
- Require the demolition of a historical resource.

3.9.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. If a flood event were to occur, potential historic properties such as levees or prehistoric sites within the study area could undergo damage from erosion or levee failure. In addition, there would be no direct effects to potential historic properties as a result of construction if the project is not built. Sections of the Sacramento and American River levees have been determined eligible for listing in the NRHP and could be damaged should the levees fail. Levee failure resulting in the inundation of residences and other buildings and structures could threaten the integrity of those resources that may be historic properties. As a result, the No Action Alternative would likely result in an adverse effect to cultural resources. However, the magnitude of the adverse effect would depend on the location of the levee failure, severity of the storm, and river flows at the time. As a result, any evaluation of the significance of the effect would be merely speculative .

3.9.4 Alternative 1 – Improve levees

The effects of the erosion repair on the American River, levee geometry measures, cutoff walls, and bank protection on the Sacramento River and construction of cutoff walls, correction of the levee geometry, installation of floodwalls, installation of a conduit or box culvert, raising of floodwalls and existing levees, construction of maintenance roads, installation of floodgates, and creation of a detention basin on the East Side Tributaries would likely result in an adverse effect to some historic properties located within the APE for the project. Adverse effects to historic properties are considered significant. Approximately 30% of the APE for Alternative 1 has been previously inventoried for cultural resources.

The records and literature search conducted for the project identified 69 known prehistoric and historic resources in the total project APE. For the purposes of this EIS/EIR, the Corps assumes that all of these resources would be impacted by the levee improvement alternatives. Site specific determinations of effect and impact cannot be made at this time because each site within the APE would need to be field checked, the previous recordation (included site boundary, associated features, integrity) verified, and each site would need to be considered for eligibility for listing in the NRHP. The process for field checking cultural resources sites and making determinations of eligibility for listing in the NRHP are outlined in the PA. The specific sites are listed on Table 25 and the general levee fix site locations (American River, Sacramento River, East Side Tributaries) that would impact each resource are indicated as well. In Table 28, Primary refers to a cultural resource site's assigned identification number. In California, nearly all identified cultural resource sites are given a Primary number when initially recorded, but Trinomial identification numbers are assigned to cultural resources upon receipt of adequate documentation by the California Historic Resources Information System.

Table 25. Known Prehistoric and Historic Resources within the APE.

Primary	Trinomial	Site Type	Hist	Pre	American River	Sacramento River	East Side Tributaries
34-00011		Isolate: Gunther point		x		x	
34-00012		1900-1910 farmhouse	x			x	
34-00044	CA-SAC-17	Mound (not relocated, cf. CA-SAC-494/H)		x		x	
34-00045	CA-SAC-18	Mound/ lithic scatter		x		x	
34-00053	CA-SAC-26	Mound		x	x		
34-00058	CA-SAC-31	Mound and historic residence	x	x	x		
34-00059	CA-SAC-32	Mound (possibly destroyed)		x	x		
34-00066	CA-SAC-39	Mound		x	x		
34-00067	CA-SAC-40	Mound (not relocated)		x	x		
34-00070	CA-SAC-43	Mound		x		x	
34-00071	CA-SAC-44	Mound (possibly destroyed)		x		x	
34-00073	CA-SAC-46	Mound (not relocated)		x		x	
34-00075	CA-SAC-48	Mound		x		x	

Primary	Trinomial	Site Type	Hist	Pre	American River	Sacramento River	East Side Tributaries
34-00191	CA-SAC-164	Midden		x		x	
34-00295	CA-SAC-268	Lithic scatter		x		x	
34-00333	CA-SAC-306/H	Mound and historic features/debris	x	x	x		
34-00343	CA-SAC-316	Mound (may not be cultural)		x	x		
34-00457	CA-SAC-430/H	Managed channel	x			x	
34-00486	CA-SAC-459/H	Ranch buildings	x				x
34-00490	CA-SAC-463H	RD 100 and associated resources	x		x	x	x
34-00491	CA-SAC-464H	Western Pacific Railroad	x		x		x
34-00494	CA-SAC-467H	Cistern and spillway	x		x		
34-00495	CA-SAC-468H	Concrete structure	x		x		
34-00508	CA-SAC-481H	American River right bank levee	x		x		x
34-00509	CA-SAC-482H	American River left bank levee	x		x	x	
34-00521	CA-SAC-494/H	Prehistoric and Historic debris (possibly associated with CA-SAC-17)	x	x		x	
34-00522	CA-SAC-495H	Arcade Creek levees	x				x
34-00619	CA-SAC-505H	Historic debris	x			x	
34-00639		WWII Victory Trees	x			x	
34-00640	CA-SAC-516H	Pumping station	x				x
34-00641	CA-SAC-517H	Historic debris	x				x
34-00642	CA-SAC-518H	Concrete bridge abutments	x				x
34-00643	CA-SAC-519H	Robla Creek levee	x				x
34-00644	CA-SAC-520H	Modern building (built 1995)	x				x
34-00645	CA-SAC-521H	Union Pacific Railroad trestle bridge	x				x
34-00646	CA-SAC-522H	Northern Electric concrete slab bridge	x				x
34-00647	CA-SAC-523H	Railroad trestle bridge	x				x
34-00739	CA-SAC-567H	Historic road	x				x
34-00740	CA-SAC-568H	Historic road	x		x		x
34-00741	CA-SAC-569H	Historic Del Paso Road	x				x
34-00742	CA-SAC-570H	Historic road	x		x		
34-00746	CA-SAC-571H	Sacramento Northern Railroad	x		x		
34-00749	CA-SAC-574H	Historic dump	x		x		
34-00816	CA-SAC-623H	Historic residence	x			x	
34-00817	CA-SAC-624H	Historic residence	x			x	
34-00832	CA-SAC-641H	Farmstead	x			x	
34-00833	CA-SAC-642H	Historic residence	x			x	
34-00858	CA-SAC-657H	Hagginwood/ N. Sacramento dump	x		x		
34-00859	CA-SAC-658H	Pilings in the river	x			x	
34-00884		Historic Road	x			x	
34-00886		Historic Elkhorn Boulevard	x				x
34-00895		River dock	x			x	
34-01000	CA-SAC-689H	Sacramento Gas Works tank supports	x			x	
34-01374		Railroad bridge	x			x	
34-01436	CA-SAC-866H	El Camino Avenue bridge	x				x

Primary	Trinomial	Site Type	Hist	Pre	American River	Sacramento River	East Side Tributaries
34-01497		Southern Pacific Railroad	x			x	
34-01580	CA-SAC-954H	Railroad depot	x			x	
34-01611	CA-SAC-960H	Cliff's marina	x			x	
34-01663		Historic state route 160	x		x		
34-01711		PG&E Power Plant	x			x	
34-02104		Row of valley oaks	x			x	
34-02143		Sacramento River levee	x			x	
34-02215	CA-SAC-115H	Ranch buildings	x			x	
51-00080		Historic debris	x				x
51-00083		Feed mill	x				x
51-00084	CA-SUT-84H	Natomas cross canal and Pleasant Grove Creek levees	x				x
51-00085	CA-SUT-85H	NEMDC east levee	x				x
51-00138	CA-SUT-138H	Historic residence	x				x
	CA-SAC-1115/H	Historic Buildings	x			x	

The results of the archaeological sensitivity assessment, which are based on proximity to water sources, lithology, and historic vegetation, are quite consistent in the areas around the levee fixes along the Sacramento and American Rivers. In these areas, predicted archaeological sensitivity is expected to be most accurate. However, the assessment may be overestimating sensitivity in the areas around the East Side Tributary levee improvements. The dominant vegetation throughout much of this portion of the project APE was historically grassland, which the sensitivity assessment suggests may be less sensitive than proximity to water alone would indicate. Based on the application of the Archaeological Sensitivity Assessment, the Corps estimates that an additional 12 prehistoric archaeological sites could be located in close proximity to the APE for Alternative 1, in addition to the sixty-nine known from the records and literature search.

Specific individual determinations of effect for historic properties that may be affected by Alternative 1 would be completed under the stipulations of the PA, which includes a framework to identify historic properties, evaluate NRHP eligibility, and assess effects. Although specific effects to historic properties cannot be determined at this time, effects could include, but is not limited to, the following: temporary visual and auditory effects caused by construction activities, temporary lack of access and/or privacy to areas traditionally used by Native American tribes for ceremonies, temporary and/or permanent effects to the viewshed of TCPs caused by construction activities and associated noise levels, vibration or compression effects caused by construction activities to historic properties located in proximity to construction activities, alteration or destruction of built environment resources, removal of trees and vegetation that may represent plants significant to Native American tribes and used in ceremonies or for other traditional uses.

The adverse effects to cultural resources as a result of Alternative 1 would be reduced to less than significant by implementing stipulations in the PA intended to resolve adverse effects to historic properties through development of a Historic Properties Management Plan (HPMP) and potential development of Historic Property Treatment Plans (HPTPs). The HPMP and HPTPs may include a number of possible mitigation measures to reduce effects to less than significant. Although adverse effects to historic properties may include demolition and direct or indirect alteration of a cultural resource's characteristics that qualify the resource's eligibility for listing in the NRHP, adverse effects would be resolved by developing HPTPs that specifically address the changes caused by the alternative to the individual resource. Those may include Historic American Building Survey/Historic American Engineering Record/Historic American Landscape Survey (HABS/HAER/HALS), oral histories, historic markers, exhibits, interpretive brochures or publications, or other methods agreed upon by the Corps and SHPO and in consultation with Native American tribes and other interested parties. Further discussion of specific effects anticipated for Alternative 1 and known cultural resources within those parts of the APE are below.

American River

Within the APE identified for erosion repairs on the American River, a number of cultural resources are known (Table 25), though most have not yet been evaluated for NRHP eligibility. The only known NRHP eligible site (i.e. historic property) is the American River levee. Portions of the levee have been previously found eligible for listing in the NRHP. Impacts could be incurred to prehistoric sites located under or near the levees that may be disturbed by construction of the launchable rock trench, installation of rock on the levee slope, and the construction of access ramps. Historic sites such as the levees, levee features, and buildings, structures, or objects could be impacted by modification to existing features, removal, or temporary relocation due to project construction. The effects of the erosion repair on the American River would likely result in an adverse effect to some of the sites and resources listed on Table 25, and possibly to others that may be discovered during the inventory efforts required under the PA. However, with the implementation of the PA, these effects would be reduced to less than significant under NEPA. Effects to historical and unique archaeological resources under CEQA would be potentially significant and unavoidable.

Sacramento River

Known historic and prehistoric sites and resources that exist within the APE, including the Sacramento River levee and associated features, are listed in Table 25. The only known NRHP eligible sites (i.e. historic property) include CA-SAC-1115/H, a complex of historic buildings, and the Sacramento River levee. Portions of the levee have been previously found eligible for listing in the NRHP. Impacts could be incurred to prehistoric sites located under or near the levees that may be disturbed by construction of the cutoff walls, measures to correct the levee geometry, and installation of bank protection. Other effects to historic properties may result from disturbance of cultural resources sites

due to the construction of access ramps and possibly removal of structures due to the acquisition of properties for levee construction, inspection, maintenance, monitoring, and flood-fighting access. The effects of the levee geometry measures, construction of cutoff walls, and installation of bank protection on the Sacramento River would likely result in an adverse effect to some historic properties located within the APE for the Sacramento River. However, with the implementation of the PA, these effects would be reduced to less than significant under NEPA. Effects to historical and unique archaeological resources under CEQA would be potentially significant and unavoidable.

East Side Tributaries

Proposed activities that would occur within the APE for these levee improvements includes construction of cutoff walls, correction of the levee geometry, installation of floodwalls (NEMDC), installation of a conduit or box culvert, installation of geotextile material and a floodwall, correction of the levee geometry (Arcade Creek), raising of a floodwall, correction of the levee geometry (Dry and Robla Creeks), raising of the existing levee, construction of maintenance roads, installation of floodgates, construction of a box culvert, and creation of a detention basin (Magpie Creek Diversion Canal). Historic and prehistoric archaeological sites and resources known to occur in these areas are listed in Table 25. Other potential cultural resources that may be affected include previously unidentified prehistoric sites located under or near the levees that may be disturbed by the construction of cutoff walls or the installation of maintenance roads and creation of the detention basin, and historic sites relating to the existing levees or within the areas identified for the ground disturbing activities. The effects of the measures described above for the East Side Tributaries would likely result in an adverse effect to some historic properties located within the APE for the East Side Tributaries. However, with the implementation of the PA, these effects would be reduced to less than significant under NEPA. Effects to historical and unique archaeological resources under CEQA would be potentially significant and unavoidable.

3.9.5 Alternative 2 – Sacramento Bypass and Improve Levees

Effects to cultural resources from the construction of levee improvements under Alternative 2 would be consistent with those analyzed for Alternative 1 with the addition of effects resulting from construction of the Sacramento Weir and Bypass widening. The effects of Alternative 2 would likely result in an adverse effect to some historic properties located within the APE for the project. Adverse effects to historic properties are considered significant. Like Alternative 1, approximately 30% of the APE for Alternative 2 has been previously inventoried for cultural resources. The addition of the Sacramento Weir and Bypass reduces the need for levee raising on the Sacramento River to less than 1 mile compared to 8 miles with Alternative 1. The Sacramento Bypass has not been previously inventoried for cultural resources, however the Sacramento Weir has been previously recommended as eligible for inclusion in the NRHP.

In addition to known cultural resources sites and anticipated discoveries described under Alternative 1, the Archaeological Sensitivity Assessment predicts slightly less than one additional archaeological site in the APE under Alternative 2. These results suggest that there is approximately an 80% chance of encountering at least one prehistoric archaeological site. However, the majority of this Alternative occurs in the Qb lithologic unit (Holocene basin deposits) which, according to the sensitivity analysis done for the Archaeological Sensitivity Assessment, may be less archaeologically sensitive than proximity to water sources might suggest.

For purposes of NHPA compliance, the specific individual determinations of effect for historic properties that may be affected by Alternative 2 would be completed under the stipulations of the PA, which include a framework to identify historic properties, evaluate NRHP eligibility, and assess effects. The adverse affects to cultural resources as a result of Alternative 2 would be reduced to less than significant by implementing stipulations in the PA to resolve adverse effects to historic properties through development of an HPMP and potential development of HPTPs. Further discussion of effects from the features of Alternative 2 and known cultural resources within that part of the APE different from Alternative 1 are below.

Sacramento Bypass

Within the APE identified for construction of levee improvements associated with the Sacramento Weir and Bypass widening, the Sacramento Weir is a known potential historic property. Although specific design refinements for the widening of the weir are not complete, modifications to the weir may result in an adverse effect to the Sacramento Weir, which could result in a significant effect. Other potential cultural resources and historic properties that may be affected include prehistoric or historic sites located under or near the north side of the Sacramento Bypass where the channel may be widened and disturbed and where relief wells may be installed. Affects to historic properties may also result from disturbance of cultural resources sites due to remediation of a hazardous, toxic, and radiological waste (HTRW) site near the existing north levee, which may consist of historic era debris. HTRW sites encountered would be removed and properly disposed of prior to land acquisition and would be the responsibility of the local partners. The effects of the widening of the Sacramento Weir and Bypass may result in an adverse effect to some historic properties located within the APE for the Sacramento Bypass. However, with the implementation of the PA, these effects would be reduced to less than significant under NEPA. Effects to historical and unique archaeological resources under CEQA would be potentiallysignificant and unavoidable.

3.9.6 Mitigation Measures

The Corps has determined that the No Action Alternative, Alternative 1, and Alternative 2 may result in an adverse effect to historic properties. Because there would be no Federal undertaking under the No Action Alternative, no further action is required by the Corps under the No Action Alternative. Adverse effects to cultural resources eligible for listing or listed in the NRHP are considered significant. Adverse effects would only potentially result with the Corps' execution of Alternatives 1 or 2. Under NEPA and the NHPA, any significant effect that would result from the implementation of Alternatives 1 or 2 would be reduced to less than significant, as adverse effects would be resolved by implementing stipulations in the PA. Under CEQA, the impacts to historical and unique archaeological resources as a result of Alternatives 1 or 2 would be significant and unavoidable. Mitigation for these impacts would be proposed in accordance with the PA.

Avoidance of adverse effects to historic properties is the preferred treatment approach. The Corps will consider design refinements of project elements in order to avoid historic properties and project effects that may be adverse. Avoidance of adverse effects to historic properties is a significant part of the Corps planning and cultural resources management for this project as described in the PA. However, it may not be possible to refine the design of the project in order to avoid adverse effects to historic properties. Implementation of the PA would resolve adverse effects to historic properties through development of a HPMP and, if necessary, development of HPTPs. Mitigation measures for historic properties adversely affected by the project may include data recovery, Historic American Building Survey/Historic American Engineering Record/Historic American Landscape Survey documentation, oral histories, historic markers, exhibits, interpretive brochures or publications, or other means determined in accordance with execution of the PA and the HPMP and HPTP(s). With the execution and implementation of the PA, the ARCF GRR project is in compliance with Section 106 of the NHPA.

3.10 Transportation and Circulation

3.10.1 Environmental Setting

Regulatory Setting

- Federal Highway Administration (FHWA) Standards
- California Department of Transportation (CalTrans) Standards
- Sacramento County General Plan Circulation Element

Existing Conditions

The study area is urbanized with many roads and levee structures which can be used for construction activities if a project is authorized. There are also many public and non-public access points to the levee structures in the study area.

Sacramento County uses a roadway classification system for long-range planning and programming. Roadways are classified based on the linkages that they provide and their function, both of which reflect their importance to the land use pattern, traveler, and general welfare. The functional classification system recognizes differences in roadway function and standards between urban/suburban areas and rural areas. The following list describes the linkage and functions provided by each class:

- **Freeways:** Operated and maintained by Caltrans, these facilities are designed as high-volume, high-speed facilities for intercity and regional traffic. Access to these facilities is limited, and in some cases on- and off-ramps are metered during peak-hour periods to reduce congestion caused by merging cars and trucks.
- **Arterials:** Major arterials (four to six lanes) and minor arterials (four lanes) are the principal network for through-traffic within a community, and often between communities.
- **Collectors:** These two-lane facilities function as the main interior streets within neighborhoods and business areas. Collectors serve to connect these areas with higher classification roads (i.e., arterials and freeways).
- **Local Streets:** These facilities are two-lane streets that provide local access and service. They include residential, commercial, industrial, and rural roads.

To evaluate a roadway's operational characteristics, a simple grading system is used that compares the traffic volume carried by a road with that road's design capacity. Levels of service (LOS) are used to measure the quality of operational conditions within a traffic stream based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. Six LOS range from A (best) to F (worst) and describe each type of transportation facility discussed above.

Most analyses typically use service flow rates at LOS C, D, or higher to describe acceptable operating service for facility users. LOS E generally is considered unacceptable for planning purposes, unless there are extenuating circumstances or attain a higher LOS is not feasible or extremely costly. For LOS F, it is difficult to predict flow due to stop-and-start conditions. LOS are typically described in terms of traffic operating conditions for intersections, and would be applicable to roadway conditions, as shown in Table 26 below.

Table 26. Regulatory Criteria for Roadways and Intersections.

Level of Service (LOS)	Description of Traffic Conditions
A	Conditions of free flow; speed is controlled by the driver's desires, speed limits, or roadway conditions.
B	Conditions of stable flow; operating speeds beginning to be restricted; little or no restrictions on maneuverability from other vehicles.
C	Conditions of stable flow; speeds and maneuverability more closely restricted; occasional backups behind left-turning vehicles at intersections.
D	Conditions approach unstable flow; tolerable speeds can be maintained, but temporary restrictions may cause extensive delays; little freedom to maneuver; comfort and convenience low; at intersection, some motorists, especially those making left turns, may wait through one or more signal changes.
E	Conditions approach capacity; unstable flow with stoppages of momentary duration; maneuverability severely limited.
F	Forced flow conditions; stoppages for long periods; low operating speeds.

Source: Transportation Research Board, 2000

Regional roadways in the greater project area that connect the various basins include freeways and major arterial roadways. The freeways in the project area include the following:

- **Interstate 80 (I-80):** I-80 is a major freeway that runs northeast to southwest through the project area. I-80 heads towards Reno to the east and San Francisco to the west. The freeway crosses the Sacramento River just south of the Sacramento Bypass and continues northeast into the Natomas Basin. It is the primary transportation corridor from Sacramento to the Roseville and Rocklin area of Placer County.

- **U.S. Highway 50 (U.S. 50):** U.S. 50 is a major highway that runs east to west through the Sacramento area. U.S. 50 is the primary transportation corridor from Sacramento to the foothills in El Dorado County and Lake Tahoe. U.S. 50 crosses the Sacramento River near downtown Sacramento from the west, and transects American River South basin from east to west, running generally parallel to the American River.
- **Interstate 5 (I-5):** On the western edge of the study area I-5 runs parallel to the Sacramento River and is the primary transportation corridor between northern and southern California. I-5 passes over the American River in the downtown area near the confluence of the Sacramento and American rivers and continues north into the Natomas basin. The Sacramento River levee is directly adjacent to I-5 from downtown Sacramento to about one mile south near the Sutterville Road off ramp.

- **Business 80/Capitol City Freeway:** Business 80, also known as the Capitol City Freeway, runs north, connecting U.S. 50 in downtown Sacramento to I-80. Business 80 crosses the American River near Cal Expo. This freeway is a major commute route to downtown Sacramento.
- **Highway 160:** Highway 160 is a minor freeway that connects Business 80 to downtown Sacramento. It runs east to west in the American River North basin from Business 80 to 16th Street in downtown Sacramento. Highway 160 crosses the American River just upstream of the confluence with the Sacramento River and downstream of Business 80.

Railroads

The Sacramento area has several railroad crossings, including the Union Pacific Railroad (UPRR), the Western Pacific Railroad (WPRR), the Northern Sacramento Railway, and the Yolo Shortline railroad tracks. The Sacramento Valley Station is a major rail hub utilized by several rail companies, including Amtrak and the Sacramento Regional Transit District light rail. These rail lines connect the greater Sacramento area with goods, services, and public transportation. There is a portion of the Sacramento Southern Railroad located along the Sacramento River that is still in recreational use by the California State Railroad Museum. Potential impacts to this segment of railroad are further discussed in Section 3.14, Recreation.

American River

The American River levees would be accessed primarily from I-80, U.S. 50, Business 80, and Highway 160, as described above. In addition, the major arterial roadways which would be used to access the project areas include Watt Avenue, Howe Avenue, Fair Oaks Boulevard, Folsom Boulevard, and Arden Way. These major roadways would be used to connect to local, minor arterials, and connectors to access the study areas.

Five vehicle bridges, which are major arterial roadways, cross the American River: I-5, Business 80, Highway 160, Watt Avenue, Howe Avenue, and H Street. These roads and bridges are the primary commuter routes within the study area. Between the H Street and Howe Avenue bridges, the Guy West Bridge provides pedestrian access across the river into CSUS. Additionally, there are two railroad crossings on the American River between Highway 160 and Business 80 and one Sacramento Regional Transit light rail track crossing on the Highway 160 American River bridge.

Within the study area, adjacent to the levee system, are many residential streets used primarily for access to the main commuter routes and homes. The streets are also used to access the American River Parkway for both land based and water based recreation activities. Access to the Parkway within this reach requires crossing the levee structure. Many public roads provide access to recreation facilities along the American River, including: William Pond Recreation Area, Campus Commons Golf Course,

River Bend Park, Gristmill Park, Waterton Park, Watt Avenue, Glen Hall Park, Howe Avenue, Sutter's Landing Regional Park, and Discovery Park. Most of these access points require crossing the levee structure to enter the recreation facilities. Although the actual recreation trail is located at the levee toe in most areas in this reach, often pedestrian commuters to CSUS will use the top of the levee.

Sacramento River

The Sacramento River levees would be accessed primarily from U.S. 50 and I-5. In addition, the major arterial roadways which would be used to access the project areas include Richards Boulevard, Meadowview Road/Pocket Road, 43rd Avenue, Riverside Boulevard, and Freeport Boulevard. These major roadways would be used to connect to local, minor arterials, and connectors to access the study areas. Work along the Sacramento River near Old Sacramento could have affects to access across the Tower Bridge during the installation of the floodwall along the levee. Coordination with Department of Transportation would occur to ensure that traffic can continue access between Sacramento and West Sacramento. This could include detours to the I Street Bridge to cross the Sacramento River in this area. There are no major bridges within this area of the project that would be impacted by construction of the project.

Access to the levees in this area is from residential streets which connect to maintenance ramps and public access points. Most of these streets are two lane roads with residents on both sides. On the Sacramento River, Miller Park and Garcia Bend Park provide public access to the levee and river. Garcia Bend Park is one of the few locations where park access does not require crossing the levee, however, access to the boat launch does require crossing the levee.

Further south in the study reach, Freeport Boulevard runs parallel to the levee for about 3 miles to the end of the study area. South of Pocket Road/Meadowview Road, Freeport Boulevard (Highway 160) is a rural two lane road used to access the town of Freeport and many small Delta towns south of the project. There is limited access to the levee structure in this southern portion of the reach.

East Side Tributaries

The east side tributaries area would primarily be accessed via I-80. In addition, major arterial roadways that would be used to access construction sites include Raley Boulevard, Norwood Avenue, and Marysville Boulevard.

Site access to the NEMDC east levee is extremely limited, because the Union Pacific railroad runs along the landside levee toe. As a result, site access to NEMDC will be primarily via the Arcade Creek levee and over the railroad tracks. Additional site access to NEMDC could occur from the Dry/Robla Creek south levee via Main Avenue and Kelton Way.

Sacramento Bypass

The Sacramento Bypass area would be accessed primarily by I-80 or U.S. 50. Major arterial roadways that serve the project area include Reed Avenue and Harbor Boulevard. The Sacramento Bypass can only be accessed by North Harbor Boulevard, which turns into Old River Road near the bypass. This section of the roadway north of Reed Avenue is classified as a connector roadway. North Harbor Boulevard/Old River Road runs along the top of the Sacramento Weir, as does the Yolo Short line railroad tracks.

3.10.2 Methodology and Basis of Significance

Methodology

The proposed alternatives, if authorized, would consist of constructing levee improvements throughout the Sacramento area. Construction would intermittently generate substantial volumes of traffic due to the earthwork involved and the need for materials deliveries. Once the construction is completed, maintenance needs would be similar to current conditions. Analysis of traffic effects therefore concentrated on the construction of levee alternatives. The key effects were identified and evaluated based on the environmental characteristics of the study area and the magnitude, intensity, and duration of activities related to the construction and operation of this project.

Basis of Significance

Project alternatives under consideration would result in a significant effect related to transportation and circulation if they would:

- Substantially increase traffic in relation to existing traffic load and capacity of the roadway system.
- Substantially disrupt the flow of traffic.
- Expose people to significant public safety hazards resulting from construction activities on or near the public road system.
- Reduce the supply of parking spaces sufficiently to increase demand above supply.
- Cause substantial deterioration of the physical condition of nearby roadways.
- Result in inadequate emergency access.
- Disrupt railroad services for a significant amount of time.

3.10.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. Traffic would be expected to remain generally the same in the Sacramento Metropolitan Area, with gradual increase associated with urban population growth.

In the event of a flood, roadways and railroads could be inundated with floodwaters, causing disruptions in traffic, inadequate emergency access, deterioration of the roadway condition, and exposing people to public safety hazards. Some of these roadways could be emergency evacuation routes which would result in people being stranded or prevent emergency vehicles from getting to those in need of help. Roadways and railroads could also be damaged by the floodwaters and would require repairs once waters have receded. A precise determination of significance is not possible and cannot be made because the extent of magnitude of impact is unknown. Because of this uncertainty, this potential impact is considered too speculative for meaningful consideration.

3.10.4 Alternative 1 – Improve Levees

Implementation of Alternative 1 would require hauling construction equipment and materials along highways and local roads that provide access to the project levees. Proposed construction actions are not expected to result in a reduction of parking availability, since construction vehicles would be required to park in designated staging areas. The estimated duration of construction for each study reach under Alternative 1 is shown on Table 4 in Chapter 2. Construction of Alternative 1 is estimated to take approximately 10 years, with work spread out evenly over the entire time period. There would be no impact to transportation from long-term O&M of Alternative 1.

Evaluation of effects to transportation are based on a maximum of 1 million cubic yards of borrow material and 2.8 million tons of rock being transported for construction. Construction would intermittently generate substantial volumes of traffic due to the earthwork involved and the need for materials deliveries. Traffic patterns would return to existing conditions once construction is completed. Traffic associated with long-term maintenance would not change following construction of the ARCF GRR.

Implementation of Alternative 1 would result in a substantial increase in traffic on local roadways associated with truck haul trips during construction activities. Haul trucks could cause additional damage or deterioration to roadway conditions. In addition, traffic controls would cause or contribute to substantial temporary increases in traffic levels on several roadways, as traffic is detoured, slowed, or disrupted by lane closures. Traffic controls could cause delays during the morning and evening peak commute hours, which could disrupt emergency response times in the vicinity of the construction sites. All construction vehicles would be required to follow local traffic laws and speed limits.

American River

Haul trucks would increase traffic on major surface streets such as Watt Avenue, Fair Oaks Boulevard, Howe Avenue, Folsom Boulevard. Overall, project construction would result in a substantial temporary and short-term increase in traffic on local roadways, and these temporary and short-term impacts are considered significant.

Additionally, haul trucks would use local minor arterial streets to access the construction sites. All construction vehicles would be required to follow local traffic laws and speed limits. Construction on the American River would require trucks to enter the American River Parkway. The increased traffic in the Parkway would result in impacts to recreational users, bicycle commuters, and residents adjacent to the levee structure. A detour would be established where the bike trail is impacted to excavate for the installation of the rock trench. Outside of the Parkway, hauling on residential roads to access the Parkway would result in significant impacts to residents along the selected routes.

Haul routes have not been finalized at this time however, previous work on other Corps projects in this area have used existing roadways to access the project sites. Potential borrow sites have also not yet been determined, so the transportation corridors for borrow material are currently unknown. The rock needed for construction will be obtained from a commercial source; however, the location of the commercial source is also unknown. Because the American River has many shallow areas, barges cannot be used to transport material to the site; therefore, rock would be transported to the construction site using haul trucks. There would be no impacts to railroads or rail transportation along the American River portion of the project.

Sacramento River

Haul trucks would increase traffic on major surface streets such as Pocket Road, Freeport Boulevard, and Riverside Boulevard. Overall, project construction would result in a substantial temporary and short-term increase in traffic on local roadways, and these temporary and short-term impacts are considered significant. Additionally, haul trucks would use local minor arterial streets to access the construction sites and levee systems.

Where bank protection is proposed to reduce the risk of erosion, the rock material would be transported from a commercial rock quarry by either barge or haul trucks. Both of these methods of transporting rock have been used in the past on Corps projects. The barges are not expected to have a significant impact on traffic as the Sacramento River is not a major transportation corridor for goods. The primary traffic on the Sacramento River is recreational boaters and they would be able to maneuver around any barges transporting materials to the construction site. Transporting rock using barges would have a less than significant impact on traffic. However, if the rock is transported using haul trucks there would be a short term significant impact on traffic as all the rock is moved on major roadways and onto surface streets to reach the construction sites. There would be no impacts to rail transportation along the Sacramento River portion of the project. Potential impacts to the Sacramento Southern Railroad are further discussed in Section 3.14, Recreation.

East Side Tributaries

Haul trucks would increase traffic on major surface streets such as Marysville Boulevard and Raley Boulevard. Overall, project construction would result in a substantial temporary and short-term increase in traffic on local roadways, and these temporary and short-term impacts are considered significant. There are many smaller surface streets that will also be used to transport the material to the construction sites. Construction would not require any closures of the UPRR line adjacent to the NEMDC levee; however, construction vehicles and haul trucks would cross the tracks at access points, which would be coordinated with UPRR prior to construction.

3.10.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Alternative 2 would require 1 mile of levee raise compared to the 8 miles under Alternative 1. This would result in fewer trucks hauling material along mostly residential streets and along the levee alignment. The construction of the Sacramento Weir and Bypass expansion would require fill material in order to construct the new levee. Hauling would occur on existing roads in the rural area of Yolo County. The new weir construction would include a new segment of the Old River Road and the Yolo Shortline railroad tracks. The existing Old River Road would remain in place during the majority of construction; however, due to the limited access the Yolo Shortline Railroad could be temporarily closed and the trains rerouted. Additionally, there would be some temporary closures and service disruptions of the Old River Road when the new segment of road is being connected to the existing road. The East Yolo Levee Road, County Road 124, and County Road 126 would also be rerouted on or around the new segment of levee.

Impacts to traffic under this alternative would be short-term and significant until construction is completed. Once the construction is completed, traffic would return to the pre-project conditions. There would be no impact to transportation from long-term O&M under Alternative 2.

3.10.6 Mitigation Measures

In order to reduce the impacts from traffic to below the significant level, measures would be implemented which could include, but are not limited to the following:

- The contractor would be required to prepare a Traffic Control and Road Maintenance Plan. A traffic control plan describes the methods of traffic control to be used during construction. All on-street construction traffic would be required to comply with the local jurisdiction's standard construction specifications. The plan would reduce the effects of construction on the roadway system in the project area throughout the construction period.
- Construction contractors would follow the standard construction specifications of affected jurisdictions and obtain the appropriate encroachment permits, if required. The conditions of the encroachment permit would be incorporated into the construction contract and would be enforced by the agency that issues the encroachment permit.
- If rock or other materials are transported by barge on the Sacramento River, appropriate water safety measures would be utilized in order to reduce impacts to recreational boaters.
- The construction contractor would provide adequate parking for construction trucks, equipment, and construction workers within the designated staging areas throughout the construction period. If inadequate space for parking is available at a given work site, the construction contractor would provide an off-site staging area and, as needed, coordinate the daily transport of construction vehicles, equipment, and personnel to and from the work site.
- Proposed lane closures would be coordinated with the appropriate jurisdiction and would be minimized to the extent possible during the morning and evening peak traffic periods. Standard construction specifications also typically limit lane closures during commuting hours. Lane closures will be kept as short as possible. If a road must be closed, detour routes and/or temporary roads would be made to accommodate traffic flows. Detour signs would be provided to direct traffic through detours. Advance notice signs of upcoming construction activities would be posted at least 1 week in advance so that motorists are able to avoid traveling through the study area during these times. Within the Parkway, detours would be used to allow for continued use by bicycle commuters.
- Safe pedestrian and bicyclist access would be maintained in or around the construction areas at all times. Construction areas would be secured as required by the applicable jurisdiction to prevent pedestrians and bicyclists from entering the work site, and all stationary equipment would be located as far away as possible from areas where bicyclists and pedestrians are present.

- The construction contractor would notify and consult with emergency service providers to maintain emergency access and facilitate the passage of emergency vehicles on city streets.
- Emergency vehicle access would be made available at all times. Coordination with local emergency responders by the contractor to inform them of the construction activities would be required by the contractor.
- The construction contractor would assess damage to roadways used during construction and will repair all potholes, fractures, or other damages.
- Trains utilizing the Yolo Shortline Railroad would be detoured to a different rail line during construction. If an alternative rail line is not available, railroad services would be continued by transporting goods on public roads using cargo trucks during the extent of closures required by the construction and realignment of the railroad on the new portion of the Sacramento Weir.

As mentioned above, the number of required truck trips has not been determined at this time. However, based on other Corps projects in the area and past experience with similar activities it is assumed that effects to transportation would be significant during construction due to the volume of trucks on local roadways.

3.11 Air Quality

3.11.1 Environmental Setting

Regulatory Setting

The following Federal, State, and Local laws and regulations apply to the resources covered in this Section. Descriptions of the laws and regulations can be found in Section 5.0.

Federal

- Federal Clean Air Act (CAA)

State

- California Clean Air Act

Existing Conditions

The ARCF GRR study area is located in the Sacramento Valley Air Basin (SVAB), which includes both Sacramento and Yolo Counties. The majority of the study area is located in Sacramento County, which places the project primarily under the jurisdiction of the Sacramento Metropolitan Air Quality Management District (SMAQMD). However, the Sacramento and Yolo Bypasses are located in Yolo County, which is under the jurisdiction of the Yolo-Solano Air Quality Management District (YSAQMD).

The study area is located at the southern end of the Sacramento Valley, which has a Mediterranean climate characterized by hot, dry summers and mild, rainy winters. Summer high temperatures are hot, often exceeding 100 degrees Fahrenheit (°F). Winter temperatures are cool to cold, with minimum temperatures often dropping into the high 30s. Most of the precipitation occurs as rainfall during winter storms. The rare occurrence of precipitation during summer is in the form of convective rain showers. Also characteristic of the SVAB are winters with periods of dense and persistent low-level fog that are most prevalent between storms. Prevailing wind speeds are moderate.

The topographic features giving shape to the SVAB include the Coast Range to the west, the Sierra Nevada to the east, and the Cascade Range to the north. These mountain ranges channel winds through the SVAB, but also inhibit the dispersion of pollutant emissions. Ozone pollution presents a serious problem when an inversion layer traps pollutants close to the ground, causing unhealthy air quality levels. Vehicles and other mobile sources, including trucks, locomotives, buses, motorcycles, agricultural equipment, and construction equipment cause about 70 percent of the region's air pollution problems during the summer (SMAQMD 2010).

May through October is ozone season in the SVAB. This period is characterized by poor air movement in the mornings and the arrival of the Delta sea breeze from the southwest in the afternoons. Typically, the Delta breeze transports air pollutants northward out of the SVAB; however, a phenomenon known as the Schultz Eddy prevents this from occurring during approximately half of the time between July and September. The Schultz Eddy causes the wind pattern to shift southward, causing air pollutants that have moved to the northern end of the Sacramento Valley to be blown back toward the south before leaving the valley. This phenomenon exacerbates concentrations of air pollutants in the area and contributes to violations of the ambient air quality standards (Solano County 2008).

Criteria Pollutants

The CAA established the National Ambient Air Quality Standards (NAAQS) for specific air pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), respirable particulate matter with an aerodynamic diameter of 10 micrometers or less (PM_{10}), fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less ($PM_{2.5}$), and lead (Pb). O_3 is a secondary pollutant that is not emitted directly into the atmosphere. Instead it forms by the reaction of two ozone precursors: reactive organic gases (ROG) and nitrogen oxides (NO_X).

For these criteria pollutants, NAAQS and the California Ambient Air Quality Standards (CAAQS) were established to protect public health and welfare. The standards create a margin of safety protecting the public from adverse health impacts caused by exposure to air pollution. The U.S. Environmental Protection Agency (USEPA) is responsible for enforcing the NAAQS, primarily through their review of the State Implementation Plans (SIPs) for each state. In the State of California, the California Air Resources Board (CARB) is responsible for the establishment of the SIP. The local air quality management districts are responsible for the enforcement of the SIP, as well as the NAAQS and CAAQS. The NAAQS and CAAQS are shown in Table 27.

Table 27. State and Federal Ambient Air Quality Standards.

Pollutant	Averaging Time	National Primary Standard[a]	California Standard[b]	Violation Criteria	
				National	California
CO	8 hour	9 ppm	9 ppm	Not to be exceeded more than once per year	Not to be exceeded
	1 hour	35 ppm	20 ppm	Not to be exceeded more than once per year	Not to be exceeded
NO_2	Annual	0.053 ppm	0.030 ppm	If exceeded mitigation credits will be required.	Not to be exceeded
	1 hour	0.100 ppm	0.18 ppm	The 3-year average of the annual 98th percentile of the 1-hour daily maximum concentrations at each site must not exceed 0.100 ppm.	Not to be exceeded
O_3	8 hour	0.075 ppm	0.070 ppm	The ozone standard is attained when the 4th highest 8-hour concentration measured at each site in a year, averaged over 3 years, is equal to or less than the standard.	Not to be exceeded
	1 hour	N/A	0.09 ppm	N/A	Not to be exceeded
PM_{10}	Annual	N/A	20 µg/m3	N/A	Not to be exceeded
	24 hour	150 µg/m3	50 µg/m3	The 24 hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m3 is equal to or less than one.	Not to be exceeded
$PM_{2.5}$	Annual	12 µg/m3	12 µg/m3	The 3-year average of the weighted annual mean must not exceed	Not to be exceeded

Pollutant	Averaging Time	National Primary Standard[a]	California Standard[b]	Violation Criteria	
				National	California
	24 hour	35 µg/m3	N/A	The 24 hour standard is attained when 98% of the daily concentrations, averaged over three years, are equal to or less than the standard	N/A
SO_2	3 hour	N/A[c]	N/A	N/A	N/A
	1 hour	0.075 ppm	0.25 ppm	The 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations at each site must not exceed 0.075 ppm.	Not to be exceeded
Pb	30 day	N/A	1.5 µg/m3	N/A	Not to be exceeded or equaled
	Quarter	1.5 µg/m3	N/A	Not to be exceeded more than once per year	N/A
	3 month	0.15 µg/m3	N/A	Not to be exceeded more than once per year	N/A

Source: CARB, 2012

[a] 40 CFR 50.4 through 50.13

[b] California Code of Regulations, Table of Standards, Section 70200 of Title 17

[c] No National Primary 3 hour standard for SO_2. National Secondary 3 hour standard for SO_2 is 0.5 ppm.

µg/m3 micrograms per cubic meter
ppm parts per million
N/A Not Applicable; State and Federal Standards do not exist.

Table 28. State and Federal Attainment Status.

Criteria Pollutant	Averaging Time	Federal Status	State Status
O_3	1 Hour	N/A	Non-Attainment--Serious
	8 Hour	Non-Attainment--Severe	Non-Attainment--Serious
PM_{10}	24 Hour	Attainment	Attainment
	Annual	N/A	Attainment
$PM_{2.5}$	24 Hour	Non-Attainment*	N/A
	Annual	N/A	Non-Attainment
CO	1 Hour	Attainment	Attainment
	8 Hour	Attainment	Attainment
NO_2	1 Hour	N/A	Attainment
	Annual	Attainment	N/A
SO_2	3 Hour	Attainment	N/A
	24 Hour	Attainment	Attainment
	Annual	Attainment	N/A
Pb	30 Day	N/A	Attainment
	Quarter	Attainment	N/A

Source: SMAQMD, 2012
N/A Not Applicable; State or Federal Standards do not exist.
* USEPA used the updated 2010-2012 ambient air quality data for the determination and final rule became effective on August 14, 2013.

Due to the non-attainment designations for the SVAB discussed above, SMAQMD is required to prepare SIPs for O_3, PM_{10}, and $PM_{2.5}$. The status of these SIPs for the SVAB is summarized below.

- O_3: A final attainment designation for the 2008 O_3 NAAQS of 0.075 ppm has been provided by the USEPA (77 FR 30160) and an attainment plan will be developed for submittal to USEPA in 2015.
- $PM_{2.5}$: Since SMAQMD has determined this to be below thresholds for the past several years they are preparing a maintenance plan and redesignation request for adoption and submittal to CARB in October 2013.

Additionally, Federal projects are subject to the CAA General Conformity Rule (40 CFR 51, Subpart W). The purpose of the General Conformity Rule is to ensure that Federal project conform to applicable SIPs so that they do not interfere with strategies used to attain the NAAQS. The rule applies to Federal project in non-attainment areas for any of the six criteria pollutants for which the EPA has established these standards, and in any areas designated as “maintenance” areas. The rule covers both direct and indirect emission of criteria pollutants or their precursors that result from a Federal project, are reasonably foreseeable, and can be practicably controlled by the Federal agency through its continuing program responsibility.

Toxic Air Contaminants

A Toxic Air Contaminant (TAC) is defined by California law as an air pollutant that "may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health." TACs can be emitted from stationary or mobile sources. Ten TACs have been identified through ambient air quality data as posing the greatest health risk in California. Direct exposure to these pollutants has shown to cause cancer, birth defects, damage to the brain and nervous system, and respiratory disorders. TACs do not have ambient air quality standards because no safe levels of TACs have been determined. Instead, TAC impacts are evaluated by calculating the health risks associated with exposure.

TACs relevant to the project were determined based on SMAQMD guidance and the project area conditions. The only TAC that has the potential to occur due to this project is diesel particulate matter (DPM). DPM differs from other TACs in that it is not a single substance, but rather a complex mixture of gases, vapors, and particles, many of which are known human carcinogens. Most researchers believe that diesel exhaust particles contribute most of the risk because the particles in the exhaust carry many harmful organics and metals. Unlike the other TACs, no ambient monitoring data are available for diesel PM because no routine measurement method currently exists (DWR, 2012).

With implementation of CARB's Diesel Risk Reduction Plan, it is expected that DPM concentrations in the State of California will be reduced by 75 percent in 2010 and 85 percent in 2020 from the estimated year-2000 level. The Diesel Risk Reduction Plan is a comprehensive plan to reduce diesel PM emissions, and consists of three major components (CARB, 2000):

- New regulatory standards for all new on-road, off-road, and stationary diesel-fueled engines and vehicles, to reduce DPM emissions by about 90 percent overall from current levels.
- New retrofit requirements for existing on-road, off-road, and stationary diesel-fueled engines and vehicles, where determined to be technically feasible and cost effective.
- New Phase 2 diesel fuel regulations to reduce sulfur content levels in diesel fuel to no more than 15 parts per million, to provide the quality of diesel fuel needed by the advanced diesel PM emission controls.

Odors

Odors are considered a local air quality problem, as USEPA has no regulations to address generation of odors. However, local air districts have developed rules that regulate the generation of odors. Odors are generally regarded as an annoyance rather than a health hazard. However, manifestations of a person's reaction to foul odors can range from psychological (e.g., irritation, anger, anxiety) to physiological (e.g., circulatory and respiratory effects, nausea, vomiting, headache).

The ability to detect odors varies considerably among the population and overall is quite subjective. Some individuals have the ability to smell minute quantities of specific substances; others may not have the same sensitivity but may have sensitivities to odors of other substances. In addition, people may have different reactions to the same odor; an odor that is offensive to one person may be perfectly acceptable to another. It is important to also note that an unfamiliar odor is more easily detected and is more likely to cause complaints than a familiar one. This is because of the phenomenon known as odor fatigue, in which a person can become desensitized to almost any odor and recognition only occurs with an alteration in the intensity.

Quality and intensity are two properties present in any odor. The quality of an odor indicates the nature of the smell experience. For instance, if a person describes an odor as flowery or sweet, the person is describing the quality of the odor. Intensity refers to the strength of the odor. For example, a person may use the word “strong” to describe the intensity of an odor. Odor intensity depends on the odorant concentration in the air. When an odorous sample is progressively diluted, the odorant concentration decreases. As this occurs, the odor intensity weakens and eventually becomes so low that the detection or recognition of the odor is quite difficult. At some point during dilution, the concentration of the odorant reaches a detection threshold. An odorant concentration below the detection threshold means that the concentration in the air is not detectable by the average human (DWR, 2012).

Sensitive Receptors

A sensitive receptor is generally defined as a location where human populations, especially children, seniors, and sick persons are found, and where there is a reasonable expectation of continuous human exposure according to appropriate standards (e.g., 24-hour, 8-hour, and 1-hour standards). Sensitive land uses and sensitive receptors generally include residents, hospital staff and patients, and school teachers and students.

In the ARCF GRR study area, the primary sensitive receptors would be the residents whose properties are adjacent to the levees along the American and Sacramento Rivers and the East Side Tributaries. Residents back up to the levee and in most cases there is very little space between the levee toe and the back fence. In addition, there are a number of schools along the rivers within both the American River North and South Basins. Additional sensitive receptors could also include recreationists and local wildlife species.

3.11.2 Methodology and Basis of Significance

Methodology

The air quality emissions analysis for the ARCF GRR was developed based on several interrelated assumptions and constraints:

- The project will require 10 separate years to construct the required features;
- Project funding will be limited to $100 million per construction year;
- The project will receive $100 million per construction year;
- In any given year, approximately 85% of the funding will be applied toward construction;
- A construction season is six months (April 15 to October 15);
- Construction will begin in 2015; (this date was used for analysis purposes of this EIS/EIR, however construction would not occur until the project is authorized by Congress);
- All project plans and specifications will require that construction contractors use only off-road equipment that implements the SMAQMD Enhanced Exhaust Control Practices and only use on-road hauling equipment that was manufactured in 2010, or later; and,
- While not required, the Corps will encourage the construction contractors to use off-road construction equipment that meets Tier 4 standards.

It was determined through discussions with staff from the SMAQMD, that the most reasonable approach to determine if the project was to be in compliance with Federal and local standards was to base the evaluation on a “worst case scenario” construction year.

Furthermore, the most combined air emissions would occur during the second year of construction in Reach F of the American River South basin. Reach F was chosen because it is the single longest reach (5 miles) in the entire Common Features Project, and due to design, constructability, and funding constraints, will take 3 1/3 years to construct. This would allow for 1.5 miles of construction in years 1 through 3, with the last 0.5 miles to be completed in the fourth year. The following construction activities are scheduled for this reach: clearing of trees and vegetation, degrading and excavation of the levee, construction of two types of seepage control slurry cutoff walls (conventional slot-trench and deep soil mixing), reconstruction of the levee, relocation of utilities, and delivery and installation of rip-rap on the waterside slope. The slurry cutoff walls must be allowed to cure until the following construction season before the rip-rap is placed. Under this scenario, the rip-rap would be placed on the slopes of the segment completed in the first year of construction, while all other construction activities are being conducted in the second year segment. The staggering of construction years for the placement of rip-rap would continue until Reach F would be completed.

In close coordination with SMAQMD, the Corps used their Road Construction Emissions Model (RCEM), as it was designed to calculate air emissions for linear projects. The construction activities listed above were broken out into 19 individual sub-tasks based on information developed by Corps engineering and cost-estimating staff. Using the RCEM, a model run was conducted for each sub-task, with one exception: the barging of rip-rap material to the project site. In this case, information for barging material was developed, in close coordination with SMAQMD staff, for similar activities being conducted for the Folsom JFP. It was agreed that it is reasonable to use this information for the purposes of a feasibility-level study. Although calculations for the JFP involved smaller harbor craft than that assumed for the ARCF project, SMAQMD staff determined that it was reasonable to extrapolate the air emissions data by increasing the horsepower, daily hours and number of days in the JFP model to calculate specific emissions data (ROG, CO, NO_X, PM, and CO_2) for the Common Features project.

In order to provide a means of comparison for future decision-making purposes, the delivery and placement task was also calculated using the assumption that the same amount of material to be barged to the project site would be trucked to the site in the same period of time. Borrow sites have not been identified at this time but are assumed to be located within a 20 miles radius from the project area. Emissions associated with material borrow activities could fall within SMAQMD, YSAQMD, or Feather River Air Quality Management District (FRAQMD). The average one-way hauling distance between the borrow site locations is assumed to be approximately 20 miles, of which 18 miles could be in the YSAQMD, 20 miles could be in the SMAQMD, and 8 miles could be in the FRAQMD. It was assumed barges powered by towboats would carry the riprap material from the San Rafael Rock Quarry through the Bay-Delta and the Sacramento River to the project sites. The average one-way hauling distance between the San Rafael Rock Quarry and the project area is approximately 100 miles, of which 22 miles would be in the YSAQMD, 37 miles in the SMAQMD, and 41 miles in the Bay Area Air Quality Management District (BAAQMD).

The results of the construction emissions analysis are shown for Alternative 1 in Tables 32 (truck delivery scenario) and 32 (barge delivery scenario) and for Alternative 2 in Tables 36 and 37 in both pounds per day (for local standards) and tons per year (for Federal standards). Note that neither version of this scenario (barging or trucking rip-rap) would be able to perform consistently under the local standard for NO_X (Table 28); however, the trucking alternative would require a lower overall mitigation fee cost. In the case of the Federal *de minimis* standards (Table 30), the alternative that involves trucking the rip-rap is within the Federal *de minimis* standard, even without mitigation. The barging alternative is assumed to meet the standard using the mitigation provided by the implementation of Enhanced Exhaust Control Practices for off-road equipment and only using on-road heavy-duty diesel trucks or equipment with a gross vehicle weight rating of 19,500 pounds or greater that comply with USEPA 2010 on-road emission standards for PM and NO_X.

Additional air quality analysis for the proposed Sacramento Weir and Bypass Widening is performed separately since the Sacramento Weir construction would be entirely in the YSAQMD jurisdiction. The Sacramento Weir and Bypass Widening portion of the project is only proposed under Alternative 2.

The air quality emissions analysis for the Sacramento Weir and Bypass Widening was developed based on the following assumptions:

- The Sacramento Weir and Bypass Widening would be constructed as three phases over three years: the new levee, the weir, and the deconstruction of the old levee;
- The Sacramento Weir would be constructed on dry land on the portion of land between the railroad and the Old River Road;
- The Old River Road and the railroad would be realigned onto the new weir crown;
- The existing weir would remain in place;
- The new levee would be constructed using soil existing in the Sacramento Bypass, and no new soil would be imported from other borrow sites.

Basis of Significance

For this analysis, an effect was considered significant if it would:

- Conflict with, or obstruct implementation of, the applicable air quality plan;
- Violate any air quality standard or substantial contribution to existing or projected air quality violation;
- Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is a non-attainment area under NAAQS and CAAQS;
- Expose sensitive receptors to substantial pollutant concentrations; or
- Create objectionable odors affecting a substantial number of people.

An air quality effect is considered to be significant if the project's construction emissions would exceed districts' CEQA emission thresholds. Because district-specific CEQA thresholds apply only to the portions of emissions generated under their jurisdiction. The CEQA emission thresholds for the YSAQMD, SMAQMD, BAAQMD, and FRAQMD are shown in Table 29.

Table 29. CEQA Thresholds of Significance.

Pollutant	YSAQMD	SMAQMD	BAAQMD	FRAQMD
Construction				
ROG	10 tons/year	None	54 lb/day	25 lb/day
NO_X	10 tons/year	85 lb/day	54 lb/day	25 lb/day
CO	Violation of a CAAQS	Violation of a CAAQS	None	None
PM10	80 lb/day	Violation of a CAAQS or failure to implement emissions control practices	Exhaust: 82 lb/day; Fugitive dust: failure to implement BMPs.	80 lb/day
PM2.5	None	Same as PM10	Exhaust: 54 lb/day; Fugitive dust: failure to implement BMPs.	None
TACs	None	None	Increased cancer risk of 10 in 1 million; increased non-cancer risk of greater than 1.0 (HI); PM2.5 increase of greater than 0.3 micrograms per cubic meter	None
Operation				
ROG	Same as construction	65 lb/day	Not applicable to the project because no operation and maintenance activity would occur within the district.	Not applicable to the project because no operation and maintenance activity would occur within the district.
NO_X	Same as construction	65 lb/day		
CO	Same as construction	Same as construction		
PM10	Same as construction	Same as construction		
PM2.5	Same as construction	Same as construction		
TACs	Increased cancer risk of 10 in 1 million or increased non-cancer risk of greater than 1.0 (HI)	Increased cancer risk of 10 in 1 million or increased non-cancer risk of greater than 1.0 (HI)		

An air quality effect is considered to be significant under NEPA if the project's construction emissions would exceed the General Conformity *de minimis* thresholds listed in Table 30.

Table 30. Federal General Conformity *de Minimis* Thresholds.

Air Basin	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$
	Annual Air Pollutant Emissions in Tons per Year				
Sacramento Valley Air Basin (include YSAQMD , SMAQMD and FRAQMD)	25	25	100	100	100
Bay Area Air Basin (includes BAAQMD)	100	100	100	None	100

Source: 40 CFR 93.153

3.11.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. Current levee operations and maintenance activities would continue, with limited, temporary, intermittent emissions that would not result in a significant level of impact.

Without improvements to the levee system, the risk of levee failure would remain high. Under these conditions, a flood event could cause portions of the levees to fail, triggering widespread flooding and extensive damage. If a catastrophic flood were to occur, emergency flood fighting and clean-up actions would require the use of a considerable amount of heavy construction equipment. Timing and duration of use would directly correlate with flood fighting needs, but it is likely that pollutants emitted would violate air quality standards for pollutants (including those for which the area is already considered non-attainment), increase greenhouse gas (GHG) emissions, create objectionable odors, and expose sensitive receptors to toxic air emissions. Depending on the magnitude of the flood, flood fighting could last for weeks or even months. Furthermore, because of the unpredictable nature of an emergency response, no BMPs to manage emissions would be in place. All of these effects could be considered significant. However, the timing, duration, and magnitude of a flood event are speculative and unpredictable, and therefore a precise determination of significance is not possible.

3.11.4 Alternative 1 – Improve Levees

A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Growth-inducing and cumulative effects are addressed in Chapter 4. As discussed in Chapter 4, the project would not conflict with or obstruct the implementation of air quality plans; therefore this direct effect would be less than significant and no mitigation is required.

Construction Emissions

The construction emissions are estimated for the project site based on the emission rates and assumptions described in Section 3.11.2., Methodology. Emission sources associated with the project site include the off-road construction equipment operating at project sites, on-road vehicles traveling to and from the project sites, retaining wall, utility usage, and fugitive dust associated with earthmoving and soil-disturbance activities at project sites. Emission sources associated with the material borrow activities include the off-road construction equipment operating at borrow sites, on-road hauling trucks traveling between borrow sites and the project sites, and fugitive dust associated with earthmoving and soil-disturbance activities at borrow sites. The delivery of rip-rap was calculated using the assumption that the material could be barged to the project site or trucked to the site during the same period of time. Table 31 summarizes the emission sources associate with the project construction that would occur in the SMAQMD, YSAQMD, BAAQMD, and FRAQMD.

Table 31. Emission Sources occurring in the SMAQMD, YSAQMD, BAAQMD, and FRAQMD.

Emission Sources	SMAQMD	YSAQMD	BAAQMD	FRAQMD
Off-Road Construction Equipment	X			
On-Road Vehicles	X			
On-Water Towboats/ Barges	X	X	X	
Dust Emissions from Land Disturbance and Earth Moving	X			
Off-Site Material Borrow, including fugitive dust, off-road construction equipment, and on-road vehicles associated with the activity.	X	X		X

Maximum daily emissions are estimated for ROG, NO_X, PM_{10}, and $PM_{2.5}$ to evaluate emissions against SMAQMD and YSAQMD thresholds under the truck delivery scenario. Those results are shown in Table 32. Construction-related emissions under Alternative 1 would exceed the SMAQMD's emission threshold for NO_X. The actual emissions may be reduced depending on the availability of the borrow pits that are located closer to the project sites; regardless, the overall construction emissions under the alternative still would exceed the thresholds and result in a significant effect. Although mitigation measures as recommended by SMAQMD would reduce in NO_X for off-road equipment by 20 percent, construction-related emissions still would exceed the SMAQMD's emission thresholds for NO_X.
The Corps would be required to pay an off-site mitigation fee for NO_X emissions in the SVAB, which would reduce the effect to a less-than-significant level. Borrow activities emissions would not exceed YSAQMD thresholds and would result in a less-than-significant impact. Since less than 50 percent of borrow activities emissions could occur in FRAQMD, it was assumed FRAQMD thresholds would not be exceeded. Borrow activities emissions associated with potential borrow sites located north of the project site were captured in the SMAQMD off-site soil estimations.

Table 32. Construction Emissions: Alternative 1, Truck Delivery Scenario.

Construction Year	Annual Emissions in Tons					Maximum Daily Emissions in Pounds					
	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$	ROG	NO_X	NO_X* Mitigated	CO	PM_{10}	$PM_{2.5}$
Emissions generated in SMAQMD											
Year 2 Onsite Construction	1.5	22.3	8.9	7.4	2.0	11.6	159.7	143.7	66.8	29.9	5.4
Year 2 Off-Site Soil Borrow	0	0.7	0.1	0.1	0	6.7	176.2	166.0	34.2	71.8	17.5
Year 2 Total	1.5	23.0	9.0	7.5	2.0	18.3	335.9	309.7	101	101.7	22.9
CEQA Threshold							85				
Exceed Threshold?							Yes				
General Conformity *de minimis* Threshold	25	25	100	100	100						
Exceed Threshold?	No	No	No	No	No						
Emissions generated in YSAQMD											
Year 2 Off-Site Soil Borrow	0	0.6	0.1	.01	0	6.03	158.8	149.4	30.78	65.67	15.75
CEQA Threshold	10	10	NA	NA	NA					80	
Exceed Threshold?	No	No								No	
General Conformity *de Minimis* Threshold	25	25	100	100	100						
Exceed Threshold?	No	No	No	No	No						

Notes:
* Values based on a 20% mitigation for off-road equipment

Maximum daily emissions are estimated for ROG, NO_X, PM_{10}, and $PM_{2.5}$ to evaluate emissions against SMAQMD, YSAQMD, and BAAQMD thresholds under the barge delivery scenario. Those results are shown in Table 33. Construction-related emissions under Alternative 1 would exceed the SMAQMD's and BAAQMD's emission thresholds for NO_X. Therefore, construction of the alternative with barge delivery would result in a significant effect. After a 20 percent reduction in NO_X for off-road equipment mitigation, construction-related emissions still would exceed the SMAQMD's emission thresholds for NO_X. Because NO_X emissions would exceed SMAQMD's threshold, the Corps would be required to pay an off-site mitigation fee for NO_X emissions in the SVAB would be reduced to a less-than-significant level. Borrow activities and barge delivery emissions would not exceed YSAQMD thresholds, therefore, would result in a less-than-significant impact. Since less than 50 percent of borrow activities emissions could occur in FRAQMD, it was assumed FRAQMD thresholds would not be exceeded. Borrow activities emissions associated with potential borrow site located north of the project site were captured in the SMAQMD off-site soil estimations.

Table 33. Construction Emissions: Alternative 1, Barge Delivery Scenario.

Construction Year	Annual Emissions in Tons					Maximum Daily Emissions in Pounds					
	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$	ROG	NO_X	NO_X* Mitigated	CO	PM_{10}	$PM_{2.5}$
Emissions generated in SMAQMD											
Year 2 Onsite Construction	2.0	22.6	10.7	6.25	1.6	11.6	159.7	143.7	66.8	29.9	5.4
Year 2 Off-Site Soil Borrow	0	0.7	0.1	0.1	0	6.7	176.2	166.0	34.2	71.8	17.5
Year 2 Barge Delivery	0.41	3.92	1.67	0.15	0	10.2	95.0	82.9	39.4	3.7	1.7
Year 2 Total	2.4	27.2	12.5	6.5	1.6	28.5	430.9	392.7	140.4	105.4	24.6
CEQA Threshold	NA	NA	NA	NA	NA	NA	85		NA	NA	NA
Exceed Threshold?							Yes				
General Conformity *de Minimis* Threshold	25	25	100	100	100						
Exceed Threshold?	No	Yes	No	No	No						
Emissions generated in YSAQMD											
Year 2 Off-Site Soil Borrow	0	0.6	0.1	.01	0	6.03	158.8	149.4	30.78	65.67	15.75
Year 2 Barge Delivery	0.24	2.33	1	.01	0	6.07	56.5	48.9	23.43	2.2	1
Year 2 Total	0.24	2.93	1.1	.02	0	12.1	215.3	198.3	54.21	67.87	16.75
CEQA Threshold	10	10	NA	NA	NA					80	
Exceed Threshold?	No	No								No	
General Conformity *de Minimis* Threshold	25	25	100	100	100						
Exceed Threshold?	No	No	No	No	No						
Emissions generated in BAAQMD**											
Year 2 Barge Delivery	0.45	4.35	1.85	.16	0	11.32	105.3	91.2	43.67	4.1	1.84
CEQA Threshold						54	54			82	54
Exceed Threshold?						No	Yes			No	No
General Conformity *de Minimis* Threshold	100	100	100	NA	100						
Exceed Threshold?	No	No	No		No						

Notes:
* Values based on a 20% mitigation for off-road equipment
**Only on-water exhaust emissions generated from towboats are expected to occur within the BAAQMD.

As shown in Table 32, annual construction emissions under the truck delivery scenario would not exceed the General Conformity threshold for NO_X in the SVAB, resulting in a less than significant effect. However, under the annual construction emissions for the barging alternative would exceed the General Conformity threshold for NO_X in the SVAB, resulting in a significant adverse effect (Table 33). With the implementation of the Enhance Exhaust Control Practices for off-road equipment and only using on-road heavy-duty diesel trucks or equipment that comply with USEPA 2010 on-road emission standards, annual construction emissions would be reduced to below *de minimis* thresholds. Therefore, this direct effect would be reduced to a less-than-significant level.

As noted in Section 3.11.2, the air quality management agencies in the project area consider emissions in excess of their project-level thresholds to have the potential to contribute to a cumulative impact on regional air quality. Cumulative effects are addressed in Section 4.2.7.

Fugitive Dust

Construction of the proposed project would result in short-term dust emissions from grading and earth moving activities at the project construction sites and the soil borrow sites. The amount of dust generated would be highly variable and is dependent on the size of the disturbed area at any given time, amount of activity, soil conditions, and meteorological conditions. Nearby land uses, especially those residences and schools located downwind of the project sites could be exposed to dust generated during construction activities, indirectly resulting in potential adverse health effects. This indirect effect would be significant, but implementation of mitigation measures would reduce dust emissions during construction to a less-than-significant level.

Toxic Air Contaminants

Construction of the proposed project would result in short-term diesel particulate emissions from onsite heavy duty equipment and on-road haul trucks. DPM, which is classified as a carcinogenic TAC by CARB, is the primary pollutant of concern with regard to indirect health risks to sensitive receptors. Nearby land uses, especially those residences and schools located downwind of the project sites could be exposed to DPM generated during construction activities, indirectly resulting in potential adverse health effects.

The assessment of health risks associated with exposure to diesel exhaust typically is associated with chronic exposure, in which a 70-year exposure period is often assumed. However, while cancer can result from exposure periods of less than 70 years, acute exposure periods (i.e., exposure periods of 2 to 3 years) to diesel exhaust are not anticipated to result in an increased health risk, as health risks associated with exposure to diesel exhaust are typically seen in exposures periods that are chronic. Because construction activities along each segment are not expected to take place for more than 180 days per year over the of 13-year construction period, construction activities would occur linearly along the segment alignment and would not occur over a prolonged period in any one general location, there

would a limited number of pieces of heavy equipment used at a construction site. Furthermore, as required by CARB regulation 13 CCR 2449(d)(3), no in-use off-road diesel vehicles may idle for more than 5 consecutive minutes. In addition, implementation of mitigation measures would further reduce exhaust emissions and associated health risks during construction to less than significant.

Odors

The proposed project would not result in any major sources of odor, and the project would not involve operation of any of the common types of facilities that are known to produce odors (e.g., landfill, wastewater treatment facility). Odors associated with diesel exhaust emissions from the use of onsite construction equipment may be noticeable from time to time by adjacent receptors. However, the odors would be intermittent and temporary and would dissipate rapidly from the source with an increase in distance. Furthermore, as required by CARB regulation 13 CCR 2449(d)(3), no in-use off-road diesel vehicles may idle for more than 5 consecutive minutes. Therefore, this direct effect would be less than significant. In addition, implementation of mitigation measures, which are required under other air quality effects, would further reduce exhaust emissions and provide advanced notification of construction activity.

Operation and Maintenance

Long-term O&M activities under Alternative 1 would result in limited emissions of criteria pollutants from activities such as driving trucks on the levees for inspections and maintenance actions, mowing of grasses on the levees, and possibly limited heavy earth-moving equipment for repair of any damage to the site. These emissions would be limited to a very temporary timeframe once or twice a year. Any emissions that resulted from long-term O&M activities would not exceed the local, State, or Federal thresholds and would be less than significant.

3.11.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Alternative 2 would include all levee improvements as in Alternative 1, except for a majority of the levee raises along the Sacramento River. Instead of the levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. Similar to Alternative 1, Alternative 2 would not conflict with or obstruct the implementation of an applicable air quality plan. Growth-inducing and cumulative effects are addressed in Chapter 4.

The construction emissions are estimated for the project site based on the emission rates and assumptions described in Section 3.11.2., Methodology. Although Alternative 2 would reduce the number of levee raises along the Sacramento River compared to Alternative 1, the air quality analysis is based on the worst-case scenario. Therefore, the assumptions based on the distance and delivery of material is the same as described under Alternative 1. Table 34 summarizes the emission sources

associate with the project construction that would occur in the SMAQMD, YSAQMD, BAAQMD, and FRAQMD. Effects associated with long-term O&M in for Alternative 2 would be the same as described for Alternative 1.

Table 34. Emission Sources Occurring in the SMAQMD, YSAQMD, BAAQMD, and FRAQMD.

Emission Sources	SMAQMD	YSAQMD	BAAQMD	FRAQMD
Off-Road Construction Equipment	X	X		
On-Road Vehicles	X	X		
On-Water Towboats/ Barges	X	X	X	
Dust Emissions from Land Disturbance and Earth Moving	X	X		
Off-Site Material Borrow, including fugitive dust, off-road construction equipment, and on-road vehicles associated with the activity.	X	X		X

Construction of the Sacramento Weir and Bypass Widening would occur in YSAQMD and include clearing of trees and vegetation, construction of the new levee, construction of the new portion of the weir, construction of new sections of road and railroad on the top of the new portion of the weir and the new levee, relocation of utilities, degrading and excavating the existing levee, and delivery and installation of rip-rap on the waterside slope of the new levee. Materials for the construction of the new levee would be reused from the existing levee to the greatest extent possible. The potential borrow sites would be located in or adjacent to the Bypass, reducing the number of haul truck trips going to and from the site.

The construction of Alternative 2 would be spread over 10 years. Construction of the Sacramento Weir and Bypass would reduce the need for most of the levee raises along the Sacramento River. Materials required for the levee raises was assumed to be trucked from with-in a 20 miles radius.

Construction Emissions

As discussed under Alternative 1, the construction emissions are estimated for the project site based on the emission rates and assumptions described in Section 3.11.2., Methodology. Emission sources associated with the project site include the off-road construction equipment operating at project sites, on-road vehicles traveling to and from the project sites, retaining wall, utility usage, and fugitive dust associated with earthmoving and soil-disturbance activities at project sites. Emission sources associated with the material borrow activities include the off-road construction equipment operating at borrow sites, on-road hauling trucks traveling between borrow sites and the project sites, and fugitive dust associated with earthmoving and soil-disturbance activities at borrow sites.

Additional air quality analysis for the proposed Sacramento Weir and Bypass Widening has been performed separately since the Sacramento Weir is located entirely in the YSAQMD. The Sacramento Weir and Bypass widening portion of the project is only proposed under Alternative 2.

Maximum daily emissions are estimated for ROG, NO_X, PM_{10}, and $PM_{2.5}$ to evaluate emissions against YSAQMD thresholds. Those results are shown in Table 35. Construction-related emissions from the Sacramento Weir and Bypass widening would exceed the YSAQMD's emission threshold for NO_X. The actual emissions may be reduced by reducing the number and type of large construction vehicles utilized on site at one time and by following the mitigation measures as recommended by SMAQMD; however, the overall construction emissions under the alternative would likely exceed the thresholds and would therefore result in a significant effect. The Corps would be required to pay an off-site mitigation fee for NO_X emissions in the SVAB in order to reduce the effect to a less-than-significant level.

Table 35. Construction Emissions: Alternative 2, Sacramento Bypass and Weir Widening Construction.

	Annual Emissions in Tons					**Maximum Daily Emissions in Pounds**				
Construction Year	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**
Emissions generated in YSAQMD										
Construction of New Levee	0.7	7.3	6.5	2.5	0.8	18.5	184.7	157.9	47.9	15.6
Construction of New Weir	0.8	7.5	5.9	2.8	0.8	1532	148.6	114.6	47.0	6.3
Demolition of Old Levee	1.5	14.2	13.1	3.0	1.1	30.3	297.2	281.8	52.4	19.7
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	Yes							No	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					

Although Alternative 2 would reduce the number of levee raises along the Sacramento River compared to Alternative 1, for the purposes of air quality analysis the emissions estimates are assumed to be similar to Alternative 1, because the construction area and duration of construction would be similar under both alternatives. Alternative 1 summarizes the maximum daily emissions estimated for ROG, NO_X, PM_{10}, and $PM_{2.5}$ under the construction scenario that would result in the most combined air emissions. As shown in Table 35, the greatest potential emissions impacts would occur during the demolition of the old levee due to the large number of scrapers and other large construction equipment to displace and redistribute soil. These emissions are combined with the previously analyzed emissions from Alternative 1 in Tables 36 and 37, below.

Table 36. Construction Emissions: Alternative 2, Truck Delivery Scenario With Bypass Widening.

	Annual Emissions in Tons					Maximum Daily Emissions in Pounds				
Construction Year	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**
Emissions generated in SMAQMD										
Year 2 Onsite Construction	1.5	22.3	8.9	7.4	2.0	11.6	159.7	66.8	29.9	5.4
Year 2 Off-Site Soil Borrow	0	0.7	0.1	0.1	0	6.7	176.2	34.2	71.8	17.5
Year 2 Total	1.5	23.0	9.0	7.5	2.0	18.3	335.9	101	101.7	22.9
CEQA Threshold							85			
Exceed Threshold?							Yes			
General Conformity *de minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					
Emissions generated in YSAQMD										
Year 2 Off-Site Soil Borrow	0	0.6	0.1	.01	0	6.03	158.8	30.78	65.67	15.75
Bypass Widening: Levee Demolition	1.5	14.2	13.1	3.0	1.1	30.3	297.2	281.8	52.4	19.7
Total	1.5	14.8	13.2	3.01	1.1	36.6	456.0	312.58	118.07	35.45
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	Yes							No	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					

Table 37 shows the maximum daily emission under the barge delivery scenario with the Sacramento Bypass and Weir widening segment added. Under this scenario, emissions would exceed SMAQMD's and BAAQMD's NO_X thresholds and would result in a significant effect. The Corps would be required to pay an off-site mitigation fee for NO_X emissions. With the implementation of mitigation measures, the effect from NO_X emissions would be reduced to a less-than-significant level.

Table 37. Construction Emissions: Alternative 2, Barge Delivery Scenario With Bypass Widening.

	Annual Emissions in Tons					Maximum Daily Emissions in Pounds				
Construction Year	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**
Emissions generated in SMAQMD										
Year 2 Onsite Construction	2.0	22.6	10.7	6.25	1.6	11.6	159.7	66.8	29.9	5.4
Year 2 Off-Site Soil Borrow	0	0.7	0.1	0.1	0	6.7	176.2	34.2	71.8	17.5
Year 2 Barge Delivery	0.41	3.92	1.67	0.15	0	10.2	95.0	39.4	3.7	1.7
Year 2 Total	2.4	27.2	12.5	6.5	1.6	28.5	430.9	140.4	105.4	24.6
CEQA Threshold	NA	NA	NA	NA	NA	NA	85	NA	NA	NA
Exceed Threshold?							Yes			
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	Yes	No	No	No					
Emissions generated in YSAQMD										
Year 2 Off-Site Soil Borrow	0	0.6	0.1	.01	0	6.03	158.8	30.78	65.67	15.75
Year 2 Barge Delivery	0.24	2.33	1	.01	0	6.07	56.5	23.43	2.2	1
Bypass Widening Levee Demolition	1.5	14.2	13.1	3.0	1.1	30.3	297.2	281.80	52.4	19.7
Year 2 Total	1.74	17.13	14.2	3.02	1.1	42.4	512.5	336.01	120.27	36.45
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	Yes							Yes	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					
Emissions generated in BAAQMD **										
Year 2 Barge Delivery	0.45	4.35	1.85	.16	0	11.32	105.3	91.2	4.1	1.84
CEQA Threshold						54	54		82	54
Exceed Threshold?						No	Yes		No	No
General Conformity *de Minimis* Threshold	50	100	100	NA	100					
Exceed Threshold?	No	No	No		No					

Notes:
**Only on-water exhaust emissions generated from towboats are expected to occur within the BAAQMD.

Fugitive Dust

Construction of Alternative 2 could result in slightly higher short-term dust emissions from grading and earthmoving activities in the SVAB relative to Alternative 1. Nearby land uses, especially those residences located downwind of the project sites, could be exposed to dust generated during construction activities, indirectly resulting in potential adverse health effects. This indirect effect would be significant. Implementation of mitigation measures would reduce the impact from dust emissions during construction to a less-than-significant level.

Toxic Air Contaminants

Construction of Alternative 2 would result in slightly higher short-term DPM emissions in the SVAB relative to Alternative 1. Nearby land uses, especially those residences located downwind of the project sites could be exposed to DPM generated during construction activities, indirectly resulting in potential adverse health effects. However, construction activities along each segment are not expected to take place for more than 180 days at each reach, which is well below the 70-year exposure period often assumed in chronic health risk assessment. Moreover, construction activities would occur linearly along the segment alignment and would not occur over a prolonged period in any one general location and all off-road diesel equipment would comply with CARB regulations regarding consecutive idling. In addition, implementation of mitigation measures, which is required under other air quality effects, would further reduce exhaust emissions during construction to a less-than-significant level.

Odors

Odors associated with diesel exhaust emissions from onsite construction equipment in the SVAB may be slightly higher than Alternative 1. These odors may be noticeable from time to time by adjacent receptors. However, the odors would be intermittent and temporary and would dissipate rapidly from the source with an increase in distance. Furthermore, as required by CARB regulations, no in-use off-road diesel vehicles may idle for more than 5 consecutive minutes. Therefore, this direct effect would be less than significant. In addition, implementation of mitigation measures, which are required under other air quality effects, would further reduce exhaust emissions and provide advance notification of construction activities.

3.11.6 Mitigation Measures

As described above, some emissions from the project would exceed applicable CEQA and NEPA significance criteria. Therefore, the Corps would implement the following mitigation measures to reduce the potential air quality effects of the project.

SMAQMD's Basic Construction Emissions Control Practices

The SMAQMD requires construction projects to implement basic construction emission control practices to control fugitive dust and diesel exhaust emissions (SMAQMD 2015). The Corps would comply with the following control measures for the project:

- Water all exposed surfaces twice daily. Exposed surfaces include but are not limited to: soil piles, graded areas, unpaved parking areas, staging areas, and access roads.
- Cover or maintain at least two feet of free board space on haul trucks transporting soil, sand, or other loose material on the site. Any haul trucks that would travel along freeways or major roadways should be covered.
- Use wet power vacuum street sweepers to remove any visible trackout mud or dirt from adjacent public roads at least once a day. Use of dry power sweeping is prohibited.
- Complete all roadways, driveways, sidewalks, or parking lots to be paved as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.
- Minimize idling time either by shutting equipment off when not in use or reducing the time of idling to 5 minutes [required by California Code of Regulations, Title 13, sections 2449(d)(3) and 2485]. Provide clear signage that posts this requirement for workers at the site entrances.
- Maintain all construction equipment in proper working condition according to the manufacturer's specifications. The equipment must be checked by a certified mechanic and determined to be running in proper condition before it is operated.

Fugitive Dust Emission Mitigation Measures

Fugitive dust mitigation would require the use of adequate measures during each construction activity and would include frequent water applications or application of soil additives, control of vehicle access, and vehicle speed restrictions. The Corps would implement the dust mitigation measures listed below.

- Water exposed soil with adequate frequency for continued moist soil.
- Suspend excavation, grading, and/or demolition activity when wind speeds exceed 20 mph.
- Install wind breaks (e.g., plant trees, solid fencing) on windward side(s) of construction areas.
- Plant vegetative ground cover (fast-germinating native grass seed) in disturbed areas as soon as possible.

- Install wheel washers for all exiting trucks, or wash off all trucks and equipment leaving the site.
- Treat site accesses to a distance of 100 feet from the paved road with a 6 to 12-inch layer of wood chips, mulch, or gravel to reduce generation of road dust and road dust carryout onto public roads.
- Post a publicly visible sign with the telephone number and person to contact at the lead agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The phone number of the District shall also be visible to ensure compliance.

Exhaust Emission Mitigation Measures

The project will ensure that emissions from all off-road diesel powered equipment used on the project site do not exceed 40 percent opacity for more than three minutes in any one hour. Any equipment found to exceed 40 percent opacity (or Ringelmann 2.0) shall be repaired immediately. Non-compliant equipment will be documented and a summary provided to the Corps and SMAQMD monthly. A visual survey of all in-operation equipment shall be made at least weekly, and a monthly summary of the visual survey results shall be submitted throughout the duration of the project, except that the monthly summary shall not be required for any 30-day period in which no construction activity occurs. The monthly summary shall include the quantity and type of vehicles surveyed as well as the dates of each survey.

Marine Engine Standards

The use of USEPA adopted Tier 3 and Tier 4 standards for newly-built marine engines in 2008 would be encouraged under the barge delivery scenario. The Tier 3 standards reflect the application of technologies to reduce engine PM and NO_X emission rates. Tier 4 standards reflect application of high-efficiency catalytic after-treatment technology enabled by the availability of ultra-low sulfur diesel. These Tier 4 standards would be phased in over time for marine engines beginning in 2014 (USEPA 2008).

The Corps will use Tier 2 and 3 marine engines standards to reduce marine exhaust emissions. Due to uncertainty as to the availability of Tier 4 marine engines within the required project timeline, this mitigation measure does not require the use of Tier 4 marine engines. However, should they become available during the appropriate construction periods, use of these engines would further lower project emissions.

Construction Equipment

The Corps will require that all off-road construction equipment comply with SMAQMD's enhanced exhaust controls (20% NO_X and 45% PM reductions). The Corps will encourage their construction contractors to use off-road diesel-powered construction equipment greater than 50 horsepower that meets Tier-4 off-road emission standards under the barge delivery scenario. In addition, if not already supplied with a factory-equipped diesel particulate filter, all construction equipment shall be outfitted with Best Available Control Technology (BACT) devices certified by CARB. Any emissions control device used by the Contractor shall achieve emissions reductions that are no less than what could be achieved by a Level 3 diesel emissions control strategy for a similarly sized engine as defined by CARB regulations.

On-road heavy-duty diesel trucks or equipment with a GVWR of 19,500 pounds or greater shall comply with EPA 2010 on-road emission standards for PM and NO_X (0.01 g/bhp-hr and at least 1.2 g/bhp-hr, respectively) under the barge delivery scenario. Use of these trucks would provide the best available emission controls for NO_X and PM emissions.

Use of Electrical Equipment

Construction equipment powered by electricity, rather than diesel fuel, eliminates criteria pollutant emissions from diesel combustion. Electrification would result in a small amount of indirect CO_2 emissions due to the operation of the electric grid. Various types of construction equipment may feasibly be run on electricity.

NO_X Mitigation Fee to SMAQMD

As of July 1, 2015, the mitigation fee rate is $18,030 per ton of emissions. The Contractor would provide payment of the appropriate SMAQMD-required NO_x mitigation fee to offset the project's NO_x emissions when they exceed SMAQMD's threshold of 85 lbs/day. Estimated calculations for these mitigation fees are included under each alternative's effects analysis in Appendix D. The NO_X Mitigation Fee applies to all emissions from the project: on-road (on-and off site), off-road, portable, marine and stationary equipment and vehicles.

NO_X Mitigation Fee to BAAQMD

The Corps would consult with the BAAQMD in good faith to enter into a mitigation contract for an emission reduction incentive program (e.g., TFCA or Carl Moyer Program). The current emissions limit is $17,080/weighted ton of criteria pollutants (NO_X + ROG + [20*PM]). An administrative fee of 5 percent would be paid to the BAAQMD to implement the program. The contractor would conduct daily and annual emissions monitoring to ensure onsite emissions reductions are achieved and no additional mitigation payments are required. The contractor would be required to ensure the requirement is met.

This requirement would be incorporated into the construction contracts as part of the project's specifications.

If a sufficient number of emissions reduction projects are not identified to meet the required performance standard, the Corps would coordinate with the BAAQMD to meet the performance standards of achieving quantities below applicable BAAQMD CEQA thresholds.

3.12 Climate Change

3.12.1 Environmental Setting

Regulatory Setting

The following Federal, State, and local laws and regulations apply to the resources covered in this section. Descriptions of the laws and regulations can be found in Section 5.0.

Federal

- Mandatory Greenhouse Gas Reporting Rule

State

- State Regulations on Greenhouse Gases and Climate Change
- Assembly Bill 32, Global Warming Solutions Act of 2006
- Senate Bill 97
- Executive Order S-13-08
- California Clean Air Act of 1988

Local

- Yolo-Solano Air Quality Management District
- Sacramento Metropolitan Air Quality Management District
- Bay Area Air Quality Management District
- Sacramento County Climate Action Plan
- City of Sacramento Climate Action Plan

Existing Conditions

This section addresses the impacts of GHG emissions associated with implementation of the ARCF GRR on global climate change. Emissions of GHGs are a concern because all GHGs and GHG emissions contribute, on a cumulative basis, to global climate change. Global climate change has the potential to result in sea level rise (which may result in flooding of low-lying areas), to affect rainfall and snowfall levels (which may lead to changes in water supply and runoff), to affect temperatures and habitats (which in turn may affect biological and agricultural resources), and to result in many other adverse effects. Although global climate change is inherently a cumulative impact, it is important to remember that any single project is unlikely to be able to generate sufficient GHGs by itself to have a significant impact on the environment. However, the cumulative effect of human activities which generate GHG have been clearly linked to quantifiable changes in the composition of the atmosphere, which in turn have been shown to be the main cause of global climate change.

Global Climate Trends and Associated Impacts

On October 30, 2009, the USEPA published a rule for the mandatory reporting of GHGs from sources that in general emit 25,000 metric tons or more of carbon dioxide equivalent per year in the United States. On December 18, 2014, CEQ released revised draft guidance that applies to all proposed Federal agency actions, including land and resource management actions. This guidance states that "Agencies are required to consider direct, indirect, and cumulative effects when analyzing any proposed Federal actions and projecting their environmental consequences" and "climate change is a particularly complex challenge given its global nature and inherent interrelationships…however, analyzing the proposed action's climate impacts and the effects…can provide useful information to decision makers" (CEQ, 2014). Implementation of 40 CFR Part 98 is referred to as the Greenhouse Gas Reporting Program. The purpose of the rule is to collect accurate and timely GHG data to inform future policy decisions (EPA, 2012).

Global warming is the name given to the increase in the average temperature of the Earth's near-surface air and oceans since the mid-20th century and its projected continuation. Warming of the climate system is now considered by a vast majority of the scientific community to be unequivocal, based on observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC, 2007).

Global mean surface temperatures have risen by 0.74 degrees Celsius (°C) ± 0.18°C when estimated by a linear trend over the last 100 years (1906 to 2005). The rate of warming over the last 50 years is almost double that over the last 100 years (0.13°C ± 0.03°C versus 0.07°C ± 0.02°C per decade). The causes of this measured warming have been identified as both natural processes and the result of human actions. For the next two decades, a warming of about 0.2°C per decade is projected for a range of emissions scenarios.

The Intergovernmental Panel on Climate Change (IPCC) concludes that variations in natural phenomena such as solar radiation and volcanoes produced most of the warming from preindustrial times to 1950 and had a small cooling effect afterward. However, since 1950, increasing GHG concentrations resulting from human activity such as fossil fuel burning and deforestation have been responsible for most of the observed temperature increase. These basic conclusions have been endorsed by more than 45 scientific societies and academies of science, including all of the national academies of science of the major industrialized countries. Since 2007, no scientific body of national or international standing has maintained a dissenting opinion (DWR, 2012).

Increases in GHG concentrations in the Earth's atmosphere are thought to be the main cause of human-induced climate change. GHGs naturally trap heat by impeding the exit of solar radiation that has hit the Earth and is reradiated back into space as infrared radiation. Some GHGs occur naturally and are necessary for keeping the Earth's surface habitable. However, increases in the concentrations of these gases in the atmosphere above natural levels during the last 100 years have increased the amount of infrared radiation that is trapped in the lower atmosphere, intensifying the natural greenhouse effect and resulting in increased global average temperatures.

The effects of warming of the Earth's atmosphere and oceans affect global and local climate systems. Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, in addition to temperature increases (IPCC, 2007). Based on growing evidence, there is high confidence that the following effects on hydrologic systems are occurring: (1) increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers; and (2) warming of lakes and rivers in many regions, with effects on thermal structure and water quality (IPCC, 2008).

There is very high confidence, based on increasing evidence from a wider range of species, that recent warming is strongly affecting terrestrial biological systems, including such changes as earlier timing of spring events (e.g., leaf-unfolding, bird migration, egg-laying); and poleward and upward shifts in ranges in plant and animal species. Based on satellite observations since the early 1980s, there is high confidence that there has been a trend in many regions toward earlier "greening" of vegetation in the spring linked to longer thermal growing seasons resulting from recent warming (IPCC, 2007).

There is high confidence, based on substantial new evidence, that observed changes in marine and freshwater biological systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. These include shifts in ranges and changes in algal, plankton, and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier fish migrations in rivers (IPCC, 2007).

Changes in the ocean and on land, including observed decreases in snow cover and Northern Hemisphere sea ice extent, thinner sea ice, shorter freezing seasons of lake and river ice, glacier melt, decreases in permafrost extent, increases in soil temperatures and borehole temperature profiles, and sea level rise, provide additional evidence that the world is warming (IPCC, 2007).

Climate Change Conditions in California

With respect to California's water resources, the most important effects of global warming have been changes to the water cycle and sea level rise. Over the past century, the precipitation mix between snow and rain has shifted in favor of more rainfall and less snow (Mote et al., 2005; Knowles et al., 2006), and snowpack in the Sierra Nevada is melting earlier in the spring (Kapnick and Hall, 2009). The average early-spring snowpack in the Sierra Nevada has decreased by about 10 percent during the last century, a loss of 1.5 million acre-feet of snowpack storage (DWR, 2008). These changes have major implications for water supply, flooding, aquatic ecosystems, energy generation, and recreation throughout the state.

Precipitation

Climate change can affect precipitation by changing the overall amount of precipitation, type of precipitation (rain versus snow), and timing and intensity of precipitation events. Changes to these factors propagate through the hydrologic system in California and have the potential to affect snowpack, runoff, water supply, and flood control.

Former State Climatologist James Goodridge compiled an extensive collection of precipitation records from throughout California. These data sets were used to evaluate whether there has been a changing trend in precipitation in the state over the past century (DWR, 2006). Long-term runoff records in selected California watersheds were also examined dating back to 1890. Based on a linear regression of the data, the long-term historical trend for statewide average annual precipitation appears to be relatively flat (no increase or decrease) over the entire record. However, it appears that there might be an upward trend in precipitation toward the latter portion of the record. Precipitation in Northern California appears to have increased between 1 and 3 inches annually between 1890 and 2002 (DWR, 2006).

Snowpack

An increase in the global average temperature is expected to result in a decreased volume of precipitation falling as snow in California and an overall reduction in the Sierra Nevada's snowpack. Snowpack in the Sierra Nevada provides both water supply (runoff) and storage (within the snowpack before melting), which is a major source of supply for California. According to the California Energy Commission, the snowpack portion of the water supply has the potential to decline by 30 to 90 percent

by the end of the 21st century (CEC, 2006). A study by Knowles and Cayan projects that approximately 50 percent of the statewide snowpack will be lost by the end of the century (Knowles and Cayan, 2002).

On average, California's annual snowpack has the greatest accumulations from November through the end of March. The snowpack typically melts from April through July. California's reservoir managers rely on snowmelt to fill reservoirs once the threat of large winter and early-spring storms and related flooding risks have passed.

An analysis conducted by DWR of the effect of rising temperatures on snowpack shows that a rise in average annual air temperature of 3°C (5.4°F) would likely cause snowlines to rise approximately 1,500 feet (DWR, 2006). This would result in the equivalent of approximately 5 million acre-feet of water per year falling as rain rather than snow at lower elevations.

Runoff

Runoff is directly affected by changes in precipitation and snowpack. If the amount of precipitation falling as rain rather than snow were to increase earlier in the year, flooding potential could increase. Water that normally would be held in the Sierra Nevada snowpack until spring would flow into the Central Valley concurrently with the rain from winter storm events. This scenario would place more pressure on California's flood control system (DWR, 2006).

Changes in both the amount of runoff and the seasonality of the hydrologic cycle also have the potential to greatly affect the heavily managed water systems of the western United States. The hydrology of the Sacramento River watershed is highly dependent on the interaction between Sierra Nevada snowpack, runoff, and management of reservoirs. Higher snow lines and more precipitation falling in the form of rain rather than snow will increase winter inflows to reservoirs. Higher winter inflows will also likely mean that a greater portion of the total annual runoff volume will occur in the winter, which would translate to higher flows in the Sacramento and American Rivers in the winter than those that currently occur.

Sea Level Rise

Sea level rise has been a persistent trend for decades, and is expected to continue beyond the end of the century. Past trends provide valuable insight in preparing for future environmental change, but by themselves are insufficient for assessing the risks associated with an uncertain future. A wide range of estimates for future global mean sea level rise are scattered throughout scientific literature, but aside from the IPCC there is no coordinated interagency effort to identify sea level rise estimates for the purpose of planning, policy, and management. Current predictions of global mean sea level rise state that increases in sea level could be between 8 inches to six feet by year 2100 (NOAA, 2012).

Although the Sacramento region is an inland basin and is unlikely to be directly impacted by sea level rise, the potential inundation of low lying areas in the Bay area and parts of the Delta could increase the likelihood of salinity intrusion and river bank erosion due to increased tidal influx. Additionally, continued land subsidence in the Delta could increase the risk of sea water intrusion further inland than current predictions.

Greenhouse Gas Emissions

As defined in Section 38505(g) of the California Health and Safety Code, the principal GHGs of concern are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). With the exception of NF_3, these are the same gases named in the USEPA's Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act. Each of the principal GHGs has a long atmospheric lifetime (one year to several thousand years), and is globally well mixed. In addition, the potential heat trapping ability of each of these gases varies significantly from one another. On a 100-year timescale, methane is about 25 times as potent as CO_2, nitrous oxide is about 298 times as potent as CO_2, and sulfur hexafluoride is about 22,800 times more potent than CO_2 (IPCC, 2007). Conventionally, GHGs have been reported as CO_2 equivalents (CO_2e). CO_2e takes into account the relative potency of non-CO_2 GHGs and converts their quantities to an equivalent amount of CO_2 so that all emissions can be reported as a single quantity.

The primary human-made processes that release these gases include: (1) the burning of fossil fuels for transportation, heating, and electricity generation; (2) agricultural practices that release methane, such as livestock grazing and crop residue decomposition; and (3) industrial processes that release smaller amounts of high global warming potential gases, such as SF_6, perfluorocarbons, and hydrofluorocarbons. Deforestation and land cover conversion have also been identified as contributing to global warming by reducing the Earth's capacity to remove CO_2 from the air and altering the Earth's surface reflectance. The major sources of GHGs that are relevant to the ARCF GRR project are transportation sources and construction emissions. These are discussed in greater detail below.

Transportation

Transportation is a major source of GHGs in California, accounting for 36 percent of the State's total GHG emissions in 2008 (CARB, 2011). Transportation emissions within California are generated primarily by combustion of gasoline, diesel, and some alternative fuels by mobile sources. The indicators of vehicular activity, and resulting GHG emissions, are vehicle miles traveled and the fuel economies of the individual vehicles composing the vehicular fleet. Vehicle miles traveled are associated with movement of people and goods on local, regional, and statewide scales.

Construction

Construction emissions are generated when materials and workers are transported to and from construction sites and when machinery is used for construction activities such as trenching, grading, dredging, paving, and building. Emissions from construction activities are generated for shorter periods than operational emissions; however, GHGs remain in the atmosphere for hundreds of years or more, so once released, they contribute to global climate change unless they are removed through absorption by the oceans or by terrestrial sequestration.

Construction emissions are not accounted for in a separate category in the California GHG inventory (or other inventories that use IPCC GHG emissions sectors for accounting purposes). However, based on the category "Transportation—Not Specified," which includes off-road vehicles and associated diesel fuel combustion, construction emissions accounted for a maximum of 0.4 percent of California's GHG inventory between 2000 and 2008 (CARB, 2011).

Greenhouse Gas Emissions Inventories

A GHG inventory is a quantification of GHG emissions and sinks within a selected physical and/or economic boundary over a specified time. GHG inventories can be performed on a large scale (i.e., for global and national entities) or on a small scale (i.e., for a particular building or person).

Many GHG emission and sink specifications are complicated to evaluate because natural processes may dominate the carbon cycle. Although some emission sources and processes are easily characterized and well understood, some components of the GHG budget (i.e., the balance of GHG sources and sinks) are not known with accuracy. Because protocols for quantifying GHG emissions from many sources are currently under development by international, national, state, and local agencies, ad-hoc tools must be developed to quantify emissions from certain sources and sinks in the interim.

Table 38 outlines the most recent global, national, statewide, and local GHG inventories to help contextualize the magnitude of potential project-related emissions.

Table 38. Global, National, State, and Local GHG Emission Inventories.

Emissions Inventory	CO_2e (metric tons)
2004 IPCC Global GHG Emissions Inventory	49,000,000,000
2009 USEPA National GHG Emissions Inventory	6,633,200,000
2008 CARB State GHG Emissions Inventory	477,740,000
2008 Yolo County GHG Emissions Inventory[a]	651,740
2005 Sacramento County GHG Emissions Inventory	13,925,537

Sources: IPCC 2007; USEPA 2011a; CARB 2010; Yolo County 2011; ICF Jones & Stokes 2009.
[a] Only includes emissions associated with the unincorporated county.

3.12.2 Methodology and Basis of Significance

This section describes the climate change effects associated with the project. It describes the methods used to determine the effects of the project and lists the thresholds used to conclude whether an effect would be significant.

Methodology

Although construction activities would result in temporary effects on air quality in the study area, the project would comply with all Federal, State, and local air quality regulations. Where a potentially significant climate change effect is identified, mitigation measures are recommended to reduce the level of expected effects.

The key sources of data and information used in the preparation of this section are listed below.

- *Handbook for Assessing and Mitigating Air Quality Impacts* (Yolo-Solano Air Quality Management District 2007)
- *Guide to Air Quality Assessment in Sacramento County* (Sacramento Metropolitan Air Quality Management District 2009)
- CEQA and Climate Change, Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act (California Air Pollution Control Officers Association 2008)
- Quantifying Greenhouse Gas Mitigation Measures, a Resource for Local Government to Assess Emission Reductions from Greenhouse Gas Mitigation Measures (California Air Pollution Control Officers Association 2010)

This section provides an evaluation of the direct and indirect GHG emissions that contribute to the cumulative impact on global climate change from implementing the proposed project.

Almost all increased GHG emissions associated with the proposed project would be generated by construction-related activities. After the project is constructed, operation and maintenance of the project facilities would generally be performed as needed. Maintenance work is less extensive than the construction activities and takes place over a few days per year. In addition, operation and maintenance activities are part of the existing environmental baseline and thus would not create a substantial source of new emissions. Consequently, operation of the project would not result in any adverse effects under NEPA or significant impacts under CEQA related to GHG emissions and are not quantified in this analysis because they are part of the existing environmental baseline. The assessment, therefore, focuses on evaluating GHG impacts from construction activities.

GHG emissions from project construction would result from fuel usage by off-road equipment, on-road vehicles, electricity consumption by office trailers, and barge delivery of materials. For the GHG analysis, the project alternatives were evaluated using conservative construction scenarios referred to as "worse-case scenarios" to estimate the maximum construction emissions generated by each alternative. The delivery and placement task was also calculated using the assumption that same amount of material to be barged to the project site, would be trucked to the site in the same period of time. The primary GHG emissions generated from these sources would be CO_2, CH_4, and N_2O. Models, tools, and assumptions used to calculate the GHG emissions are described below.

- Off-Road Equipment: CO_2 emissions generated from onsite construction equipment were estimated using the Roadway Construction Emissions Model (Version 7.1.3) emissions model, following the same assumptions described in Section 3.11.
- On-Road Vehicles: CO_2 emissions generated from the on-road vehicle trips were estimated, following the same assumptions described in Section 3.11.
- Barge Delivery: CO_2, CH_4, and N_2O emissions generated from towboats were estimated using emission factors following the same assumptions described in Section 3.11.

Basis of Significance

For this analysis, an effect pertaining to climate change was analyzed based on professional judgment, draft NEPA Guidance published by CEQ, and State CEQA Guidelines Appendix G (14 CCR 15000 *et seq*.). An effect was considered significant if it would:

- Conflict with an applicable plan adopted for the purpose of reducing GHG emissions.

The SMAQMD,YSAQMD, and BAAQMD have local jurisdiction over the project area. In January 2008, the SMAQD made a resolution to adopt guidance published by the California Air Pollution Control Officers Association, entitled "CEQA and Climate Change, Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act" (CAPCOA, 2008). This resolution adopted the following recommended greenhouse gas thresholds of significance:

- Construction phase of projects: 1,100 metric tons of CO_2e per year;
- Operational phase of land development projects: 1,100 metric tons of CO_2e per year; and,
- Stationary source projects: 10,000 direct metric tons of CO_2e per year.

Based on the CEQA guidelines established by each district, the districts recommend that GHG emissions from construction activities be quantified and disclosed, a determination regarding the significance of these GHG emissions be made based on a threshold determined by the lead agency, and BMPs be incorporated to reduce GHG emissions during construction, as feasible and applicable.

3.12.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, itwould be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. As discussed in Section 3.12.1, Environmental Setting, several indirect effects on the environment are expected throughout California as a result of global climate change. The extent of these effects is still being defined as climate modeling tools become more refined. Regardless of the uncertainty in precise predictions, it is widely understood that substantial climate change is expected to occur in the future. Potential climate change effects in California and the Sacramento area include, but are not limited to, Delta salt water intrusion, extreme heat events, increased energy consumption, increase in infectious diseases and respiratory illnesses, reduced snowpack and water supplies, increased water consumption, and potential increase in wildfires.

Global climate change could expose the No Action Alternative to increased rainfall runoff and flood flows in the Sacramento River. The effects of increased flood flows would be most severe for the No Action Alternative, which does not include any flood risk reduction measures.

Without improvements to the levee system, the risk of levee failure would remain high. Under these conditions, any of the levee deficiencies could cause portions of the levees to fail, triggering widespread flooding and extensive damage. If a catastrophic flood were to occur, emergency flood fighting and clean-up actions would require the use of a considerable amount of heavy construction equipment. Timing and duration of use would directly correlate with flood fighting needs, but it is assumed that pollutants emitted would increase GHG emissions to above the stated thresholds, and expose sensitive receptors to toxic air emissions. Depending on the magnitude of the flood, flood fighting could last for weeks or even months. Furthermore, because of the unpredictable nature of an emergency response, no BMPs to manage emissions would be in place, which would be in violation with applicable climate change plans that require efforts to reduce GHGs, as practicable, during construction activities. All of these effects could be considered significant. However, the timing, duration, and magnitude of a flood event are speculative and unpredictable, and therefore a precise determination of significance is not possible.

3.12.4 Alternative 1 – Improve Levees

Currently, SMAQMD recommends a construction emission threshold of 1,100 metric tons (MT) of CO_2e per year (SMAQMD 2014). Additionally, YSAQMD collaborated with SMAQMD in order to determine an established threshold of significance for GHG to be used in CEQA analysis. Although this threshold is still in concept design, the working group determined that a 21.7 percent reduction of emissions by 2020 would conform to the CARB goals of AB 32. The working group also proposed a "screening level" that considers smaller projects (less than 1,100 MT CO_2e per year) less than significant (YSAQMD 2014). At this time, since this threshold is still in concept design, the Corps is not adopting reduction threshold; however, should the Corps conduct any supplemental NEPA/CEQA analysis prior to construction, the Corps will incorporate any applicable thresholds that are established at that time. The BAAQMD's threshold of 10,000 MT per year of CO_2e for stationary sources is compared against the GHG emissions generated from the entire project construction to determine the indirect cumulative contribution to climate change that would result from the construction of Alternative 1.

The construction emissions are estimated for Alternative 1 site–related activities and off-site borrow material activities based on the emission rates and assumptions described in Section 3.11.2. Emission sources associated with site–related activities include the off-road construction equipment operating at project sites, on-road vehicles (except vehicles associated with the material borrow) traveling to and from the project sites, barge delivery to and from the project sites on the Sacramento River, and office trailers operating at project sites. Emission sources associated with borrow material activities include the off-road construction equipment operating at borrow sites, and on-road hauling trucks traveling between borrow sites and the project sites.

The estimated construction GHG emissions, which include CO_2, CH_4, N_2O, and other GHG emissions, are shown in Table 39. The total construction project would exceed the SMAQMD and YSAQMD threshold of 1,100 MT CO_2e per year, but project-wide GHG emissions would be well below the BAAQMD's GHG threshold of 10,000 MT CO_2e per year. Implementation of mitigation measures would further reduce GHG emissions during construction to the maximum extent practicable. For any emissions not reduced through proposed mitigation, the Corps would purchase carbon offset credits in coordination with SMAQMD and YSAQMD, as needed. With these offset credits, impacts to climate change from construction would be reduced to less than significant.

Alternative 1 would increase the likelihood that the flood management system could accommodate future flood events as a result of climate change. Consequently, the project alternative would improve the resiliency of the levee system with respect to changing climatic conditions, potentially reducing exposure of property or persons to the effects of climate change. Effects to Climate Change from long-term O&M activities would be the same as discussed in Section 3.11.4 for Air Quality. These impacts would be less than significant, and no mitigation would be required.

Table 39. Construction GHG Emissions for All Alternatives, Truck and Barge Delivery Scenarios.

Construction Year	Total GHG Emissions (MT/year of CO_2e)			
	SMAQMD	**YSAQMD**	**BAAQMD**	**Project-Wide**
Alternative 1 and 2, Truck Delivery Scenario				
Year 2 On-site Construction	3,204.6	0	0	3,204.6
Year 2 Off-site Soil Borrow	101.3	91.2	0	192.5
Bypass Widening and Demolition of Old Levee	0	2,910.86	0	2,910.86
Year 2 Total	3,305.9	3,002.06	0	6,307.96
Alternative 1 and 2, Barge Delivery Scenario				
Year 2 On-site Construction	1,920.8	0	0	1,920.8
Year 2 Off-site Soil Borrow	101.3	91.2	0	192.5
Year 2 Barge Delivery	148.6	88.4	164.7	401.6
Bypass Widening and Demolition of Old Levee	0	2910.86	0	2910.86
Year 2 Total	2,170.7	3,090.46	164.7	5,425.76
BAAQMD Threshold	1,100	1,100	10,000	
Exceed Threshold?	Yes	Yes	No	

3.12.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

The estimated construction GHG emissions for Alternative 2 are shown in Table 39. While the truck delivery scenario would generate slightly more GHG emissions relative to the barge delivery scenario, emissions would be well below the BAAQMD's GHG threshold. Implementation of mitigation measures would further reduce GHG emissions. Effects to Climate Change from long-term O&M activities would be the same as discussed in Section 3.11.4 for Air Quality. These impacts would be less than significant, and no mitigation would be required.

Under Alternative 2, the Sacramento Weir and Bypass would be expanded to accommodate future flood events. The project alternative would allow the State of California future flexibility in the operations of the weir to move more water into the bypass once the river reaches a certain height. While there is no proposed change in operations of the weir at this time, Alternative 2 would improve the resiliency of the levee system by making the system more adaptable to changing climatic conditions, potentially reducing exposure of property or persons to the effects of climate change.

3.12.6 Mitigation Measures

The following measures may be considered to lower GHG emissions during the construction:

- Encourage and provide carpools, shuttle vans, transit passes and/or secure bicycle parking for construction worker commutes.

- Recycle at least 75% of construction waste and demolition debris.
- Purchase at least 20% of the building materials and imported soil from sources within 100 miles of the project site.
- Minimize idling time either by shutting equipment off when not in use or reducing the time of idling to no more than 3 minutes (5 minute limit is required by the state airborne toxics control measure [Title 13, sections 2449(d)(3) and 2485 of the California Code of Regulations]). Provide clear signage that posts this requirement for workers at the entrances to the site.
- Maintain all construction equipment in proper working condition according to manufacturer's specifications. The equipment must be checked by a certified mechanic and determined to be running in proper condition before it is operated.
- Use equipment with new technologies (repowered engines, electric drive trains).
- Perform on-site material hauling with trucks equipped with on-road engines (if determined to be less emissive than the off-road engines).
- Use a CARB approved low carbon fuel for construction equipment. (NO_x emissions from the use of low carbon fuel must be reviewed and increases mitigated.)
- Purchase GHG offset for program-wide GHG emissions (direct emissions plus indirect emissions from on-road haul trucks plus commute vehicles) exceeding SMAQMD or CEQ's significance thresholds applicable at the time of construction. Carbon offset credits shall be purchased from programs that have been approved by SMAQMD.

3.13 Noise

3.13.1 Environmental Setting

Regulatory Setting

- City of Sacramento Noise Ordinance
- Sacramento County Noise Ordinance

Existing Conditions

Noise is generally defined as sound that is loud, disagreeable, or unexpected. Sound is characterized by various parameters that include the rate of oscillation of sound waves (frequency), the speed of propagation, and the pressure level or energy content (amplitude). The decibel (dB) scale is used to quantify sound intensity. The human ear is not equally sensitive to all frequencies in the entire spectrum, so noise measurements are weighted more heavily for frequencies to which humans are sensitive in a process called "A-weighting". Since humans are less sensitive to low frequency sound than to high frequency sound, A-weighted decibel (dBA) levels de-emphasize low frequency sound energy to better represent how humans hear. Table 40 summarizes typical A-weighted sound levels.

Different types of measurements are used to characterize the time-varying nature of sound. These measurements include the equivalent sound level (L_{eq}), the minimum and maximum sound levels (L_{min} and L_{max}), percentile-exceeded sound levels (L_{xx}), the day-night sound level (L_{dn}), and the community noise equivalent level (CNEL). Below are brief definitions of these measurements and other terminology used in this section:

- **Sound.** A vibratory disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.
- **Ambient noise.** The composite of noise from all sources near and far in a given environment exclusive of particular noise sources to be measured.
- **Decibel (dB).** A unitless measure of sound on a logarithmic scale, which indicates the squared ratio of sound pressure amplitude to a reference sound pressure amplitude. The reference pressure is 20 micro-pascals.
- **A-weighted decibel (dBA).** An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
- **Equivalent sound level (L_{eq}).** The average of sound energy occurring over a specified period. In effect, L_{eq} is the steady-state sound level that in a stated period would contain the same acoustical energy as the time-varying sound that actually occurs during the same period.
- **Exceedance sound level (L_{xx}).** The sound level exceeded XX percent of the time during a sound level measurement period. For example, L_{90} is the sound level exceeded 90 percent of the time, and L_{10} is the sound level exceeded 10 percent of the time. L_{90} is typically considered to represent the ambient noise level.
- **Maximum and minimum sound levels (L_{max} and L_{min}).** The maximum or minimum sound

level measured during a measurement period.

- **Day-night level (L_{dn}).** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.
- **Community noise equivalent level (CNEL).** The energy average of the A-weighted sound levels occurring during a 24-hour period with 5 dB added to the A-weighted sound levels occurring during the period from 7:00 p.m. to 10:00 p.m. and 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.

L_{dn} and CNEL values rarely differ by more than one dB. As a matter of practice, L_{dn} and CNEL values are considered to be equivalent and are treated as such in this assessment. In general, human sound perception is such that a change in sound level of three dB is just noticeable, a change of five dB is clearly noticeable, and a change of 10 dB is perceived as doubling or halving sound level.

For a point source such as a stationary compressor, sound attenuates based on geometry at rate of six dB per doubling of distance. For a line source such as free- flowing traffic on a freeway, sound attenuates at a rate of three dB per doubling of distance. Atmospheric conditions including wind, temperature gradients, and humidity can change how sound propagates over distance and can affect the level of sound received at a given location. The degree to which the ground surface absorbs acoustical energy also affects sound propagation. Sound that travels over an acoustically absorptive surface such as grass attenuates at a greater rate than sound that travels over a hard surface such as pavement. The increased attenuation is typically in the range of one to two dB per doubling of distance. Barriers such as buildings and topography that block the line of sight between a source and receiver also increase the attenuation of sound over distance.

Table 40. Typical A-Weighted Sound Levels.

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	--110--	Rock Band
Jet flyover at 1,000 feet		
	--100--	
Gas lawnmower at 3 feet		
	--90--	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	--80--	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawnmower at 100 feet	--70--	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	--60--	
		Large business office
Quiet urban daytime	--50--	Dishwasher in next room
Quiet urban nighttime	--40--	Theater, large conference room (background)
Quiet suburban nighttime		
	--30--	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	--20--	
		Broadcast/recording studio
	--10—	
	--0--	

Source: Caltrans, 1998

Noise levels and impacts are interpreted in relation to noise standards for each city or county. The majority of the project is located within Sacramento County; therefore, those noise level standards will be used to evaluate affects on noise. The Sacramento County noise ordinance states that a standard of 55 dBA is applied during the hours from 7:00 a.m. to 10:00 p.m., and a standard of 50 dBA is applied during the hours from 10:00 p.m. to 7:00 a.m. for residential and agricultural uses. The noise ordinance also states that construction noise is exempt during the hours from 6:00 a.m. to 8:00 p.m. Monday through Friday and from 7:00 a.m. to 8:00 p.m. on Saturdays and Sundays (Chapter 6.68 Noise Control, County of Sacramento Code).

The City of Sacramento exterior noise standard, as stated in the City's noise ordinance, is 55 dBA during the hours from 7:00 a.m. to 10:00 p.m. for residential and agricultural uses. The standard then adjusts to 50 dBA between 10:00 p.m. and 7:00 a.m. for residential and agricultural uses. The noise ordinance also exempts construction noise during the hours from 7:00 a.m. to 6:00 p.m. Monday through Saturday and from 9:00 a.m. to 6:00 p.m. on Sundays. The ordinance further states that the operation of an internal combustion engine is not exempt if the engine is not equipped with suitable exhaust and intake silencers in good working order (8.68.080 Exemptions, Noise Control Standards, City of Sacramento Municipal Code).

The perceptibility of a new noise source that intrudes into a background noise environment depends on the nature of the intruding sound compared to the background sound. In general, if the intruding sound has the same character as the background sound (e.g., an increase in continuous traffic noise compared to background continuous traffic noise), human sound perception is such that a change in sound level of 3 dB is just noticeable, a change of 5 dB is clearly noticeable, and a change of 10 dB is perceived as doubling or halving the sound level. However, if the intruding sound is of a character different from the background sound (e.g., construction noise in an otherwise quiet neighborhood), the intruding sound can be clearly discernible even if it raises the overall dBA noise level by less than 1 dB.

Operation of heavy construction equipment, particularly pile driving and other impulsive devices such as pavement breakers, create seismic waves that radiate along both the surface and downward into the earth. These surface waves can be felt as ground vibration. Vibration from operation of this equipment can result in effects ranging from annoyance of people to damage of structures. Varying geology and distance will result in different vibration levels containing different frequencies and displacements. In all cases, vibration amplitudes will decrease with increasing distance.

As seismic waves travel outward from a vibration source, they excite the particles of rock and soil through which they pass and cause them to oscillate. The actual distance that these particles move is usually only a few ten-thousandths to a few thousandths of an inch. The rate or velocity (in inches per second [in/sec]) at which these particles move is the commonly accepted descriptor of the vibration amplitude, referred to as the peak particle velocity (ppv). Table 41 summarizes typical vibration levels generated by construction equipment).

Table 41. Vibration Source Levels for Construction Equipment.

Equipment	PPV at 25 feet
Pile driver (impact)	0.644 to 1.518
Pile drive (sonic)	0.170 to 0.734
Vibratory roller	0.210
Hoe ram	0.089
Large bulldozer	0.089
Caisson drilling	0.089
Loaded trucks	0.076
Jackhammer	0.035
Small bulldozer	0.003

Source: Federal Transit Administration 2006.

Vibration amplitude attenuates over distance and is a complex function of how energy is imparted into the ground and the soil conditions through which the vibration is traveling. The following equation can be used to estimate the vibration level at a given distance for typical soil conditions. PPV_{ref} is the reference ppv at 25 feet from Table 41:

$$PPV = PPV_{ref}\left(\frac{25}{distance}\right)^{1.5}$$

There are no applicable Federal, state, or local quantitatively-defined regulations relating to vibration resulting from construction activities. Thresholds for annoyance and structural damage reported by Caltrans (2004) are used in this analysis. Table 42 summarizes typical human response to steady state vibration such as that produced by typical non-impact construction activity.

Table 42. Human Response to Steady State Vibration.

PPV	Human Response
3.6 (at 2 Hz) – 0.4 (at 20 Hz)	Very disturbing
0.7 (at 2 Hz) – 0.17 (at 20 Hz)	Disturbing
0.10	Strongly perceptible
0.035	Distinctly perceptible
0.012	Slightly perceptible

Source: CalTrans 2004

Table 43 summarizes typical human response to transient vibration that is usually associated with transitory impact construction sources such as pile driving activity.

Table 43. Human Response to Transient Vibration.

PPV	Human Response
2.0	Severe
0.9	Strongly perceptible
0.24	Distinctly perceptible
0.035	Barely perceptible

Source: CalTrans 2004

Table 44 summarizes vibration damage thresholds.

Table 44. Maximum Vibration Levels for Preventing Damage to Structures.

Type of Situation	Limiting Velocity (in/sec)
Historic sites or other critical locations	0.1
Residential buildings, plastered walls	0.2 to 0.3
Residential buildings in good repair with gypsum board walls	0.4 to 0.5
Engineered structures, without plaster	1.0 to 1.5

Source: CalTrans 2004

American River

The majority of the study area, including both the American River North and South basins, is located in urban areas, where the primary sources of noise are traffic, trains, common urban uses, and limited air traffic. Boating operation is common along the American River. The areas surrounding the American River are subject to the Sacramento County Noise Ordinance, and in some cases, the City of Sacramento Noise Ordinance.

Major highways and roadways which generate noise near the American River include Business 80, Highway 160, U.S. 50, Watt Avenue, H Street (Bridge), Fair Oaks Boulevard, Howe Avenue, and the Arden/Garden Connector, and Richards Boulevard. Arterial roadways and stationary sources have a localized influence on the noise environment.

Sensitive receptors along the American River include residents along the levee system and along the haul roads. Residents back up to the levee and in most cases there is very little space between the levee toe and the back fence of private properties. Since the levee is higher than the houses noise on the levees travels into the backyards and houses. Some areas have trees between the levee and homes, which will filter some noise from levee activities. In addition, recreationists using the American River Parkway would be considered sensitive receptors, as would the local wildlife in the Parkway.

Sacramento River

The majority of the noise conditions near the Sacramento River are consistent with those described for the American River above. The areas around the Sacramento River are subject to the noise ordinances for both Sacramento County and the City of Sacramento. In addition, the Yolo County and City of West Sacramento Noise Ordinances should be considered in this area due to potential impacts across the river from construction sites.

Certain areas along the Sacramento River have higher boating noise due to public marinas such as Discovery Park, Garcia Bend Park, and Miller Park. In addition, the Sacramento River in downtown Sacramento has higher ambient noise conditions due to the urban nature in this area, with additional noise provided by night life in Old Sacramento and urban activities such as baseball games at Raley Field.

Major highways and roadways which generate noise near the Sacramento River include I-5, U.S. 50, Riverside Boulevard, and Richards Boulevard. Arterial roadways and stationary sources have a localized influence on the noise environment.

Like the American River area, the majority of the Sacramento River levees are in close proximity to local residences, with many peoples' backyards very close to the toe of the levee. Since the levee is higher than the houses noise on the levees travels into the backyards and houses. Some areas have trees between the levee and homes, which will filter some noise from levee activities. In addition, recreationists at Miller, Discovery, and Garcia Bend Parks are considered to be sensitive receptors, as are any wildlife in the area.

East Side Tributaries

The majority of the noise conditions near the tributaries are consistent with those described for the American River above, with the exception that the small tributaries have no boating noise associated with them. Magpie Creek and Dry/Robla Creek may experience higher levels of air traffic noise due to their close proximity to the McClellan Airport. The tributary areas are subject to the Sacramento County Noise Ordinance.

Major highways and roadways which generate noise near the tributaries include I-80, Norwood Avenue, Rio Linda Boulevard, and Marysville Boulevard/Raley Boulevard. Arterial roadways and stationary sources have a localized influence on the noise environment.

Sensitive receptors along the tributaries include residents along the levee system and along the haul routes. Along NEMDC, Arcade Creek, parts of Dry/Robla Creek, and parts of Magpie Creek residents back up to the levee and in most cases there is very little space between the levee toe and the back fence of private properties. Since the levee is higher than the houses noise on the levees travels into the backyards and houses. Portions of the Dry/Robla Creek levees are bordered by open fields of grassland and fallow agricultural lands. Portions of the Magpie Creek Diversion Canal flow through industrial areas and business districts, as well as some open fields. In addition, sensitive receptors include recreationists using the Sacramento Northern Bike Trail, which crosses Arcade Creek just downstream of Rio Linda Boulevard, and crosses Robla Creek just upstream of the project area. Sensitive receptors near the tributaries also include local wildlife, particularly those species using the open space within the Dry and Robla Creek levees.

Sacramento Bypass

The Sacramento Bypass is located in Yolo County. The bypass area is primarily open space and agricultural. Common noises are generated from agricultural machinery, boat traffic on the Sacramento River, and vehicles along the Old River Road. Just south of the existing Bypass is the California Highway Patrol (CHP) Academy. This academy performs driver's training for officers and generates noises associated with speeding cars and police pursuits.

Noise sensitive land uses in the vicinity of the Bypass primarily consist of residents located across the Sacramento River on Garden Highway. These residences are approximately 900 feet from the eastern edge of the Bypass. There are no residential properties within the existing bypass; however, there is one residence about 1,500 feet north of the proposed construction area for the new widened weir and bypass. Sensitive receptors would include these residences, wildlife, recreationists, and nesting birds.

3.13.2 Methodology and Basis of Significance

Methodology

Construction activities (including construction equipment used for long-term maintenance) are the predominant source of noise and vibration associated with the project. Construction noise impacts have been assessed using an analysis method recommended by the U.S. Department of Transportation for construction of large public works infrastructure projects (FTA, 2006). Based on anticipated construction equipment types and methods of operation, construction noise levels for various elements of the construction process have been calculated. These predicted levels were compared to significance criteria to determine whether significant impacts are predicted to occur. Where significant noise impacts have been identified, mitigation measures to reduce noise impacts have been specified.

The magnitude of construction noise impacts at noise-sensitive land uses depends on the type of construction activity, the noise level generated by various pieces of construction equipment, the distance between the activity, and noise-sensitive land uses. For this analysis noise levels at various distances from the construction equipment were estimated using calculation procedures recommended by the Federal Transit Administration (FTA, 2006). The calculations used for this analysis include distance attenuation (6 dB per doubling of distance) and attenuation from ground absorption for both hard ground and soft ground.

Basis of Significance

For the purposes of this study, the Sacramento County noise standards will be used to determine effect levels because most of the work that would affect sensitive receptors is located in Sacramento County. The Sacramento County noise ordinance states that a standard of 55 dBA is applied during the hours from 7:00 a.m. to 10:00 p.m., and a standard of 50 dBA is applied during the hours from 10:00 p.m. to 7:00 a.m. for residential and agricultural uses. The noise ordinance also states that construction noise is exempt during the hours from 6:00 a.m. to 8:00 p.m. Monday through Friday and from 7:00 a.m. to 8:00 p.m. on Saturdays and Sundays (Chapter 6.68 Noise Control, County of Sacramento Code).

The proposed project would have a significant impact from noise if construction would result in any of the following:

- A substantial temporary or permanent increase in ambient noise levels in the study area above the existing levels.
- Exposure of sensitive receptors to excessive noise levels (those levels that exceed the Sacramento County noise ordinance, as discussed above).
- Exposure of sensitive receptors or structures to groundborne vibration.

3.13.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. As a result, there would be no construction-related effects to the acoustic environment, including the generation of groundborne vibration. The noise levels in the study area would remain consistent with the existing ambient noise levels present under current conditions. It is highly likely that if the project is not constructed that a large flood event could result in levee failure. The amount of noise that would be generated to repair the damaged levee and clean up of the flooded lands could exceed noise ordinances, and expose sensitive receptors near the rivers to excessive noise leves and groundborne vibration from the placement of riprap to repair levels. As a result, effects under the No Action Alternative would be considered significant and unavoidable.

3.13.4 Alternative 1 – Improve Levees

Construction of Alternative 1 would generate temporary, short-term, and intermittent noise at or near noise sensitive receptors in and around the study area due to construction activities associated with the proposed levee repairs. Noise sensitive receptors in and around the study area were described in detail in Section 3.13.1. Typical construction equipment noise levels are shown in Table 45 below.

Table 45. Construction Equipment Noise Levels.

Equipment Type[1]	dBA at 50 Feet	Equipment Type	dBA at 50 Feet
Air Compressor	78	Groundwater Well Drilling Operations[2]	77
Asphalt Paver	77	Generator	81
Backhoe	78	Grader	85
Compactor	83	Hoe Ram Extension	90
Concrete Breaker	82	Jack Hammer	89
Concrete Pump	81	Pneumatic Tools	85
Concrete Saw	90	Rock Drill	81
Crane, Mobile	81	Scraper	84
Dozer	82	Trucks	74-81
Front-end Loader	79	Water Pump	81

Notes:
1. All noise levels based on equipment fitted with properly maintained and operational noise control devices, per manufacturers specifications.
2. Groundwater well drilling noise was measured by AECOM for the NLIP Phase 2 EIR 1st Addendum dated May, 2009.
Sources: FTA, 2006; SAFCA, 2009

Operation of heavy construction equipment, particularly pile driving and other impulsive devices such as pavement breakers, create seismic waves that radiate along the surface of the earth and downward into the earth. These surface waves can be felt as ground vibration. Vibration from operation of this equipment can result in effects ranging from annoyance of people to damage of structures. Varying geology and distance will result in different vibration levels containing different frequencies and displacements. In all cases, vibration amplitudes will decrease with increasing distance. As seismic waves travel outward from a vibration source, they excite the particles of rock and soil through which they pass and cause them to oscillate. The actual distance the soil particles move is usually only a few ten-thousandths to a few thousandths of an inch. The rate or velocity (in inches per second) at which these particles move is the commonly accepted descriptor of the vibration amplitude, referred to as the "peak particle velocity" (PPV). Table 46 summarizes ground vibration levels generated by typical construction equipment.

Table 46. Vibration Source Levels for Construction Equipment.

Equipment	PPV at 25 feet
Vibratory roller	0.210
Large bulldozer	0.089
Loaded trucks	0.076
Jackhammer	0.035
Small bulldozer	0.003

Source: Federal Transit Administration, 2006

Vibration amplitude attenuates over distance and is a complex function of how energy is imparted into the ground and the soil conditions through which the vibration is traveling. Historically, vibration impacts caused by construction activity occur mainly in cases where both the construction site and the receptor are on bedrock, which readily transmits vibration. With regard to the proposed project, ground vibration propagates weakly through loose, alluvial soil such as that found in the project area (FTA 2006). Therefore, ground vibration from construction equipment is expected to be discernible only for very short distances from the construction site (roughly 40 feet away). Table 47 summarizes typical human response to prolonged, steady state vibration such as that produced by typical non-impact construction equipment during earthmoving activities.

Table 47. Human Response to Steady State Vibration.

PPV	Human Response
3.6 (at 2 Hz) – 0.4 (at 20 Hz)	Very disturbing
0.7 (at 2 Hz – 0.17 (at 20 Hz)	Disturbing
0.20	Potential damage to interior plaster walls
0.10	Strongly perceptible
0.035	Distinctly perceptible
0.012	Slightly perceptible

Source: Caltrans, 2004

Ground vibration generated by construction equipment would be discernible only at residences within 40 feet of the construction equipment. This alternative would not involve pile driving, which is the type of construction activity that otherwise might cause the most severe vibration impacts. Furthermore, the soil type found throughout the project area is loose alluvial soil, which does not readily transmit ground vibration (FTA, 2006). Table 48 shows estimated ground vibration levels generated by a vibratory compactor, which is the type of equipment (other than pile drivers) most likely to cause vibration impacts at a construction site. As shown in Table 48, the vibration level is expected to dissipate to less than the impact criterion of 0.10 inches/second (the “strongly discernible” level) at distances more than 40 feet of the compactor. If the vibratory roller was used within 30 feet of a building, then it is possible vibration could damage interior plaster walls. Based on this analysis, ground vibration could cause a significant effect if construction is required within 40 feet of a vibration-sensitive building (defined as a building with either plaster or wallboard for internal walls and ceilings). Implementation of mitigation measures would reduce this effect to less than significant.

Table 48. Estimated Ground Vibration Levels Caused by a Vibratory Roller.

Distance from Construction Equipment (feet)	Ground Vibration PPV (inches/second)
25	0.21
30	0.20–Potential damage to interior plaster walls
40	0.10–Strongly discernible
50	0.07
100	0.026

Note: Assumes a single vibratory roller, with a source vibration level (PPV) of 0.210 inches/second at 25 feet.
Source: Corps, 2009

American River

Erosion protection construction activities in the American River Parkway could result in temporary significant impacts on residents, recreationists, and other noise sensitive groups. While Sacramento County has a construction noise exemption during daylight hours, as described in Section 3.13.1, noise levels above 55 dBA are generally considered to be a significant effect on sensitive receptors because they exceed the noise standard for the project area. For the erosion protection activities proposed for the American River, noise levels could exceed 55 dBA during construction. Table 49 below shows estimated noise levels for erosion protection construction activities. According to the estimates in Table 52, there is the potential for significant effects to sensitive receptors that are 500 feet or less from the construction site. Mitigation would be implemented to reduce these noise levels to less than significant.

Table 49. Noise Levels during Construction of Erosion Protection.

Distance Between Source and Receiver (feet)	Calculated 1-Hour L_{eq} Sound Level (dBA)
50	82
100	74
200	66
300	61
400	58
500	56
1,000	48
1,500	43
2,000	40
3,000	35

Note: This calculation does not include the effects, if any, of local shielding from walls, topography, or other barriers which may reduce sound levels further.
Source: Corps, 2009

Sacramento River

Effects associated with the erosion protection work on the Sacramento River would be consistent with those described for the American River above. Noise effects associated with the slope stability, seepage, erosion, and height improvements for the Sacramento River levees, including the construction of a slurry wall and levee raise are discussed below.

Along the Sacramento River, many residents' homes and backyards are immediately adjacent to the levee, with little to no buffer zone. As a result, there would be very little attenuation to reduce the noise effects from construction of the levee improvements for some residents in this reach. Table 50 below lists estimated noise levels from construction activities proposed for the Sacramento River levees.

Table 50. Summary of Predicted Construction Noise Levels.

Construction Activity	Cumulative Noise Levels at 50 Feet
Stripping	88
Levee Degrading	93
Cutoff Wall Installation	83
Soil Placement/Compaction (slope work, levee raise)	95
Rip Rap Installation	88
Roadway Construction	87

Source: Based on data collected for the Southport EIP EIS/EIR (WSAFCA, 2012).
Noise levels were obtained from data collected on previous construction projects.

While Sacramento County has a construction noise exemption during daylight hours, as described in Section 3.13.1, noise levels above 55 dBA are generally considered to be a significant effect on sensitive receptors. According to the estimates shown in Table 50, noise effects to sensitive receptors would be significant during construction of the Sacramento River levee improvements. Mitigation described in Section 3.13.6 would be implemented to reduce these noise levels to less than significant.

East Side Tributaries

The majority of the features proposed for the east side tributaries' levees would have similar noise effects to those described under the Sacramento River above and would be significant. In particular, the Arcade Creek, NEMDC, and Dry Creek, and Robla Creek levees have residents living adjacent to them who would likely be adversely affected by construction noise in the area. Mitigation described in Section 3.13.6 below would be implemented to reduce these noise levels to less than significant.

The feature exclusively proposed for the east side tributaries is construction of a floodwall or floodwall raise to improve levee height. However, construction of this feature would not increase noise levels beyond that of the additional levee features proposed for this reach. As a result, the effects associated with this action would be similar to those described for the Sacramento River above and shown in Table 50. Mitigation measures would be implemented to further reduce these construction noise levels to less than significant.

Borrow Sites

The final selection of borrow sites for the proposed alternatives will not be established until the PED phase of the project, therefore it is not possible to fully analyze impacts from noise associated with borrow activities at this time. Potential effects from noise associated with borrow activities would be taken into account in selecting the final borrow sites, including the presence of any sensitive receptors in the near vicinity of proposed borrow sites. There would be potential impacts from the operation of construction equipment at borrow sites. However, these activities would occur in accordance with established noise ordinances in the area. The avoidance and minimization measures discussed in Section 3.13.6 below would be implemented at borrow sites, as appropriate, to reduce potential noise impacts to less than significant. If identification of borrow sites results in noise effects that include: (1) substantial changes in the proposed action that are relevant to environmental concerns, or (2) significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts, then supplemental NEPA/CEQA analysis may occur, as appropriate.

3.13.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Noise effects from construction of the levee repairs under Alternative 2 would be consistent with the analysis in Alternative 1, except that the noise impacts under Alternative 2 would be for a shorter duration, as there would be less than 1 mile of levee raises constructed downstream on the Sacramento River compared to 8 miles of levee raise for Alternative 1.

Noise effects associated with the widening of the Sacramento Weir and Bypass would also be similar to the effects described under Alternative 1. Noise would be generated from construction equipment and activities, however in this case the study area is primarily rural. The closest sensitive receptors are approximately 900 and 1,500 feet away from the construction area, respectively. Mitigation described in Section 3.13.6 below would be implemented to reduce these noise levels to less than significant.

3.13.6 Mitigation Measures

During construction, noise-reducing measures would be employed in order to ensure that construction noise complies with local ordinances. Prior to the start of construction, a noise control plan would be prepared that would identify feasible measures to reduce construction noise, when necessary. The following measures would apply to construction activities within 500 feet of a sensitive receptor, including, but not limited to, residences. These measures may include, but are not limited to, the following:

- Provide written notice to residents within 1,000 feet of the construction zone, advising them of the estimated construction schedule. This written notice would be provided within one week to one month of the start of construction at that location.
- Display notices with information including, but not limited to, contractor contact telephone number(s) and proposed construction dates and times in a conspicuous manner, such as on construction site fences.
- Schedule the loudest and most intrusive construction activities during daytime hours (7:00 a.m. to 7:00 p.m.), when feasible.
- Require that construction equipment be equipped with factory-installed muffling devices, and that all equipment be operated and maintained in good working order to minimize noise generation.
- Locate stationary noise-generating equipment as far as practicable from sensitive receptors.
- Limit unnecessary engine idling (i.e., more than 5 minutes) as required by State air quality regulations.
- Employ equipment that is specifically designed for low noise emission levels, when feasible.
- Employ equipment that is powered by electric or natural gas engines, as opposed to those powered by gasoline fuel or diesel, when feasible.
- If the construction zone is within 500 feet of a sensitive receptor, place temporary barriers between stationary noise equipment and noise sensitive receptors to block noise transmission, when feasible, or take advantage of existing barrier features, such as existing terrain or structures, when feasible.
- If the construction zone is within 500 feet of a sensitive receptor, prohibit use of backup alarms and provide an alternate warning system, such as a flagman or radar-based alarm that is compliant with State and Federal worker safety regulations.
- Locate construction staging areas as far as practicable from sensitive receptors.
- Design haul routes to avoid sensitive receptors, to the extent practical.

- If there are any occupied buildings with plaster or wallboard construction within 40 feet of construction equipment, a vibration control plan would be prepared prior to construction.

3.14 Recreation

3.14.1 Environmental Setting

Regulatory Setting

- American River Parkway Plan
- Sections 9 and 10 of the Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. §§ 401 and 403)
- National Wild and Scenic Rivers Act (16 U.S.C. 1271 et. seq.)
- State Wild and Scenic Rivers Act in 1972 (PRC Section 5093.50-5093.70)
- Sacramento City Parks and Recreation Master Plan
- Sacramento County Bikeway Master Plan
- Old Sacramento State Historic Park General Plan

Existing Conditions

The primary recreational feature within the American River Parkway (Parkway) which could be affected by the project is the Jedediah Smith Recreation Trail, which provides bicycle, pedestrian, and equestrian trails from Discovery Park to Folsom Lake. The trail also connects with the Sacramento River Trail and Old Sacramento State Historic Park, and many people use it daily to commute to work by bicycle into Downtown Sacramento. The southern terminus of the Sacramento Northern Bike Trail is located at the point where the Jedediah Smith Recreation Trail crosses Del Paso Boulevard headed downstream. The Sacramento Northern Bike Trail transitions to the top of the levee from the Jedediah Smith Recreation Trail at this location and continues north through Sacramento County. The levee crown is covered with a compacted aggregate base material that is also used for pedestrian recreational activities.

American River

The study area contains a significant portion of the American River Parkway. The Parkway is an open space greenbelt which extends approximately 29 miles from Folsom Dam to the American River's confluence with the Sacramento River. The river has a broad channel with riparian vegetation along the banks and is located within the American River Parkway corridor. The river is the central focus of the Parkway which provides enjoyment to residents and visitors of the Sacramento region.

The California legislature passed the State Wild and Scenic Rivers Act in 1972 (PRC Section 5093.50-5093.70). The legislature said that it was the State's intent that "certain rivers which possess extraordinary scenic, recreation, fisheries, or wildlife values shall be preserved in their free-flowing state, together with their immediate environment, for the benefit and enjoyment of the people of the State." The 23-mile portion of the American River that extends from below Nimbus Dam to the confluence with the Sacramento River has been designated as a Wild and Scenic River for its recreational uses under both the State and Federal Wild and Scenic Rivers Acts. Additionally, the American River Parkway's recreational uses are designated as an outstanding remarkable value of the river under the Federal Wild and Scenic Rivers Act.

In 2008, the County of Sacramento finalized the *American River Parkway Plan* to provide a guide to land use decisions affecting the Parkway and specifically addressing the Parkway's preservation, use, development, and administration. The Parkway Plan acts as the management plan for the Federal and State Wild and Scenic Rivers Acts (see Land Use Section 3.3).

Permitted recreational activities in the Parkway are divided into five categories: nature appreciation, recreation enjoyment, trails recreation, recreational participation in group sports and athletics, and aquatic recreation. Many activities are prohibited in the Parkway, including: hunting, motor vehicles and scooters on trails, fireworks, and jumping or diving from bridges. Most of the prohibited activities are considered to be invasive to the natural environment or could damage the integrity of the natural setting.

The bicycle trail (Jedediah Smith Memorial Trail) is a corridor for Parkway and non-Parkway destinations, providing access for bicyclists between downtown Sacramento and points to the east. The trail has become a well established commuter route and vital recreational asset. Bicyclists require wide trails and a smooth surface to accommodate a large number of users and a wide range of speeds. The needs of bicycle commuters are somewhat different than those of recreational users of the Parkway. Bicycle commuters often ride the bicycle trail during normal commuter hours. The trails near California State University, Sacramento have a much higher volume of bicyclists and pedestrians, since students bike or walk to and from classes. This volume does decrease when school is not in session.

Recreational boating is one of the primary uses of the American River. Boat access is located at Discovery Park on both the Sacramento and American River side of the park. Boat launches within the Parkway are located at Howe Avenue, Watt Avenue, and Gristmill Park. The river can become very shallow between Sunrise and Howe Avenue when releases from Folsom Dam are reduced, making motorized boating impracticable. Rafting on this stretch of the river is very common during summer months with the highest use on the weekends and holidays.

Many parks are located within the American River Parkway portion of the study. Following is a description of the parks and their activities.

Discovery Park. Located just north of downtown Sacramento at the confluence of the American River and the Sacramento River, this 302-acre park is a popular site for rafters and waders. Discovery Park is the trailhead for the 32-mile long Jedediah Smith Memorial Trail. The park itself has several large outdoor meeting venues and hosts several Parkway events every year, including large concerts. The park also features a boat launch and an archery range. Discovery Park was designed to flood and take pressure off American River levees during high water events. For safety reasons, the park closes when water flows into the public areas and remains closed until the water subsides.

Sutter's Landing Regional Park. Nestled along the banks of the American River about a mile northeast of downtown Sacramento, this 172-acre park currently offers a wide variety of recreational opportunities including a covered skateboard park, a dog park, picnic areas, basketball and bocce ball courts, as well as access to trails along the American River and a boat launch for kayaks, canoes, and other non-motorized boats. Visitors can also see a diversity of wildlife at this site including river otters, beavers, jackrabbits, cottontails, coyotes, raccoons, gopher snakes, fence lizards, skunks, ground squirrels, voles, and an occasional sea lion, as well as a wide variety of bird species ranging from shorebirds and waterfowl to raptors making it an ideal location for nature watching as well as birding. Other popular activities at this location include walking, jogging, and biking.

Paradise Beach. Close to Fair Oaks Boulevard and Howe Avenue, Paradise Beach is located at the end of Carlson Drive in the River Park neighborhood. The park offers a sandy beach area and is a popular spot for swimming. Visitors can also hike along many informal dirt trails through cottonwood forests and view a variety of wildlife.

Campus Commons Golf Course. Built in 1972, the 1,699 yard Campus Commons Golf Course is a public nine-hole executive course located just northeast of California State University Sacramento, along the American River.

Guy West Bridge. The Guy West Bridge, built in 1967, is a pedestrian-only suspension bridge crossing the Lower American River. It is modeled after the Golden Gate Bridge in San Francisco, but spans only 600 feet compared to the Golden Gate's 6,450 feet. The bridge was constructed to tie the California State University campus to the communities on the north side of the American River.

Howe Avenue. Located down river from California State University, Sacramento, this car-top launch site allows small boats and rafts to be launched into the American River. Because of the swift rapids, this site is not conducive to swimming and wading.

Waterton and Save the American River Association. Just off of U.S. 50 at Watt Avenue, Waterton Access is a small site providing access along the river. The area is inhabited by deer and jackrabbits, so it is ideal for nature watching. The nearby Save the American River Association Access offers similar opportunity.

Watt Avenue. Just off Watt Avenue is an American River access point popular as a take-out spot for rafters, canoeists, and kayakers. Fishing is also popular here because of the range of shallow and deep water.

Gristmill Park. Located off Mira Del Rio Drive and Folsom Boulevard in Rancho Cordova, Gristmill Park is a popular place for fishing, bird watching, and nature watching/photography. The area also has some nice walking paths popular with the locals that wind through oak woodlands along the southern bank of the river in either direction from the parking area. In addition to the usual assortment of birds in these woodlands such as woodpeckers, Northern flickers, and red-shouldered hawks, it is not unusual to spot deer and coyote here as well. Due to the calmness of the river at this location, it is a popular launch spot for kayaking and canoeing.

William Pond Recreation Area. Located off Arden Way, the William Pond Recreation Area is one of the most well-established and popular parks along the river. Named in honor of the first director of County Parks, the park is handicap-friendly and offers a man-made fishing pond with a specialized fishing pier and ramp and paved walking trails that gently slope around the park.

River Bend Park (formerly Goethe Park). River Bend Park, formerly C.M. Goethe Park, is one of Sacramento's oldest county parks. It is located at U.S. 50 and Bradshaw Road and offers many recreation facilities. Horse and hiking trails wind through the park for plenty of wildlife viewing. This facility also has large group picnic sites often used for community events. River Bend Park is the endpoint for many recreational rafters on the American River.

Soil Born Farms. Located on the American River in Rancho Cordova (40 acres) and in Sacramento on Hurley Way (1.5 acres), Soil Born Farms organically grows a wide variety of fruits and vegetables linked to the seasons and temperament of the Sacramento region. All produce is harvested within a day of distribution to local restaurants, famers markets, and at their own farm stand at the American River ranch location from May to November. This nonprofit farm is actively involved in fostering organic farming through their farm apprentice program and youth education. All water used in irrigation comes from the American River and no synthetic pesticides or fertilizers are used.

Sacramento River

The Sacramento River has an abundance of recreation activities within the study area. Fishing, picnicking, water skiing, and bicycling are just a few of the more popular activities. Boat launches in this area of the study are located at Miller Park and Garcia Bend Park. The bicycle trail along the Sacramento River runs from above the confluence with the American River approximately four miles downstream of the confluence. The bike trail, which is used as a commuter route to downtown Sacramento, is located on top of the levee throughout most of this area. There is a portion of the Sacramento Southern Railroad located along the Sacramento River that has been in recreational use by the California State Railroad Museum since 1984. Excursion trains operate from the California State Railroad Museum Saturdays and Sundays during the summer months (April through September).

Designated parks along the Sacramento River include the following:

Miller Park. Adjacent to the Sacramento Marina, off Harborview Drive from Front Street, this 57 acre city park is right on the Sacramento River. The park includes picnic areas, boat trailer parking, and a boat ramp and dock. There is also a store called Rat's Snack Shop.

Garcia Bend Park. Located between Pocket Road and the Sacramento River, this 19-acre community park is a popular place for recreation providing soccer fields, lighted tennis courts, play areas, picnic areas, restrooms, and a public boat ramp providing access to the Sacramento River.

The Riverfront Promenade. A new addition to Sacramento's riverfront located just downstream of Old Sacramento, the Riverfront Promenade offers a mile long walking and cycling path that connects Old Sacramento to Miller Park.

East Side Tributaries

All of the tributaries, including Arcade Creek, Dry/Robla Creek, NEMDC, and Magpie Creek, support walking, bird watching, and fishing. None of the tributaries have designated recreation areas; however, the NEMDC is considered part of the American River Parkway from the confluence with the American River upstream approximately 0.4 miles. The Sacramento Northern Bike Trail crosses through this area of the Project at Arcade Creek. The trail is used by many cyclists, and has a diverse environment ranging from industrial areas to grasslands and cattle grazing fields.

Sacramento Bypass

The Sacramento Bypass is owned by the State of California and operated by CDFW as the Sacramento Bypass Wildlife Area. Access is gained at numerous points from County Roads 126 or 127. There is a gate across County Road 127 and vehicles are not allowed on the levee road. County Road 126 is paved for 1 mile before encountering a gate, restricting further vehicle access along the levee.

Access is limited to foot traffic within the Wildlife Area and along levee roads. Fishing, wildlife viewing, and bird watching are allowed in this area. Hunting is allowed between September 1 and January 31. Game species include waterfowl (when the area is flooded), ring necked pheasant, and mourning dove. No big game hunting is allowed in this area.

The Yolo Shortline Railroad (also known as the Sacramento River Train) is another recreational opportunity in the area. The Yolo Shortline Railroad is a popular northern California tourist attraction. This dinner train operates two lines, one between Woodland and West Sacramento and the other between West Sacramento and Clarksburg. The Yolo Shortline Railroad tracks run along the top of the Sacramento Weir.

3.14.2 Methodology and Basis of Significance

Methodology

Impacts to recreational opportunities within the project area are evaluated based on temporary and permanent changes to those resources that would occur with implementation of one of the proposed alternatives. Compliance with the American River Parkway Plan and other regional planning documents (City of Sacramento General Plan, City of Sacramento Parks and Recreation Master Plan) were taken into consideration when analyzing the various alternatives. Compliance with the Rivers and Harbors Act and the Wild and Scenic Rivers Act was also taken into consideration.

Basis of Significance

The thresholds of significance encompass the factors taken into account under NEPA to determine the significance of an impact in terms of its context and intensity. The thresholds for determining the significance of impacts for this analysis are based on the environmental checklist in Appendix G of the State CEQA Guidelines. Adverse effects on recreation would be considered significant if implementation of an alternative plan would result in any of the following:

- Eliminate or substantially restrict or reduce the availability, access, or quality of existing recreational sites or opportunities in the project area;
- Cause substantial long-term disruption in the use of an existing recreation facility or activity;
- Result in inconsistencies or non-compliance with regional planning documents;
- Result in inconsistencies or non-compliance with the American River Parkway Plan; or
- Result in inconsistencies with the Rivers and Harbors Act or the Wild and Scenic Rivers Act.

3.14.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. Such an event could potentially result in flooding and inundation of existing recreational facilities, trails, bike paths, and recreation areas rendering them unusable until cleanup and restoration activities could take place. Under the No Action Alternative, sustained high flows on the American River would erode the banks in the parkway, and over time, the parkway and the recreational opportunities and facilities within it, including the levee system, would be lost. This same degree of loss could also occur as the result of a single very large event if existing erosion problems are not addressed. The No Action Alternative would result in inconsistencies and non-compliance with the American River Parkway Plan. The Parkway Plan's Flood Control Policy states that:

> *Bank scour and erosion shall be proactively managed to protect public levees and infrastructure, such as bridges, piers, power lines, habitat and recreational resources. These erosion control projects, which may include efforts to anchor berms and banks with rock revetment, shall be designed to minimize damage to riparian vegetation and wildlife habitat, and should include a revegetation program that screens the project from public view, provides for a naturalistic appearance to the site, and restores affected habitat values (Parkway Plan Policy 4.16).*

The effects of the No Action Alternative would cause significant impacts to recreation facilities that could not be mitigated as there are no areas within the urbanized Sacramento Region that would provide a similar recreation experience as the American River Parkway.

3.14.4 Alternative 1 – Improve Levees

<u>American River</u>

While the site-specific designs have not been conducted to determine which erosion protection measure is appropriate along each reach of the Parkway, certain assumptions can be made:

- Access to the American River for the purposes of erosion control construction would require some temporary closures of portions of the recreation trail during construction activities.

- Haul trucks would use portions of the recreational trail to bring materials to the construction sites, reducing accessibility to recreationists.
- Some areas within the Parkway itself would be construction staging areas.
- The presence of construction equipment and haul trucks would reduce the quality of recreational experiences.

Construction of erosion protection measures is expected to take up to 10 years, with construction occurring in multiple locations within the Parkway at the same time. While the construction would not take place in all areas of the Parkway at once, 10 years of intermittent construction would be considered a significant effect to recreation activities because it would reduce the quality of existing recreation activities. Closures and detours of the recreational trail could impact multiple events such as Eppie's Great Race, the American River Parkway Half Marathon, or the Jed Smith Ultra Classic in addition to multiple other fun runs and events. While recreational access points, boat launches, parks, and recreation sites such as the Campus Commons Golf Course would remain open to the greatest extent practicable, recreational activities could be impacted by construction equipment and material delivery during construction.

Portions of the road on top of the levee would be closed to recreational access during the construction period. Additionally, construction of the launchable rock trench would disturb several miles of bike trails as well as access to public parks and boat launches within or adjacent to the Parkway. Such closures and disturbances would result in non-compliance with the American River Parkway Plan which states that flood control berms, levees and other facilities should be, to the extent consistent with proper operation and maintenance of these facilities, open to the public for approved uses, such as hiking, biking and other recreational activities.

These closures and disturbances would also conflict with the Wild and Scenic Rivers Act which states that "certain selected river of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations". Recreational resources that could potentially be affected by construction of the erosion protection measures include Paradise Beach, the Campus Commons Golf Course, the Guy West Bridge, and the boat launches at Howe Avenue, Watt Avenue, and Gristmill Park.

Many people who use the recreation facilities in the Parkway are daily users who enjoy the tranquility of the Parkway in an urban environment. While construction activities are underway, the tranquility of the Parkway will be lost. Because the construction would be occurring for several years and would take away the overall pleasure of recreation activities, there would be a significant effect that cannot be mitigated. While bike trails, running paths, boat ramps, and equestrian trails can all be

rerouted or accessible a short distance away from the construction site, there would still be an overall reduction in the recreation quality with continuous construction over a 10 year period and, therefore, the effect would be significant. Construction will also occur during the summer months when the Parkway recreation activities are at the peak. The timing of construction cannot be mitigated as it is unsafe to perform construction activities in the floodway during the flood season.

Construction vehicles would be present in staging areas at various points along the Parkway and construction activities could result in potential disruptions/detours not only of bike trails, but of hiking trails and equestrian trails as well. The access roads in and out of the Parkway at various locations would be used as haul routes for trucks transporting borrow material, resulting in increased traffic along the entry routes used by recreationists. Proximity to construction equipment and activities may also degrade recreational experiences due to noise, visual effects, smells, and air quality. This would be a significant effect on recreation activities during construction. Mitigation measures would be implemented in order to reduce impacts on recreation; however, even with the mitigation measures, effects to recreation during construction would be significant. Once construction is complete the recreation facilities would be returned to the pre-construction conditions and long term effects would be less than significant. The mitigation measures are discussed below.

Sacramento River

Construction of levee improvements would have potential short-term effects to recreation along the Sacramento River, especially during the construction of Reach D because the recreational trail is almost exclusively on the levee crown in this reach. Construction activities could impact the operation of the Sacramento Southern Railroad as portions of the railroad are located on or adjacent to the levee. Construction would also occur during summer months when parks and trails are at the peak use time, and when the Southern Railroad excursion train is in operation.

Further, paved parking areas in the vicinity of Miller Park and Garcia Bend Park could be used for staging of equipment and other construction activities. Boat ramps and recreational access to the parks would remain open during construction, but could be impacted by construction equipment using the same access during levee construction. Walking trails and the existing bike path may be temporarily rerouted during construction. Detours would be temporary and would return to pre-construction conditions following the completion of construction. There would be short-term term significant effects along the Sacramento River reaches of the project; however, there would be no long-term effects because the area would be returned to the pre-construction conditions once completed.

East Side Tributaries

Construction of levee improvements on the tributaries would have minimal effect on recreation uses, except for the levee trail, which is sometimes used as a walking path or for cycling. People who commonly use this area would be able to continue the walking and cycling on other public roads and

trails. There are no formal recreational facilities in this area of the project that would be impacted during construction. These areas are highly urbanized and consist mainly of industrial buildings and single family dwellings along the landside of the levee. Since there are very few recreation uses in these areas, any effects to recreation would be temporary and less than significant. Construction activities are not expected to have an impact on the Sacramento Northern Bike Trail. However, tree planting mitigation could occur along this trail which would provide for a more pleasurable environment for cyclists.

Borrow Sites

The final selection of borrow sites for the proposed alternatives will not be established until the preconstruction engineering and design phase of the project, therefore it is not possible to fully analyze recreation impacts associated with borrow activities at this time. Potential recreation effects associated with borrow activities would be taken into account in selecting the final borrow sites, including the presence of any recreation sites or resources in the near vicinity of proposed borrow sites. If identification of borrow sites results in recreation effects that include: (1) substantial changes in the proposed action that are relevant to environmental concerns, or (2) significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts, then supplemental NEPA/CEQA analysis may occur, as appropriate.

3.14.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Effects to recreation from the construction of levee improvements under Alternative 2 would be consistent with those analyzed for Alternative 1 with the addition of effects resulting from construction of levee improvements associated with the Sacramento Weir and Bypass widening. Those effects are described below.

Sacramento Bypass

Construction of levee improvements associated with the Sacramento Weir and Bypass widening would have possible short-term effects on recreational use. During construction, certain areas would be closed to the public while other areas might be used as haul routes or borrow/disposal sites. Activities such as bird watching, walking, running, and jogging along the Sacramento Bypass levee crown and nearby roads would be restricted. In addition, there may be temporary effects to the Yolo Shortline Railroad. Construction activities would have a significant effect on the Yolo Shortline Railroad as portions of the railway may have to be shut down or relocated during construction activities.

Construction activities could potentially overlap with hunting season in the Sacramento Bypass Wildlife Area, which occurs from September 1 through January 31, restricting hunting activities for a limited period of time. It is likely that hunting activities would be prohibited in the areas undergoing

active construction for the safety of the construction workers, however there would likely be a conflict only during degrading of the existing levee and construction of the new Sacramento Bypass north levee. It is anticipated that construction of the new Sacramento Weir would not conflict with any existing hunting activities in the Bypass because the existing levee would remain in place during construction of the new weir, creating a barrier between hunting activities and the construction area. There also could be a reduction in the overall experience of the wildlife area due to disturbed soil and the presence of construction equipment during the levee work.

There would be short-term term significant effects at the Sacramento Bypass, as described above; however, there would be no long-term effects because the area would be returned to the pre-construction conditions once construction is complete. Additionally, the expanded bypass would create additional recreation area, which would be a long-term benefit to recreation.

3.14.6 Mitigation Measures

The following measures would be taken to keep the public informed of construction activities to mitigate for effects to bike trail/recreation trail access. Coordination with recreation user groups would occur prior to and during construction for input into mitigation measures that would reduce affects to the maximum extent practicable. Advance notice would be given to recreation users informing them of anticipated activities and detours to reduce the affects.

To ensure public safety, flaggers, warning signs, and signs restricting access would be posted before and during construction, as necessary. In the event that bike trails would be disrupted, detours would be provided. Detour routes would be clearly marked, and fences would be erected in order to prevent access to the project area. In areas where recreational traffic intersects with construction vehicles, traffic control will be utilized in order to maintain public safety. The public will have continued access to the Parkway and recreation facilities during construction, but bike and running trail users would likely be required to detour onto public roads or alternative trails. If any access point needs to be closed during construction, notices will be posted providing alternative access routes.

These mitigation measures will reduce the effects on recreation; however, impacts would still be significant because of the duration of construction and the inability to provide similar quality recreation during construction. Any recreation facilities affected by the project would be replaced in-kind within the existing area and no long-term impacts are anticipated.

3.15 Visual Resources

3.15.1 Environmental Setting

Regulatory Setting

There are no Federal or State laws regulating visual resources.

Existing Conditions

This section describes the existing visual conditions of the study area. Visual resources are the natural and human-built features of the landscape that can be seen and that contribute to the public's enjoyment of the environment. Physical features that make up the visible landscape include land, water, vegetation, and geological features; the built environment includes buildings, roadways, bridges, levees, and other structures.

Several sets of criteria have been developed for determining visual quality. One common set of criteria includes vividness, intactness, and unity (FHWA 1988). There terms are defined as follows:

- Vividness is the visual power or memorability of landscape components that combine in visual patterns.
- Intactness is the visual integrity of the natural and constructed landscape and its freedom from encroaching elements. This factor can be present in urban and rural landscapes as well as natural settings.
- Unity is the visual coherence and compositional harmony of the landscape resources of the area.

The existing visual quality in the project area is determined based on both the relative degree of vividness, intactness, and unity apparent in views, and/or visual sensitivity. Visual sensitivity or concern is based on several factors: visibility of the landscape, proximity of viewers to the visual resources, elevation of viewers compared to the elevation of the visual resources, frequency and duration of views, number of viewers, types of individuals and groups of viewers, and viewers' expectations.

American River

The main group of viewers in this area of the project consists of residents living adjacent to the levee, travelers across the Business 80, Fair Oaks Boulevard/H Street, Howe Avenue, and Watt Avenue Bridges, recreational users of the American River Parkway, and boaters on the American River.

The visual environment along the American River includes the urban development on the landside of the levee with homes and landscaped backyards. The existing levees block views of the American River from most adjacent landside areas. A view of the American River Parkway from the second story of homes directly adjacent to the levee is possible in some areas. People using the top of the levee for recreational activities see primarily riparian forest and open space lands throughout the Parkway on the waterside. Figures 16 through 20 shows a sample of views from various locations within the Parkway.

The Parkway's open spaces and natural resources provide users with a highly-valued natural setting and feeling of serenity in the midst of a developed urban area. The Parkway provides all of the visual quality of intactness, vividness, and unity as a linear park which can be observed by users with limited urban disruption. The Parkway's aesthetic values are those unique qualities that define the Parkway experience for those who use the Parkway.

According to the Parkway Plan flood control policies:

> *Bank scour and erosion shall be proactively managed to protect public levees and infrastructure, such as bridges, piers, power lines, habitat and recreational resources. These erosion control projects, which may include efforts to anchor berms and banks with rock revetment, shall be designed to minimize damage to riparian vegetation and wildlife habitat, and should include a revegetation program that screens the project from public view, provides for a naturalistic appearance to the site, and restores affected habitat values.*

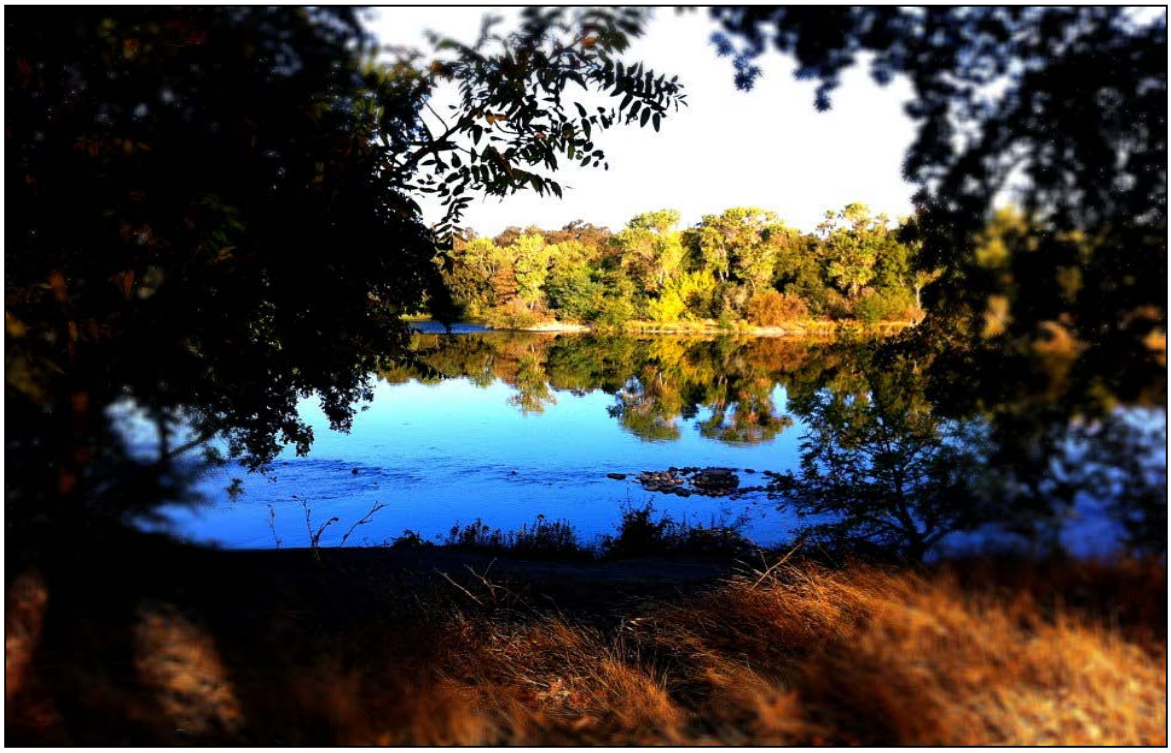

Figure 16. View of American River from Bike Trail. (Source: Tim Davis 2013)

Figure 17. View of American River with Artist. (Source: Tim Davis 2013)

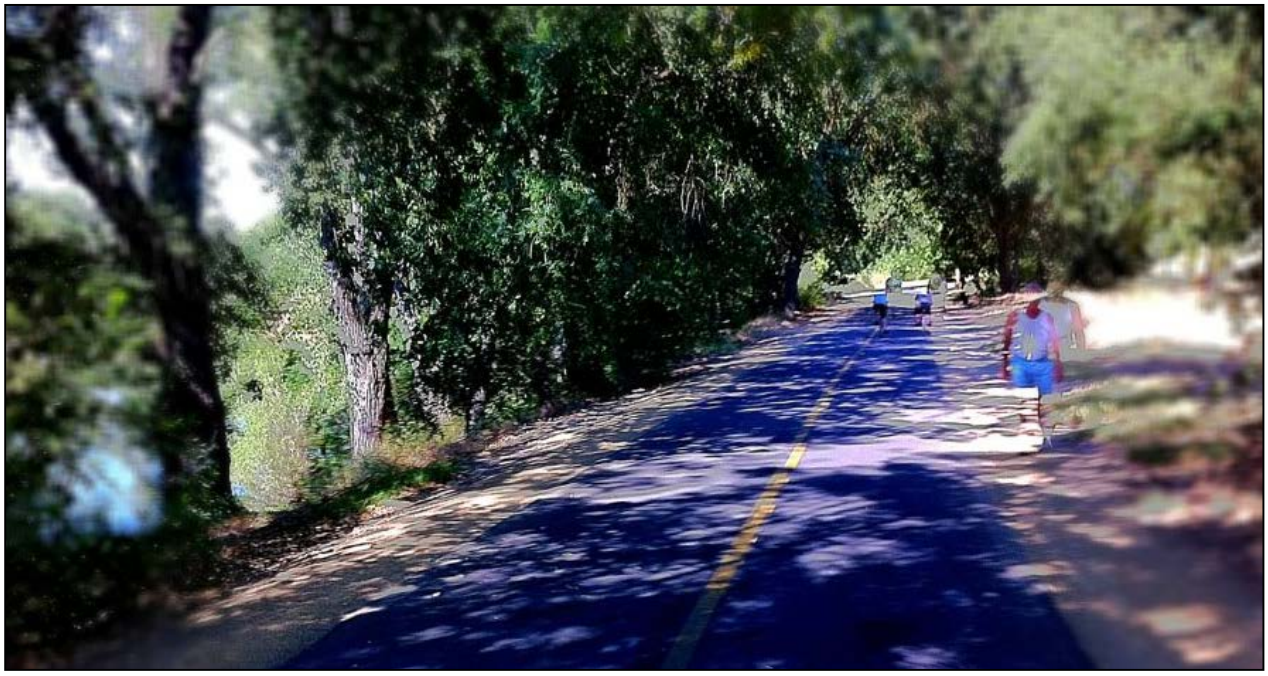

Figure 18. American River Bike Trail with Cyclist and Jogger. (Source: Tim Davis 2013)

Figure 19. View of American River near Watt Avenue. (Source: Tim Davis 2013)

Figure 20. View of American River from Guy West Bridge looking at H Street Bridge.
(Source: Tim Davis 2013)

Sacramento River

The main groups of viewers along the Sacramento River are residents living adjacent to the levee; travelers across U.S. 50, Tower, and I Street bridges; recreational users of the existing bike path and facilities; and boaters on the Sacramento River. Figure 21 is a typical view of this area.
Within this reach of the study the Sacramento River has residential properties on the landside and a narrow riparian corridor on the waterside. Much of this area is closed to the public by gates that prevent public access onto private property. Boaters on the Sacramento River view the narrow riparian corridor and the tops of homes adjacent to the levee. Discovery Park is located in this area of the study and is used for both water and land based recreation. This area includes large picnic areas, a sandy beach, and bike trails.

Figure 21. Sacramento River in Pocket Area.

East Side Tributaries

Natomas East Main Drain Canal

This area is very urbanized with industrial buildings and single family dwellings along the landside of the levee. There are also some small vacant parcels of land along the lower stretch of this waterway. The waterside levee slopes are grasses with some trees within the canal channel. Viewers in the area include residents on the landside and vehicle traffic across the Arden Garden Connector, El Camino Avenue, and San Juan Road/Silver Eagle Road bridges. The highly urbanized area and lack of natural vegetation prevents this reach from providing an intact visual experience. There are not a lot of recreational users in this area of the project due to the lack of facilities. Figures 22 and 23 are pictures of a typical view of this area.

Figure 22. Natomas East Main Drain Canal.

Figure 23. Natomas East Main Drain Canal Levee.

Arcade Creek

This area is very urbanized with homes on the landside and little vegetation on the water side. A small floodwall is on top of the levee in much of the study area. Viewers in the area include residents, and a few recreational users. Because the homes are lower than the levee in this area and there is a floodwall the landside residents have very little view of the creek. Figures 24 and 25 are pictures of a typical view of this area.

Figure 24. Arcade Creek.

Figure 25. Arcade Creek at its Confluence with NEMDC.

Magpie Creek

This area is open space with some small ranchettes and light industrial uses on the fringe of the creek. Viewers in this area are primarily local residents. The levee structure is very low in this area and hard to define from a viewer's perspective. Figure 26 is a typical view of this area.

Figure 26. Magpie Creek Diversion Channel.

Sacramento Bypass

The Sacramento Bypass consists primarily of open space and flood conveyance land uses. No development or agricultural activities occur within the bypass, and that portion of the floodway (bypass) west of the Sacramento Weir is designated as the Sacramento Bypass Wildlife Area. This wildlife area is operated and managed by the CDFW. Agricultural land within the Yolo Bypass borders the west end of the Sacramento Bypass (the bypass outfall), and agricultural land is adjacent to the north side of the northern bypass levee. The Sacramento Weir serves as its eastern boundary, separating the Bypass from the Sacramento River, although the floodway formed by the bypass continues for several feet east of the weir before intersecting the river. The California Highway Patrol (CHP) Academy and agricultural land are adjacent to the south side of the southern levee of the Bypass.

The primary viewers using the Sacramento Bypass area are recreationists. Recreational uses within the bypass proper (e.g. the Sacramento Bypass Wildlife Area) include hunting, fishing, bird and wildlife watching, and simply enjoying the open space. Recreational uses on the crown of the bypass levees include walking, running, jogging, and bird watching. Boating and fishing are common recreational uses along the Sacramento River where it borders the Bypass. Viewers using the levees of the bypass for recreation have expansive views of the open space within the bypass in many locations and can also see the agricultural fields adjacent to the bypass levees. In a few locations along the crown of the southern bypass levee, the high-rise buildings of downtown Sacramento can be seen above the tree line. Background views to the Sierra Nevada foothills to the east are rare, while views of mountains within the Coastal Range to the west are more common. Views of the bypass floodway from the bypass levees are obscured by trees in several places, particularly from the crown of the northern levee. Views also differ seasonally, offering different views when vegetation is dormant or in leaf. Standing within the bypass itself, views of the Sacramento River are limited to the area east of the weir and the areas beyond the flanking levees cannot be seen due to the height of these levees.

While the visual quality of the bypass itself is moderate, the views offered from it are moderately high. Appealing views of the bypass and Sacramento cityscape present both rural and urban scenes that are attractive. Figures 27 through 29 are pictures of this area during a high water event.

Figure 27. Sacramento Weir.

Figure 28. Sacramento Weir in High Water Event.

Figure 29. Sacramento Bypass (Downstream of Weir) with Water.

3.15.2 Methodology and Basis of Significance

Methodology

Evaluation of the project's potential impacts on visual resources was based on a review of scenic vistas and landscapes that could be affected by project-related activities. Visual contrasts were examined, which included evaluations of changes in form, size, colors, project dominance, view blockage, and duration of impacts. Other elements such as natural screening by vegetation or landforms, placement of project components in relation to existing structures, and likely viewer groups were also considered.

Basis of Significance

The thresholds of significance encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and intensity. The thresholds for determining the significance of impacts for this analysis are based on the environmental checklist in Appendix G of the State CEQA Guidelines. A proposed alternative would result in a potentially significant impact to visual resources if it would:

- Have a substantial adverse effect on a scenic vista.
- Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings.
- Substantially degrade the existing visual character or quality of the site and its surroundings.
- Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area.

3.15.3 No Action Alternative

Under the No Action Alternative, the Corps would not participate in construction of the proposed project. The LMA would still address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. As a result, if a flood event were to occur, the Sacramento area would remain at risk of a possible levee failure.

Without some kind of erosion control measures, the Sacramento River levees would continue to erode during high flows. As the banks of the river erode vegetation would be lost and the levees could fail. It is likely that in order to save the levee structures, flood fight activities would occur during a high flow emergency response. Flood fighting is usually performed by placing large rock along the levee slope to stop erosion and prevent levee failure and loss of lives. The placement of rock would prevent or impede future growth of trees and vegetation on the levee slopes. In the event that flood fighting activities are not successful and a levee failure occurs all vegetation would be lost and any wildlife would be swept away in the flood waters. The loss of vegetation that could occur in a large flood event and the placement of rock along the banks are considered significant impacts to visual resources.

Over time the berms within the American River Parkway would erode, and vegetation would be lost. Because we cannot predict when and how large events will occur it is inappropriate to determine at which time the berms will erode. Additionally, flood fighting would occur as described above, and the Sacramento area would be in danger of a levee failure, as described above. The potential loss of the entire Parkway and its associated levees would be considered a significant impact because it would permanently degrade the visual quality of the American River and would substantially damage the scenic resources along the rivers. Additionally, the No Action Alternative would be in conflict with the flood control policies of the American River Parkway Plan. These effects would be significant under the No Action Alternative.

3.15.4 Alternative 1 – Improve Levees

Borrow Sites

Activities at borrow sites would consist of large excavation equipment removing soil to extract suitable material and transporting the material to the levee construction sites. The estimated amount of borrow material needed is 1 million cubic yards, which could require more than 400 acres of land to extract suitable material. Multiple sites have been considered for borrow material. The sites being considered are in rural areas and are not currently being used for crop production or other urban uses. Actual selection of borrow sites would be determined based on the least damage to the natural and human environment. During construction the existing visual character will be diminished as large equipment moves soil and the sites become exposed dirt. However, this is a short term impact and once the site is completed and restored the effects will be less than significant or could be a positive effect on the visual character.

The Corps will coordinate with the CDC to comply with the Surface Mining and Reclamation Act of 1975. Reclamation of the sites is included as part of the project design by returning the sites to pre-construction conditions or improving the sites visual character with compensation plantings. After the completion of restoration, the borrow sites would be similar to existing conditions or would increase habitat and the natural looking environment by placing compensation for other project affects on the sites after soil is extracted. No mitigation would be required for borrow sites.

American River

Construction would occur on approximately 11 of the 26 miles of the American River Parkway, a construction area of nearly 200 acres. Within the 200 acres are approximately 65 acres of riparian habitat that would be removed to construct the launchable rock trenches. The remaining 135 acres are existing levee slopes, which will be degraded to install the rock trench, and staging areas. Vehicles in the Parkway are normally limited to maintenance, park rangers, and random field crews. During construction equipment would be moving throughout the Parkway as equipment and materials are delivered and removed from the sites. This would create a reduction in the visual quality of the Parkway for both recreationists using the Parkway, and for the residents living adjacent to the Parkway. Construction in the Parkway would be primarily during the summer months and would last for approximately 10 years. While this is considered a short-term impact, because the location of the construction would change from year-to-year, with the number of construction vehicles required and the construction timeframe extending for 10 years, this is considered a significant effect to the visual tranquility of the Parkway.

The loss of riparian vegetation from the construction of the launchable rock trenches would have a long term impact on the visual resources in the Parkway. The launchable rock trenches would be designed to include a planting berm, which would be planted with trees outside of the 15 foot vegetation free zone to compensate for some of the 65 acres of lost riparian habitat. However, the trees would take many years to grow to the similar visual value as those removed. Long-term effects to vegetative visual resources would be less than significant with the implementation of mitigation. However, there would remain a significant and unavoidable short-term effect to visual resources from this vegetation removal..

Over time, there would be some locations where the river bank erodes to a degree that the rock trench would launch. In this scenario, rocks in the trench would spill over the eroded bank as designed (e.g. the rocks would be “launched”). There would then be a relatively continuous revetment slope from near the water side of the levee toe to the margin of the eroded river channel under this scenario. In such locations, the visual resource quality and value would be substantially degraded. Some trees and shrubs could potentially re-colonize the revetment slope over several years, but it is also likely that some slopes would remain devoid of significant vegetation. In either case, there would be a long term adverse impact to visual resources, mainly apparent to persons travelling on or swimming in the river or

to parkway users near the affected river bank segment. Such long term effects, while significant, would be less detrimental compared to the no action alternative. Under the no action alternative, there would be no revetment to help halt the progress of bank erosion thereby leading to a significantly greater loss of land and vegetation along the river bank and a greater adverse impact to visual resources.

During construction of the bank protection sites, activities in the Parkway would be similar to those for the rock trench. Construction vehicles would be moving throughout the Parkway transporting materials to the sites. The footprint for the bank protection sites would be adjacent to the river channel, varying distances from the public access areas. Visual impacts of completed bank protection sites would likely only be seen from the river and to those within the Parkway. Trees would remain in place and anchored with rock to protect them from future erosion. These sites would also be planted with vegetation. It would likely take 3 to 5 years to establish the vegetation at these sites. Figures 11 through 13 are pictures of a site similar to some of the proposed bank protection sites, illustrating what the site looked like 4 years after construction and 9 years after construction. The visual value of river bank protection areas similar to that shown in the aforementioned photographs would take a few years to be restored to conditions similar to those present prior to installation of the bank protection. In some cases once vegetation has fully developed, the visual quality of some currently eroded bank segments may be enhanced by the proposed bank protection through the establishment of a relatively stable assemblage of trees and shrubs. In other cases, the affected bank protection sites would provide a relatively natural looking environment similar to existing conditions, with the exception that some of the rock protection would still be visible, particularly when the river's water level is low. The rock bank would be most visible from the river itself, thereby degrading the visual quality of the river bank from the standpoint of observers on the river. Overall, the proposed bank protection would result in a significant short term adverse impact to visual resources. Once vegetation has been established, however, it is anticipated this impact would be less than significant.

Sacramento River

Construction activities along the Sacramento River would require the hauling of equipment and materials to the sites. There would be large construction equipment on barges and on top of the levee during construction of the levee improvements. Boaters and pedestrians would be able to see the construction equipment and activities. Residents that back up to the levee would also see the construction activities from their backyard and windows. The presence of construction equipment would degrade the visual quality of the scenic vistas of the Sacramento River for the residents and recreational users. Construction along the Sacramento River would be intermittent for approximately 8 years. Construction would occur laterally so most residents would experience construction activities behind their homes for one to two construction seasons.

This alternative would require the removal of some vegetation and landscaping from private property in areas where levee raising is recommended. This would have a long term effect on those individual residents as the levee and maintenance corridor would replace portions of their landscaped backyard. This would be a significant effect to the individual homeowners because it would decrease the existing visual character of the backyards.

Construction of the bank protection would be visible from the river and the levee. People using the river and levee do not normally see construction equipment in the area. While construction is taking place, people would have a visual disturbance compared to the existing conditions. Like the American River, the visual effects would be short-term and, similar to the American River effects discussed above, vegetation planted along the bank would cover the rock and provide natural habitat within 3 to 5 years. Large trees would also remain in place, which would reduce the effects to visual resources. While effects to visual resources from waterside bank protection construction are considered less than significant with mitigation, the overall project would have a significant effect to visual resources due to the effects to residents during construction detailed above, which cannot be mitigated.

East Side Tributaries

The waterways in this area of the project are much different from the Sacramento and American Rivers because the creeks are dry much of the year. The creeks contain overgrown vegetation and multiple areas have scattered debris such as shopping carts, appliances, and tires. Construction equipment would use the levee roads and ramps to access each area of construction. Residents would view the equipment during construction activities, however, this would last only one construction season and once complete the area would return to the pre-construction conditions. Work in each area would only last for a single season, however, it would take approximately 3 years to complete all of the east side tributaries.

Levee modifications along the NEMDC, Dry Creek, Robla Creek, and Magpie Creek would not significantly alter the visual environment in these areas. These tributaries are not located in an area used for recreation or where viewer sensitivity is high. Homes back up to some of the areas where activities would occur and the levees are mostly void of vegetation and wildlife. Many of these areas are industrial parks with commercial buildings and have restricted public access. Those areas with public access are primarily used by walkers and runners for exercise purposes.

Levee improvements, and specifically levee raises along Arcade Creek would require the acquisition of residential private property. Most of the properties in this area have minimal or no backyard landscaping and there is no vegetation on the levee slopes, therefore, overall the visual effects in this area would be less than significant. However, there are a few residents that have landscaping which would need to be removed. This would result in an affect to that individual resident; however, because overall there are limited residents that have landscaping this effect would be considered less than significant.

During construction, heavy equipment would be present in the area and seen by local residents as equipment enters and exits the area. Construction in this area is expected to last for approximately 3 years. Construction on the levees would move laterally so most people would experience activities near their residences for one construction season. These effects are considered to be short term and less than significant.

3.15.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Visual resource effects are the same as Alternative 1 for the American River, Sacramento River, and East Side Tributaries.

Sacramento Weir and Bypass

Expansion of the Sacramento Weir and Bypass would include the removal of the existing north levee and contouring of land within the expanded bypass. This requires the use of large construction equipment to remove and rebuild the levee, to construct the new weir, and to conduct the grading within the bypass. Large equipment moving throughout this area would be a change from the natural environment that currently exists. This would be a short-term impact and once construction is complete the area would become a natural floodway. Since this is not a populated area, this impact is considered less than significant.

Construction of the weir would have some visual effects as the concrete weir is formed and poured. This would also require the relocation of the River Road and rail road on top of the weir. These construction activities would be seen by people using the river for recreational purposes and driving along Old River Road. Similarly, construction of the new northern levee and seepage berm would require the relocation of CR 126, CR 124, and East Yolo Levee Road. Construction activities would be visible to people driving on these roadways as well, although it is noted that East Yolo Levee Road is gated in this area and not accessible to the general public.

Grading plans for the bypass expansion have not yet been prepared. However, it is anticipated that earthwork and grading within portions of the existing bypass could be substantial in order to acquire material for the levee, to achieve the desired drainage pattern and flow regimes within the overall expanded bypass, and to help avoid or minimize entrainment of fish as can presently occur within the existing bypass. These activities could substantially degrade the visual quality of the existing bypass through the removal of trees and other vegetation and through general topographic disturbance. Grading and other earthwork necessary along the Sacramento River necessary to extend the existing weir would require the removal of a narrow band of scattered trees and shrubs fringing the west bank of the river. North of the existing northern bypass levee, row crop fields and orchards would be eliminated during construction of the expanded bypass, the weir extension, and the new northern levee and seepage berm.

Construction would last approximately 3 years. Visual quality of the area during construction would be impaired and degraded during the construction phase; however this would be a relatively short term impact and is considered less than significant. The loss of trees and shrubs along the bank of the Sacramento River would be a long term impact, although it would not have a substantial effect on the overall scenic value of the river, because the visual quality of this area is already disrupted by the existing weir. Earthwork within the existing bypass would also have a long term impact to visual resources due to the loss of an undetermined number/extent of trees and shrubs.

These impacts would be mitigated by planting native trees and shrubs within portions of the existing bypass and the bypass expansion, as described below. Native grasses and forbs would be seeded in the disturbed portions of the existing bypass and throughout the bypass expansion. The planted grasses and forbs would quickly establish a ground cover similar to, or in some cases better than, the existing vegetative ground cover. It would take several years for the planted trees and shrubs to reach the height of many of the trees and shrubs that would be eliminated during project construction. However, it is probable that the existing visual quality of the bypass would be restored on a long term basis and therefore long term impacts to visual resources would be less than significant. To the contrary, the proposed work would increase the acreage of the bypass by more than 85 percent compared to existing conditions and, with the mitigation described, would enhance the natural visual attributes of the area. The conversion of agricultural fields to open space bypass lands would not significantly affect visual resources since a large expanse of similar agricultural fields (row crops and orchards) would remain on the north side of the new northern levee and seepage berm.

3.15.6 Mitigation Measures

Mitigation measures are similar for both Alternatives 1 and 2 since the footprint does not change for these two alternatives with the exception of the Sacramento Bypass, which would only be required for Alternative 2.

American River

Significant effects to visual resources during construction cannot be avoided and cannot be mitigated. Construction equipment would need to be moving within the Parkway during construction activities to access sites and transport materials. Once construction is complete vehicles movement in the Parkway would return to the pre-project conditions.

Trees will be planted along the outer portion of the rock trench where there is sufficient space. These trees will take some time to mature to the visual value of those removed, however, as shown in the Figures 11 through 13, it does not take a lot of time. Additional trees could be planted at other areas within the Parkway in compliance with the Parkway Plan to mitigate for the removal of the trees which provide a natural environmental in an urban area. The short term effects will be significant,

however, the planting of trees will reduce the effects to visual resources to less than significant once the trees are established and provide similar views as those removed.

Sacramento River

Significant effects to visual resources during construction cannot be avoided and cannot be mitigated. Construction equipment would need to be moving along the levee and within the river during construction activities to access sites and transport materials. Once construction is complete vehicle and barge movement would return to the pre-project conditions.

To minimize visual impacts trees would be left in place on the waterside lower third of the levee. The understory vegetation will be removed in order to place rock. To mitigate the removal of understory vegetation, planting berms will be installed and planted with vegetation to provide a similar visual appearance as before construction. By constructing the planting berms and installing vegetation the long term effects to visual resources will be reduced to less than significant.

On the landside of the levee visual resources cannot be mitigated because the new levee maintenance corridor would be constructed where backyards currently exist. The removal of landscaping would take away the current visual character of the individual properties and would be a significant affect.

East Side Tributaries

Because homes are directly adjacent to the levee and there is insufficient space for the maintenance corridor, other than in the backyards of private property, no mitigation for visual resources is available. No other mitigation measures for visual resources are available, however, due to short duration of construction and the lack of existing backyard landscaping this affect would remain less than significant.

Sacramento Weir and Bypass

Significant effects to visual resources during construction cannot be avoided and cannot be mitigated. Construction equipment will move within the footprint of the bypass expansion and weir extension, within the existing bypass, and along a segment of the Sacramento River during construction activities to access sites and transport materials. Once construction is complete, vehicle movement would be similar to pre-project conditions.

Native trees and shrubs within the existing bypass would be avoided during construction as much as practicable to help minimize visual impacts. The loss of ground cover in the existing and expanded bypass would be mitigated by planting native grasses and forbs in areas disturbed by construction, except within the footprint of the extended weir. The loss of existing native trees and

shrubs within the existing bypass, along the bank of the Sacramento River, and within small portions of the agricultural lands directly impacted by the project would be mitigated by planting native trees and shrubs within certain portions of the expanded bypass. This mitigation would be coordinated with USFWS and CDFW. With implementation of these mitigation measures, the long term effects to visual resources would be reduced to less than significant.

3.16 Public Utilities and Service Systems

3.16.1 Environmental Setting

Regulatory Setting

- California Integrated Waste Management Act
- City of Sacramento General Plan

Existing Conditions

This section addresses the public utilities and service systems and their uses within the project area. Public utilities and service systems in the area include the following: water supply, storm water, wastewater, solid waste, electrical and natural gas, telephone and cable, and fire and police protection services.

Water Supply

More than 20 public and private water districts provide water supply service in the unincorporated area of Sacramento County. The Sacramento County Water Agency is responsible for providing water supply service primarily in the urbanizing portion of unincorporated Sacramento County, between the American and Cosumnes Rivers, in the American River South basin.

In the city of Sacramento, water supply is provided by the City of Sacramento from a combination of surface and groundwater. There are two water treatment plants that divert water from the Sacramento and American Rivers, as well as city-operated groundwater supply wells, to supply domestic water. The City has two water treatment plants: (1) the Sacramento River water treatment plant just below the confluence with the American River; and (2) the Fairbairn water treatment plant on the American River. Both of these water treatment plants are within the ARCF GRR project area. The City's water facilities also include pumping facilities, a system of transmission and storage mains, and water storage reservoirs.

In addition to these two facilities, the East Bay Municipal Utility District and the Sacramento County Water Agency own and operate a water intake facility just north of Freeport on the Sacramento River to supply water to central Sacramento County and the East Bay Area. The Freeport water intake facility is also located within the project area. However, no construction activities will occur directly in the vicinity of the intake structure as this was newly renovated and updated to comply with Corps policy.

The City of West Sacramento's intake structure is located at Bryte Bend, upstream of the confluence of the Sacramento and American Rivers. Water withdrawn from the Sacramento River is treated at the Bryte Bend Water Treatment Plant, which is operated 24 hours a day by State-certified water treatment plant operators.

Storm Water

Storm water management in the project area is a cooperative effort between several agencies including the Department of Water Resources, SAFCA, and local reclamation districts. SAFCA is the organization primarily responsible for drainage and flood control and the City of Sacramento provides storm water drainage to incorporated areas south of the American River. The City's storm water drainage system includes approximately 45,000 storm drain inlets, 65 miles of canals, and over 100 pump stations. Within the project area, there are approximately 80 drain inlets, 30 storm drains, 45 culverts, 8 pump stations, and 2 storm water discharge points.

Stormwater in the agricultural portions of the study area, including the Sacramento Bypass area, is drained primarily by overland flow into human-made ditches, natural drainage swales, and watercourses that discharge into waterways.

Wastewater

Wastewater treatment within the city of Sacramento is provided by the Sacramento Regional County Sanitation District (SRCSD). SRCSD operates all regional interceptors and wastewater treatment plants serving the city with the exception of the combined sewer and storm drain treatment facilities operated by the City of Sacramento. The Sacramento Regional Wastewater Treatment Plant is owned and operated by the SRCSD and provides sewer treatment for much of the study area. The City of Sacramento is responsible for providing and maintaining sewer services in incorporated Sacramento County.

Solid Waste

The Sacramento Regional Solid Waste Authority (SWA) is a joint powers authority of Sacramento County and the City of Sacramento. The SWA Board of Directors consists of elected officials from the county and the member cities. The SWA regulates commercial solid waste collection by franchised haulers through SWA ordinances.

The City of Sacramento collects municipal refuse from all residents and about a third of commercial customers on a weekly basis. The refuse is then transferred to the Sacramento Recycling and Transfer Station and then taken to the Lockwood Landfill in Sparks, Nevada. The remaining two-thirds of commercial waste is collected by private haulers and deposited at several facilities, including the Sacramento County Keifer Landfill and private transfer stations.

Electrical and Natural Gas Service

Sacramento Municipal Utility District (SMUD) and the Pacific Gas and Electric Company (PG&E) provide electric and natural gas services for the city of Sacramento and Sacramento County areas. Within the project area, there are approximately 150 overhead power/light poles and approximately 20 gas pipelines.

Telephone and Cable

Telephone, cable television, and other telecommunications services are provided by a variety of private companies within the project area. Telecommunications are primarily provided by Sprint, AT&T, Comcast, and Surewest for telephone, internet, and cable television. Cellular phone service providers in the area include T-Mobile, Verizon, Sprint, AT&T, Metro PCS, Sure West, Virgin Mobile, and Net 10.

Fire and Police Protection

The City of Sacramento provides fire and police protection within the city limits. Sacramento County provides police services (through the Sheriff's Department) and fire protection in the unincorporated areas of the county.

3.16.2 Methodology and Basis of Significance

Methodology

Effects to public utilities and service systems were identified by comparing existing service capacity and facilities against project implementation. Evaluation of potential utility and service systems impacts was based on the duration and extent to which such services would be affected as well as the ability of a service provider to continue to provide a level of service that could meet the needs of an affected community. The evaluation assumed modifications to levees would occur in phases from June through October.

Basis of Significance

The thresholds of significance encompass the factors taken into account under NEPA to determine the significance of an impact in terms of its context and intensity. The thresholds for determining the significance of impacts for this analysis are based on the environmental checklist in Appendix G of the State CEQA Guidelines because CEQA is more stringent than NEPA. Adverse effects on public utilities and services would be considered significant if implementation of an alternative plan would result in any of the following:

- Require the construction or expansion of any utility systems due to project implementation;
- Disruption or significantly diminished quality of the public utilities and services for an extended period of time;
- Create an increased need for new fire protection, police protection, or ambulance services or significantly affect existing emergency response times or facilities;
- Create damage to public utility and service facilities, pipelines, conduits, or power lines; or
- Create inconsistencies or non-compliance with regional planning documents.

3.16.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. The utilities in the area would remain consistent with current conditions and there would be no change in types, quality, or availability of services in the project area. The potential would exist,

however, for public utilities and services to be adversely affected by a future flood event or levee failure. Such an event could cause inundation from high flows and destruction or damage to utility lines, natural gas supply lines, and water or wastewater piping or facilities, all of which could lead to widespread contamination, temporary power outages, and interruptions of other utilities in the project area and surrounding areas.

If the project is not constructed and a levee failure were to occur there would be a significant amount of debris produced from the flooded properties. This would include vegetation, construction, white goods (appliances) and hazardous and toxic waste. The quantity of debris is unknown due to the fact that the size of flood and damage is unpredictable. It is likely that the debris caused by a flood would be far more than the debris generated by the construction of this project, and would therefore require the construction or expansion of solid waste disposal facilities in the study area.

Varying levels of damage could occur to public service structures as well, causing delays in fire protection, police protection, or emergency medical assistance. However, the potential for such an occurrence is uncertain, and the magnitude and duration of any related risks cannot be predicted. Additionally, because of the increased risk to public safety during an emergency flood event , there would be a need for more emergency services, such as police protection, fire protection, and other emergency response personnel. These effects would be significant under the No Action Alternative.

3.16.4 Alternative 1 – Improve Levees

Construction of Alternative 1 could have potential effects to utility systems in the project area. There is the potential for construction-related damage to infrastructure and disruption of service during construction activities. In addition, infrastructure that currently runs through the levee prism would require either relocations or other alterations in order to comply with Corps policy for encroachments through the levee structure. There is the potential for temporary disruptions in utility service during relocation or alteration of infrastructure.

Water Supply

Modifications to irrigation infrastructure would involve relocation or alteration of features located within the project footprint. Irrigation and pipeline penetrations from wells and pumps that encroach through the levee prism would be adjusted, as necessary, to meet current Corps regulations. These adjustments could consist of raising the pipelines over the levee prism or installation of positive closure devices. Some wells and pumps in the footprint of the proposed flood damage reduction facilities could be relocated outside of the project footprint. The timing of these replacements would be planned, to the extent feasible, to prevent disruption of service.

All of the known penetrations on the American River have been brought into compliance under the WRDA 96/99 project so no relocations or alteration would be required in this area. However, there are several penetrations along the Sacramento River and the East Side Tributaries that will need to be brought into compliance. Based on past experience with levee work along both the Sacramento and American Rivers, unknown penetrations may be encountered during construction. Any water supply encroachments would be brought into compliance during construction before the levee segment is completed and all efforts would be made to prevent disruption in water supply.

Although steps would be taken to minimize potential impacts to water supply infrastructure, temporary interruptions could occur if water supply infrastructure is damaged or otherwise rendered inoperable at a time when it is needed. However, with the implementation of the proposed avoidance and minimization measures (Section 3.16.6), this effect would be reduced to less than significant.

In addition, there could be impacts to the Sacramento River and Fairbairn water treatment plants, and the Freeport water intake facility. Project construction in the vicinity of these structures include bank protection, slurry wall installation, slope reshaping, ETL 1110-2-583 vegetation policy compliance, and possibly launchable rock trench construction near the Fairbairn water treatment plant. Construction would not impact the water supply facilities themselves, however, there is the potential for increased turbidity near the in-stream intake facilities due to construction of bank protection sites and increased fugitive dust during slurry wall and slope reshaping work. BMPs and minimization measures would be implemented to reduce both turbidity and fugitive dust. Turbidity effects are discussed in greater detail in Section 3.5, and the best management practices to be implemented are detailed in Section 3.5.6. Fugitive dust effects are discussed in detail in Section 3.11, and the minimization measures to be implemented are detailed in Section 3.11.6.

Storm Water

Implementation of Alternative 1 has the potential to impact storm water systems due to an increase in turbidity from construction-related runoff. However, this impact would be reduced by required best management practices that would be implemented by the contractor during construction. The contractor would prepare and implement a SWPPP prior to construction that would detail the measures that would be implemented to reduce impacts to storm water systems to less-than-significant. Effects to storm water runoff, the SWPPP, and other avoidance and minimization measures that would be implemented are discussed in greater detail in the Water Quality analysis, Section 3.5 of this document.

Wastewater

Construction-related activities could potentially affect wastewater utilities in that pipes and other utilities that penetrate the levee would have to be removed or relocated. Utilities would be removed or relocated in one of two ways: (1) a surface line over the levee prism; or (2) a through-levee line equipped with positive closure devices. Private encroachments shall be removed by the non-Federal partner or property owner prior to construction. Population size would not increase as a result of the project, therefore, there would be no increase in wastewater needs and no increases to flows or drainages within the project area and any impact to wastewater facilities would be considered less than significant.

Solid Waste

Construction of Alternative 1 would temporarily increase solid waste generation in the study area. Sources of solid waste related to construction activities would include cleared vegetation and debris. Excess earthen materials resulting from degradation of existing levee structures would be either reused for reconstruction of the levee, if appropriate, or hauled off-site and disposed of at the disposal sites established for the project during preconstruction design. Waste materials (including cleared vegetation) and excess earth materials (e.g., organic soils, roots, grass, and excavated materials that do not meet levee embankment criteria) would be used in the reclamation of borrow sites or hauled offsite to a suitable disposal location.

Other solid waste materials, such as asphalt, concrete, pipes, and gravel, would be removed from the footprint of the proposed construction sites and disposed of at an appropriate, licensed landfill. Hazardous materials (e.g., building materials containing lead paint or asbestos) encountered during the removal of structures would be disposed of in accordance with regulatory standards (see Section 3.17, “Hazards and Hazardous Materials”).

The location of the landfill used for disposal construction-related waste would be determined by the construction contractor prior to initiation of construction activity and would be approved by the Corps. This disposal site would be selected based on capacity, type of waste, and other factors. Only those landfills determined to have the ability to accommodate the construction disposal needs of the alternatives would be used. It is likely that the Kiefer Landfill, owned and operated by Sacramento County and located about 15 miles southeast of the city, would be used for a significant portion of the construction waste. Other landfills that may also be utilized include the Yolo County Central Landfill, Western Regional Landfill in Placer County and the Lockwood landfill in Sparks Nevada. Project construction and operation would not cause existing regional landfill capacity to be exceeded; therefore this impact is considered less than significant.

Electrical and Natural Gas Service

Implementation of the Alternative 1 is not expected to create additional demand for electricity or natural gas and would not require the construction or expansion of natural gas lines. However, it could be necessary to relocate existing electrical and natural gas lines. As a result, it is possible that there could be a temporary loss of service to certain areas during relocation of this infrastructure. Because the potential exists for damage and service interruptions to existing electrical and natural gas service utilities both identified and unidentified, this construction effect, though temporary, would be considered potentially significant. With the implementation of the avoidance and minimization measures discussed below, this effect would be reduced to less than significant.

Telephone and Cable

Construction-related activities could potentially impact communication and cable lines within the project footprint and surrounding areas. The extent and intensity of construction-related activities are unknown; however, these activities may require vertical and/or horizontal relocation of existing infrastructure. Construction activities could also potentially cause damage to existing infrastructure resulting in a temporary interruption in service. Such an impact would be considered potentially significant as the extent of the damage could affect the ability of service providers to quickly restore interrupted service.

Fire and Police Protection

Construction of the alternatives would not result in the need for new or altered law enforcement or fire protection facilities, however there is the potential for traffic and access related impacts to fire and police services. Impacts associated with traffic and vehicular access is covered in the Transportation analysis, Section 3.10. It is unlikely for construction and operational activities associated with the project to necessitate increased fire or police protection services, such as additional officers and equipment. Adequate service is provided in the region by local county and city service departments, and actions would be conducted in compliance with Occupational Safety and Health Administration (OSHA) standards.

Construction activities could affect emergency fire protection services because they could potentially spark a fire on a project site or an adjacent area. However, this possibility is highly unlikely and a project-specific fire protection program would be developed prior to any construction-related activities and implemented during construction. Fire and police protection would be stretched to capacity if a flood were to occur under the No-Action alternative as these services are maximized during emergency flood events and therefore, this alternatives would be less than significant compared to the without project conditions. Any effects to Fire and Police Protection Services would therefore be considered less than significant and no mitigation would be required.

3.16.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Effects to public utilities and service systems from the construction of levee improvements under Alternative 2 would be consistent with those analyzed for Alternative 1. Under Alternative 2, levee raises on the Sacramento River would be greatly reduced, however it is assumed that this would not change the level of effort or impacts associated with bringing utility encroachments into compliance with Corps policy. Under Alternative 2, the Sacramento Weir and Bypass would be widened instead of most of the levee raises. There are no major West Sacramento or Yolo County utility infrastructure systems located in the footprint of the Sacramento Weir and Bypass, therefore this action would not impact those systems. Localized effects in this area could occur if power lines or other pipe lines occur in the area, but their impacts would be consistent with those discussed for the levee improvements above. With the implementation of the avoidance and minimization measures discussed in Section 3.16.6 below, impacts to utility infrastructure and service systems would be less than significant.

3.16.6 Mitigation Measures

In order to mitigate for any disruption to public utilities and service systems, consultation with all known service providers would take place prior to construction to identify specific infrastructure locations and appropriate protection measures. Consultation would continue during construction to ensure avoidance/protection of facilities to minimize service disruptions. Where feasible, replacement utility structures would be completed before demolition of existing facilities. Mitigation measures would include the following:

- Notification of any potential interruptions in service shall be provided to the appropriate agencies and affected landowners.
- Before the start of construction, utility locations shall be verified through field surveys and the use of the Underground Service Alert services. Any buried utility lines shall be clearly marked in the area of construction on the construction specifications in advance of any earthmoving activities.
- Before the start of construction, a response plan shall be prepared to address potential accidental damage to a utility line. The plan shall identify chain of command rules for notification of authorities and appropriate actions and responsibilities to ensure the safety of the public and workers. Worker education training in response to such situations shall be conducted by the contractor. The response plan shall be implemented by the project proponent(s) and its contractors during construction activities.
- Utility relocations shall be staged to minimize interruptions in service.

- Construction activities will be coordinated with first responders within the study area so plans can be implemented to avoid response delays due to construction detours.

3.17 Hazardous Wastes and Materials

For purposes of this section, the term "hazardous materials" refers to both hazardous substances and hazardous wastes. A hazardous material is defined as "a substance or material that…is capable of posing an unreasonable risk to health, safety, and property when transported in commerce" (49 CFR Section 171.8). California Health and Safety Code Section 25501 defines a hazardous material as follows:

> *"Hazardous material" means any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. "Hazardous materials" include, but are not limited to, hazardous substances, hazardous waste, and any material which a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.*

Hazardous wastes are defined in California Health and Safety Code Section 25141(b) as wastes that:

> *…because of their quantity, concentration, or physical, chemical, or infectious characteristics, [may either] cause, or significantly contribute to an increase in mortality or an increase in serious illness[, or] pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.*

3.17.1 Environmental Setting

Regulatory Setting

The principal Federal regulatory agency responsible for the safe use and handling of hazardous materials is the EPA. Key Federal, State, and local statutes, plans, and policies pertaining to hazardous wastes are listed below.

Federal

- Resource Conservation and Recovery Act
- Comprehensive Environmental Response, Compensation, and Liability Act

State

- Hazardous Materials Release Response Plans and Inventory Act of 1985
- Hazardous Waste Control Act
- Emergency Services Act

Local

- Sacramento County Multi-Hazard Mitigation Plan
- Yolo county Multi-Hazard Mitigation Plan

Existing Conditions

The Corps conducted a Phase I Environmental Site Assessment (Phase I ESA) for the study area (Appendix H). Phase I ESAs are intended to determine the presence of recognized environmental conditions, which are defined as a past, present, or likely future releases of hazardous substances or petroleum products into the soil, groundwater, or surface water of a site. The following is a summary of the findings from the Phase I ESA completed for the study.

As a part of the Phase I ESA, a database search was conducted using the Department of Toxic Substance Control's (DTSC) Envirostor database and SWRCB Geotracker database which revealed the following sites within the ARCF footprint.

- Old Bryte Landfill (Sacramento Bypass);
- Sacramento Terminal bulk petroleum facilities on the Sacramento River (American River South);
- Old Southern Pacific rail yard on the Sacramento River (American River South);
- Site of former Harbor Sand & Gravel and Bell Marine, levee encroachment on the American River (American River South); and
- Fuel Stop Mini-Mart, leaking underground storage tank being treated by air sparging adjacent to the Arcade Creek levee and bridge crossing (American River North).

Sacramento County has historically and is currently largely an agricultural area. Agricultural land use can often involve the application of pesticides, the residues of which may remain in soils for years. Soil testing from the project footprint was not completed at the time of release of this EIS/EIR; however, prior to construction activities, soil will be tested and if pesticide concentrations in the soil are found that exceed pertinent threshold levels, a plan for safe transport, use, and disposal of these soils would be prepared.

Historic hydraulic gold mining in the Sierra foothills has left a legacy of mercury contamination in the river sediments and the levees from which they were dredged. Detection and response would be the same as for agricultural pesticides.

American River

The following issues and uses were discovered during site surveys and database searches that may have affected the following parcels within the American River footprint:

Assessor Parcel Number (APN) 001-016-011 was a former sand and gravel business, now the site of a pavement recycling company between the old Sacramento city landfill and former Scollan landfill. The business encroaches on the levee with structures and debris piles.

Two former wastewater treatment plants, located on the north bank of the American River at Exposition Park and River Walk Way, have been converted to wastewater pumping and flow equalization stations that pump wastewater south across the American River to the regional wastewater treatment plant at Elk Grove.

Lead concentration may be elevated on roadways atop the levee from past use of leaded gasoline, especially at bridge locations where old leaded paint may be present. The land between 20th Street and the Capitol City Freeway (Business I-80) north of the UPRR tracks and B Street has been completely filled in to above the levee crown elevation by old unregulated city landfills. This may pose issues of landfill gas migration, storm water runoff, and landfill leachate seepage during placement of erosion control measures.

Sacramento River

APNs 009-0012-071-072, 009-002-001, and 009-0030-054 consist of the Sacramento Terminal bulk petroleum handling facility. The site is undergoing soil and groundwater remediation for petroleum releases. Land use restrictions apply. Contaminated properties are on both sides of the levee and petroleum pipelines pass through the levee.

Treated wastewater discharge for the SRCSD is located in the project area at Freeport. Special health and safety and avoidance requirements may apply when working in the vicinity of wastewater facilities.

A railroad track runs on top of the levee on the Sacramento River below the American River. Creosoted railroad ties may have left residual contamination in the railroad roadbed.

East Side Tributaries

APN 251-0292-016 consists of a leaking underground storage tank being treated with air sparging. The site is located adjacent to the levee at a bridge crossing site, and the treatment system is located at the toe of the levee, limiting avoidance options.

APN 275-0111-001 consists of a groundwater contamination and land use restriction in industrial property adjacent to the levee. Numerous contaminated properties exist in this area of Old North Sacramento by the NEMDC.

Sacramento Bypass

APN 042-280-011 consists of the Yolo County abandoned, uncapped, unregulated dump site, adjacent to the Sacramento Bypass north levee. This site has elevated lead concentration, probably from battery waste generated by a former lead recycler in West Sacramento.

3.17.2 Methodology and Basis of Significance

Methodology

This section addresses potential sources of hazards and risks associated with hazardous material that may be associated with implementation of the proposed alternatives under consideration.

Basis of Significance

The thresholds for determining the significance of impacts for this analysis are based on the environmental checklist in Appendix G of the State CEQA Guidelines. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. The alternatives under consideration were determined to result in a significant impact related to hazards and hazardous materials if they would do any of the following;

- Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment;
- Emit hazardous emissions or involve the handling of hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school;
- Be located on a site that is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, create a significant hazard to the public or the environment; or
- Impair implementation of or physically interfere with an adopted emergency response plan or emergency excavation plan.

3.17.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and there would be no measures constructed on existing hazardous material sites. Additionally, there would be no potential releases of hazardous materials as a result of construction activities. The study area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. Sites within the study area would continue to exist and would be the responsibility of regulating agencies to continue the handling of these sites. The potential would exist, however, for these sites to be adversely affected by a future flood event or levee failure. In addition, new hazardous waste spills could occur during a flood event.

High flows could inundate utility lines, natural gas supply lines, and water or wastewater piping or facilities, destroying or damaging the lines, which could lead to widespread contamination. If the project is not constructed and a levee failure was to occur, there would be a significant amount of debris produced from the flooded properties. This would include hazardous and toxic waste. The potential for the spread of hazardous wastes from both new and existing sites would be a significant effect under the No Action Alternative and no mitigation would be possible.

Varying levels of damage could occur to public service structures as well, causing delays in fire protection, police protection, or emergency medical assistance. However, the potential for such an occurrence is uncertain, and the magnitude and duration of any related risks cannot be predicted. Additionally, because of the increased risk to public safety during an emergency flood event , there would be a need for more emergency services, such as police protection, fire protection, and other emergency response personnel. These effects would be significant under the No Action Alternative.

3.17.4 Alternative 1 – Improve Levees

American River

Construction activities would involve the use of potentially hazardous material, such as fuels, oils and lubricants, and cleaners, which are commonly used in construction projects. Construction contractors would be required to use, store, and transport hazardous materials in compliance with Federal, State, and local regulations during project construction and operation.

Site APN 001-016-011, which is currently a pavement recycling company, is in an area where no levee work is required under this alternative; therefore, no impacts would occur if this alternative were to be constructed.

Any hazardous substance encountered during construction would be removed and properly disposed of by a licensed contractor in accordance with Federal, State, and local regulations. Compliance with applicable regulations would reduce the potential for accidental release of hazardous materials during transport and construction activities. The risk of significant hazards associated with the transport, use, and disposal of these materials is low. With the implementation of the mitigation measures discussed below, effects from HTRWs along the American River would be less than significant.

Sacramento River

The Sacramento Terminal bulk petroleum handling facility is in an area where work would not occur under this alternative; therefore, no impacts would occur if this alternative were to be constructed.

The Sacramento Wastewater Treatment facility is located in this reach of the project. However, when the plant was installed in 2012, the levee surrounding the plant was re-enforced and no work is needed at this location. Coordination with SRCSD would occur prior to construction to ensure all special health and safety requirements are met when construction work occurs near this area.

In locations where the railroad is located on the top of the levee in this reach of the project, soil sampling will be done to determine if any contaminants have leached into the soil from the railroad ties. Any hazardous substance encountered would be removed and properly disposed of by a licensed contractor in accordance with Federal, State, and local regulations. With the implementation of the mitigation measures discussed below, effects from HTRWs along the Sacramento River would be less than significant.

East Side Tributaries

The sites that are located in this area of the project could be affected by construction activities. The contractor would be required to comply with all Federal, State, and local laws if contaminated soil is encountered. Any hazardous substance encountered would be removed and properly disposed of by a licensed contractor in accordance with Federal, State, and local regulations. With the implementation of the mitigation measures discussed below, effects from HTRWs along the East Side Tributaries would be less than significant.

Borrow Sites

The exact location of borrow sites has not been determined, however, a preliminary assessment using USGS soil maps has identified multiple areas within 20 miles of the project that could provide adequate borrow material. Testing of borrow sites would occur prior to the use of material and sites which have contaminated soils would not be used for this project. Any hazardous substance encountered during construction would be removed and properly disposed of by a licensed contractor in accordance with Federal, State, and local regulations. With the implementation of the mitigation measures discussed below, effects from HTRWs at the borrow sites would be less than significant.

3.17.5 Alternative 2 – Sacramento Bypass and Improve Levees (Recommended Plan)

Impacts to the Sacramento River, American River, and East Side Tributaries levees would be the same as Alternative 1, with the additional affects associated with the expansion of the Sacramento Weir and Bypass as discussed below.

Sacramento Weir and Bypass

The Old Bryte Landfill, located adjacent to the north levee of the Sacramento Bypass, would be remediated in accordance with Federal, State, and local laws by the non-federal partner prior to construction. Capping of the site is not allowed, as this area would become part of the floodway and capping is not allowed under the Comprehensive Environmental Response, Compensation, and Liability Act. No construction activities would occur in proximity to this site until the site has been completely remediated and meets all Federal, State, and local regulatory requirements. Therefore, this alternative would have no impacts.

3.17.6 Mitigation Measures

Compliance with applicable regulations would reduce the potential for accidental release of hazardous materials during construction. The contractor would also be required to prepare a SWPPP, which details the contractors plan to prevent discharge from the construction site into drainage systems, lakes, or rivers. This plan would include BMPs, as detailed in Section 3.5.6, which would be implemented at each construction site.

Project areas would be tested for contaminants prior to construction, and any materials found would be disposed of in accordance with all Federal, State, and local regulations at an approved disposal site. Implementation of these mitigation measures would reduce the impacts from hazardous materials at project sites to less than significant. If significant time has elapsed between approval of this document and construction, additional investigations should be done to reduce the risk of encountering a site during construction. If construction activities would occur in close proximity to sites listed in the existing conditions section, a Phase II ESA should also be conducted. This would further reduce the risk of exposure to workers and the public during construction and assist in the remediation planning.

3.18 Socioeconomic, Population, and Environmental Justice

3.18.1 Environmental Setting

Regulatory Setting

- Executive Order 12898 entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*

Existing Conditions

Sacramento County

According to the 2010 census, Sacramento County had a population of approximately 1.4 million. The urban development is centralized around the cities of Sacramento, Citrus Heights, Elk Grove, and Rancho Cordova. Other outlying areas include the cities of Roseville and Folsom, which are both outside the project area. The population projection for Sacramento County is 1.7 million persons by 2025, representing a gain of approximately 500,000 new residents, and an increase of slightly more than 41%. Although the county as a whole is expected to increase in population, the project area is at build out and, therefore, expected population growth would occur outside the project area where vacant land could be developed.

According to the 2010 Census data, of the 1.4 million people in Sacramento County, 65% are white, 15% are Asian, 10.9% are African American, and the remaining are of other ethnic background. The median household income is $56,439, slightly less than the State average of $60,883. There are 13.9% of the people below poverty level, which is about the same as the statewide average of 13.7%. The median value of homes is $324,200, slightly lower than the State average of $458,500.

Yolo County

According to the 2010 census, Yolo County has a population of approximately 200,000. The majority of the population is located in the cities of Davis, West Sacramento, and Woodland. The remaining portion of Yolo County is rural with scattered towns and farming communities. The largest grow the area has been in West Sacramento which grew nearly 3.5% from 1990 to 2010.

Yolo County's population is 49.9% White, 30.3 % Hispanic, 14.1% Asian, 3.0% African American, and the remaining are of other ethnic backgrounds. The median income for Yolo County is $57,077 with a median home value of $337,700. There is 17.1% of the population in Yolo County living below poverty level, slightly higher than the State average of 13.7%. Yolo County has an unemployment rate of 8.9%, lower than the state average of 10.2% (California EDD 2012). Based on 2010 Census data there are no significant low income or minority groups within the study area.

The University of California, Davis (UC Davis) is located in Yolo and Solano Counties and is the largest campus in the UC system by land area. Many of the residents of Davis are students resulting in a high percentage of rental properties and multi-unit structures. While the county's economy is based primarily on agriculture, the government sector is the largest employment sector consisting of approximately one third of the county employment. This sector is comprised primarily of State agencies and includes UC Davis employees.

Environmental Justice

Environmental justice is defined as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies". Fair treatment means that no racial, ethnic, or socioeconomic group should bear a disproportionate share of adverse effects as a result of the execution of Federal, State, local and tribal environmental programs and policies (FEMA, 2007). Analysis of environmental justice is required by NEPA. Meaningful involvement means that:

- Potentially affected community residents have an appropriate opportunity to participate in decisions about a proposed activity that affect their environmental or health.
- The public's contribution can influence the regulatory agency's decision.
- The concerns of all participants are considered in the decision-making process.
- Decision makers seek out and facilitate the involvement of those potentially affected.

Based on 2010 Census data there are no significant low income or minority groups within the study area.

3.18.2 Methodology and Basis of Significance

Methodology

NEPA requires the Federal Agency to look at both the natural and "human environment" when evaluating the impacts of a proposed project. The human environment looks at the overall quality of life for the population surrounding the project and any area that would be affected by the outcome of the project.

Basis of Significance

The thresholds of significance encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and intensity. Alternatives under consideration were determined to result in a significant impact related to population and housing if they would do any of the following:

- Induce substantial population growth in an area, either directly (for example; by proposing new homes and businesses) or indirectly (for example; through extension of roads or other infrastructure);
- Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere; or
- Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere.

3.18.3 No Action Alternative

Under the No Action Alternative the project would not be constructed and the area would continue to be at risk of flooding due to levee failure or overtopping. The LMA would address vegetation and encroachments over time under the SWIF agreement, which would improve the condition of the levee system. However, it would be speculative to assume that any additional work would be conducted to address the seepage, slope stability, overtopping, or erosion concerns in the study area. If a flood were to occur, many homes and businesses within the city of Sacramento would be destroyed or damaged, resulting in significant socioeconomic impacts from displacement of homes and people. People who live and work in the downtown area would be impacted by flooding of their homes and potentially flooding of their place of work.

Additionally, the area being flooded contains many Federal, State, and local government agencies. Because so much of the government support system is within the flooded area recovery could be delayed and people could be displaced from both their homes and jobs. The fact that people would be recovering from their personal loss could also impact the ability of the governments to be fully functional. This would result in a significant impact to the economic stability of the Sacramento metropolitan area. There would be no growth inducing effect under the No Action Alternative.

3.18.4 Alternative 1 – Improve Levees

Temporary disruption to the community would occur during construction. Disruptions to the community are primarily related to traffic congestion, noise, recreation, and leisure activities. Haul routes would consist of existing roads, causing additional traffic congestion on residential streets. Hauling would occur during normal construction hours which could coincide with commute traffic. Hauling would also occur on the existing levee adjacent to residential properties. This would be a nuisance to residents due to truck engine noise and dust. The close proximity to the residential properties would occur during the summer months and would disrupt the tranquility that currently exists for the residents. This would be a short term impact, and while significant to the residents, it is not considered significant to the overall project as it is a limited number of residents affected.

Much of the project is immediately adjacent to established communities within the city of Sacramento. Implementation of the project would require the acquisition of some private properties in established communities. Regardless of the extent to which these communities are “established,” the project’s removal of residences would disrupt, but would not physically divide, these communities. Any taking of homes would be done on a case by case basis, and all engineeringly acceptable options will be evaluated before homes are taken. If homes need to be taken to construct the project, the Corps will comply with the Federal Relocation Act.

The project is in a fully urbanized area and no additional housing or business development is expected with the construction of these alternatives. The construction of the project does not change or prevent access to large business complexes or communities.

Because the project is in an urban area, no change in population is expected. The study area is already at build out and any additional population increases would be insignificant. The alternatives would reduce the risk of flooding to the existing populations and lands behind the existing levee system. Local land use plans do not indicate significant development in areas where urban development does not already exist. The project is not anticipated to displace a significant number of residents or divide an established community. Any disruption of communities would be short term during construction when traffic, noise, and other construction related activities could affect resident's daily life styles. Construction of this alternative would result in less than significant affects because the impacts would be short term and no long term impacts are expected to occur.

Environmental Justice

Alternative 1 was designed to convey the 160,000 cfs released from Folsom Dam. All levees within the study area would be constructed to the same criteria and standard. The benefits of the Common Features project would extend to all of the Sacramento Metropolitan area; therefore it would not provide disproportionate benefits or effects to any minority or low income populations. Therefore, the effect is less than significant.

3.18.5 Alternative 2 –Sacramento Bypass and Improve Levees (Recommended Plan)

Effects under Alternative 2 would be consistent with the discussion above for Alternative 1. There would be no additional effects to socioeconomics, population, or environmental justice under Alternative 2. Construction of this alternative would result in less than significant affects.

3.18.6 Mitigation Measures

Because the project would not have a significant socioeconomic impact on the community no mitigation measures are required. However, by reducing the risk of flooding the project could result in positive impacts to the socioeconomics by reduced likelihood of flooding, loss of lives, and pain and suffering. The project would also reduce the cost of flood insurance to structures removed from the 100-year FEMA floodplain. Mitigation for relocation of people and their homes would be compensated under the Federal Relocation Act.

4.0 CUMULATIVE IMPACTS, GROWTH-INDUCING IMPACTS, AND OTHER REQUIREMENTS

4.1 Cumulative Effects

NEPA and CEQA require the consideration of cumulative effects of the proposed action, combined with the effects of other projects. NEPA defines a cumulative effect as an effect on the environment that results from the incremental effect of an action when combined with other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 C.F.R. § 1508.7). The CEQA Guidelines define cumulative effects as "two or more individual effects which, when considered together, compound or increase other environmental impacts" (CERES, 2007).

This section discusses the potential cumulative effects of the ARCF GRR when added to other past, present, and reasonably foreseeable future actions. If the project is not expected to contribute to a cumulative effect on a resource, then that resource is not included in the sections below. The resources not included below include hazardous and toxic waste, hydrology and hydraulics, land use, socioeconomics, utilities and services, and geology, as these resources would not have cumulative effects when considered with other past, present, or reasonably foreseeable future actions. The remaining resources could involve a cumulative effect, and are discussed in more detail in Section 4.2 below.

4.1.1 Methodology and Geographic Scope of the Analysis

Methodology

The cumulative effects analysis determines the combined effect of the ARCF project alternatives and other closely related, reasonably foreseeable projects. Cumulative effects were evaluated by identifying projects in and around the Sacramento region that could have individually minor but collectively significant actions taking place over a period of time. These potential effects are combined to the potential adverse or beneficial effects of the proposed alternatives to determine the type, length, and magnitude of potential cumulative effects. Those effects that cannot be avoided or reduced to less than significant are more likely to contribute to cumulative effects in the area. Mitigation of significant cumulative effects could be accomplished by rescheduling actions of proposed projects and adopting different technologies.

Basis of Significance

Significance of cumulative effects is determined by meeting the Federal and State mandates and specified criteria identified under each environmental resource section in Chapter 3 above to evaluate impacts from the combination of the proposed alternatives and the other related projects discussed below.

Geographic Scope

The geographic area that could be affected by the project varies depending on the type of environmental resource being considered. Air and water resources extend beyond the confines of the project footprint since effects on these resources would not necessarily be confined to the project area. Table 51 presents the general geographic areas associated with the different resources addressed in the EIS/EIR. The related projects that are considered may also vary under each environmental resource section depending on the type of environmental effects that may result from these projects.

Table 51. Geographic Areas that Would Be Affected by the ARCF GRR Project.

Resource Area	Geographic Area
Agriculture	Sacramento Bypass
Hydrology and Hydraulics	Sacramento and American Rivers, East Side Tributaries, and Sacramento Bypass in the vicinity of the study
Water quality	Sacramento and American Rivers, East Side Tributaries, and Sacramento Bypass in the vicinity of the study
Biological resources	Sacramento and American Rivers, East Side Tributaries, Sacramento Bypass, American River Parkway, and habitat at individual waterside improvement sites, with regional implications for species
Special Status Species	Sacramento and American Rivers, East Side Tributaries, and Sacramento Bypass in the vicinity of the study
Cultural resources	Individual ground disturbance sites, with regional implications
Transportation and circulation	Roadway network in the study area, with regional implications
Air quality	Regional (SMAQMD); global for greenhouse gas emissions
Noise	Immediate vicinity of the individual sites of construction activity
Recreation	Local (facilities near construction sites)
Visual resources	Individual levee improvement sites and landscape level

4.1.2 Past, Present, and Reasonably Foreseeable Future Projects

This section briefly describes other projects in the Sacramento area. The exact construction timing and sequencing of these projects are not yet determined or may depend on uncertain funding sources. Consideration of each of these projects is necessary to evaluate the cumulative effects of the proposed project on environmental resources in the area.

Lower American River Common Features Project

Based on congressional authorizations in WRDA 1996 and WRDA 1999, the Corps, CVFPB, and SAFCA have undertaken various improvements to the levees along the north and south banks of the American River and the east bank of the Sacramento River. Under WRDA 96, the most recent improvements include closing the gaps along the American River System (Remaining Sites) that were not completed during the original construction of the 26 miles of slurry walls completed in 2002. The Remaining Sites are anticipated to be completed in 2014 prior to construction of this project. Several other phases of repairs have been completed in the Natomas Basin under the Lower American River Common Features Project.

Natomas Levee Improvement Project

In 2007, the Natomas Levee Improvement Project was authorized as an early-implementation project initiated by SAFCA in order to provide flood protection to the Natomas Basin as quickly as possible. These projects consist of improvements to the perimeter levee system of the Natomas Basin in Sutter and Sacramento Counties, as well as associated landscape and irrigation/drainage infrastructure modifications. SAFCA, DWR, CVFPB, and the Corps have initiated this effort with the aim of incorporating the Landside Improvements Project and the Natomas Levee Improvement Project into the Federally-authorized American River Common Features Project. Construction on this early implementation project was completed in 2013. Future project features will be completed under the proposed ARCF, Natomas PACR or the ARCF GRR, upon authorization. The Natomas PACR was completed and a ROD signed in 2010, however, Congressional authorization and funding have not been provided at the time of this report preparation.

Sacramento River Bank Protection Project

The SRBPP was authorized to protect the existing levees and flood control facilities of the SRFCP. The SRBPP was instituted in 1960 to be constructed in phases. Bank protection has generally been constructed on an annual basis. Phase I was constructed from 1963 to 1975, and consisted of 436,397 linear feet of bank protection. Phase II was authorized in 1974 for 405,000 linear feet of bank protection. The SRBPP directs the Corps to provide bank protection along the Sacramento River and its tributaries, including that portion of the lower American River bordered by Federal flood control project

levees. Beginning in 1965, erosion control projects at twelve sites covering 16,141 linear feet of the south and north banks of the lower American River have been implemented. This is an ongoing project, and additional sites requiring maintenance will continue to be identified indefinitely until the remaining authority of 4,966 linear feet is exhausted over the next 3 years. WRDA 2007 authorized an additional 80,000 linear feet of bank protection to Phase II.

West Sacramento GRR

The West Sacramento GRR would determine the Federal interest in reducing the flood risk within the West Sacramento project area. The purpose of the West Sacramento GRR is to bring the 50-miles of perimeter levees surrounding West Sacramento into compliance with applicable Federal and State standards for levees protecting urban areas. Proposed levee improvements would address: (1) seepage; (2) stability; (3) levee height; and (4) erosion concerns along the West Sacramento levee system. Measures to address these concerns would include: (1) seepage cutoff walls; (2) seepage berms; (3) stability berms; (4) levee raises; (5) flood walls; (6) relief wells; (7) sheet pile walls; (8) jet grouting; and (9) bank protection. The final array of alternatives for the West Sacramento GRR include: (1) No Action Alternative; (2) Alternative 1 – Improve Levees; (3) Alternative 3 – Improve Levees with a Closure Structure on the DWSC; and (4) Alternative 5 – Improve Levees with a setback levee along the Sacramento River south levee.

Folsom Dam Safety and Flood Damage Reduction Project

The Folsom Dam Safety and Flood Damage Reduction Project address the dam safety hydrologic risk at the Folsom Facility and improves flood protection. Several activities associated the project include: the Folsom Dam Auxiliary Spillway, referred to as the Joint Federal Project (JFP), static upgrades to Dike 4, Mormon Island Auxiliary Dam (MIAD) modifications, and seismic upgrades (piers and tendons) to the Main Concrete Dam.

Auxiliary Spillway Excavation

Spring 2009 to Fall 2010. Major work under Phase II of the JFP includes partial excavation of the western portion of the auxiliary spillway, construction of the downstream cofferdams, relocation of the Natoma Pipeline, and the creation of an access road to the stilling basin. This portion of the JFP was covered under the 2007 Folsom Dam Safety and Flood Damage Reduction Project EIS/EIR (2007 EIS/EIR). Construction was conducted by the United States Bureau of Reclamation (USBR) and was completed prior to the start of the Control Structure construction effort.

Dike 4 and 6 Repairs

Summer 2009 to June 2010. To address seepage concerns due to static and hydrologic loading for Dikes 4 and 6, USBR installed full height filters, toe drains, and overlays on the downstream face of each earthen structure. This portion of the JFP was covered under the 2007 EIS/EIR.

Mormon Island Auxiliary Dam Modification Project

Summer 2010 to Spring 2016. USBR released the Draft EIS/EIR for the MIAD Modification Project in December 2009. The preferred MIAD action alternative of jet grouting selected in the 2007 Folsom Dam Safety and Flood Damage Reduction FEIS/EIR was determined to be neither technically nor economically feasible. Four action alternatives were analyzed in the MIAD Draft Supplemental EIS/EIR. All alternatives address methods to excavate and replace the MIAD foundation, place an overlay on the downstream side, and install drains and filters; the alternatives differ only in their method of excavation. In addition, all four action alternatives in the Draft Supplemental EIS/EIR include habitat mitigation proposed for up to 80 acres at Mississippi Bar on the shore of Lake Natoma to address impacts from the JFP.

Pier Tendon Installation, Spillway Pier Wraps, and Braces at Main Concrete Dam

April 2011 through Spring 2014. These three projects address seismic concerns at the main concrete dam. These improvements are designed to help stabilize the main concrete dam against movement during a major earthquake. This portion of the JFP was covered under the 2007 FEIS/EIR.

Control Structure, Chute, and Stilling Basin

Spring 2011 to Fall 2017. Phase III of the JFP consists of construction of the auxiliary spillway control structure. This effort is currently under construction by the Corps and is projected to be completed in the fall of 2014. Concrete lining of the spillway chute and stilling basin will be conducted from approximately early 2014 to fall 2017. Construction of the control structure, and the concrete lining of the chute and stilling basin were all covered under the Corps' 2010 EA/EIR.

Additional Downstream Features

Fall 2013 to Spring 2017. The design refinements to Phase III construction evaluated in a supplemental EA/EIR included the construction of a temporary traffic light, modification to dirt access haul road, installation of the stilling basin drain, and use of a a new batch plant at a nearby staging area for other downstream features work. This work would be completed by fall of 2013, with the exception of the stilling basin drain which would be installed in 2017. This portion of the JFP was covered under the 2012 Prison Staging Area and Stilling Basin Drain EA/EIR.

Approach Channel

Spring 2013 to Fall 2017. The approach channel project is the final construction activity of Phase IV of the JFP. The primary and permanent structures consist of the 1,100 foot long excavated approach channel and spur dike. A transload facility and concrete batch plant will be constructed as necessary temporary structures to facilitate the construction. Additional existing sites and facilities that would be utilized for the length of the project include the Folsom Prison staging area, the existing Bureau of Reclamation Overlook, the MIAD area, and Dike 7. This portion of the JFP was covered under the 2012 Folsom Dam Modification Project, Approach Channel EIS/EIR.

Right Bank Stabilization Project

Projected to begin in 2015. The right bank stabilization project would be the first component under Phase V of the JFP. Technical studies and hydraulic modeling indicated that the convergence of flows from the main dam and the auxiliary spillway could erode and possibly destabilize the existing slope along the right bank of the American River. Existing rock downstream of the stilling basin would be exposed to potential scour when water is released and discharged back to the American River. The proposed action would provide slope protection to the vulnerable upper slope and stabilized the lower portion of the slope with rock anchors. A draft EA/EIR should be available by summer of 2014.

JFP Site Restoration

Projected to begin in 2017. Upon completion of the JFP construction, the project area would be restored under Phase V. Activities include regrading and reseeding the site as necessary to prevent erosion, removal of the temporary haul road, removal of the Dike 8 public overcrossing, decommissioning office complex and miscellaneous activities. Restoration planning activities could begin in 2014.

Folsom Dam Water Control Manual Update

The Folsom Dam Water Control Manual (WCM) is being updated to reflect authorized changes to the flood management and dam safety operations at Folsom Dam to reduce flood risk in the Sacramento area. The WCM Update will utilize the existing and authorized physical features of the dam and reservoir, specifically the auxiliary spillway and submerged tainter gates currently under construction and scheduled to be completed in 2016.

Along with evaluating operational changes to utilize the additional operational capabilities created by the auxiliary spillway and tainter gates, the WCM Update will assess the use of available technologies to enhance the flood risk management performance of Folsom Dam to include a refinement of the basin wetness parameters and the use of real time forecasting operation. Further, the WCM Update will evaluate options for the inclusion of creditable flood control transfer space in

Folsom Reservoir in conjunction with Union Valley, Hell Hole, and French Meadows Reservoirs (also referred to as Variable Space Storage). The study will result in an Engineering Report as well as a Water Control Manual implementation the recommendations of the analysis.

It should be noted that the initial WCM Update effort will focus on additional operational capabilities created by the auxiliary spillway. The Water Control Manual will be further revised in the future to reflect the capabilities to be provided by the Dam Raise and additional Common Features project improvements as appropriate

Folsom Dam Raise

Construction of the Folsom Dam Raise project would likely follow completion of the JFP and the WCM projects The Dam Raise project includes raising the right and left wing dams, Mormon Island Auxiliary Dam and dikes 1-8 around Folsom Reservoir by 3.5 feet; the three emergency spillway gates; and three ecosystem restoration projects (automation of the temperature control shutters at Folsom Dam and restoration of the Bushy and Woodlake sites downstream). The design for the dam raise portion of the project, should begin in 2015 and be completed in FY16, with construction following in phases through 2017 and 2018. The ecosystem restoration projects are not scheduled at this time.

Bay Delta Conservation Plan (BDCP)

The BDCP is a plan with co-equal goals for water supply reliability of State Water Project and Central Valley Project and for conservation and restoration of endangered and sensitive species habitats in the Delta. The plan will identify and implement conservation strategies to improve the overall ecological health of the Delta; identify and implement more ecologically friendly ways to move fresh water through or around the Delta; address toxic pollutants, invasive species, and impairments to water quality; and provide a framework and funding to implement the plan over time.

Alternatives being evaluated under the BDCP include conveyance options of different infrastructure components and operational scenarios. The BDCP could contribute to beneficial cumulative effects by increasing suitable habitat for fish and wildlife species.

In April 2015, DWR announced a new proposed alternative to separate the conveyance facility and habitat restoration measures into two separate efforts: California WaterFix and California EcoRestore (DWR 2015). Under the new proposed alternative, proposed restoration measures are reduced and the timeline would be accelerated. The Recirculated Draft EIR/Supplemental Draft EIS was released for public comment in summer/fall 2015.

Central Valley Project Biological Opinions

Biological Opinions (BOs) issued by USFWS and NMFS for the Central Valley Project (CVP) and State Water Project (SWP) determined that the existing fish passage structure at Fremont Weir was inadequate to allow normal fish passage at most operational levels of the Sacramento River. As a result, the BOs required the USBR and/or DWR to increase inundation of suitable acreage for fish habitat within the Yolo Bypass and to modify operations of the Sacramento Weir or Fremont weir to increase juvenile rearing habitat. The BOs also require restoration of 8,000 acres of tidal marsh habitat in the Delta to benefit Delta smelt and up to 20,000 acres of salmonid habitat restoration. The operations of the SWP and CVP are currently subject to the terms and conditions of these BOs until the new water conveyance infrastructure identified in the BDCP becomes operational. At that time, an integrated BO on coordinated long-term operation of the CVP and SWP will be completed by USFWS and NMFS. Implementation of the BOs is expected to be compatible with the Common Features Project.

4.2 Cumulative Impacts Analysis

4.2.1 Water Quality

Water quality could be affected within the actual construction area and upstream and downstream of the work area. Construction activities such as rock placement, clearing and grubbing, and slope flattening, have the potential to temporarily degrade water quality through the direct release of soil and construction materials into water bodies or the indirect release of contaminants into water bodies through runoff. Related projects, including the Sacramento River Bank Protection Project and the West Sacramento GRR, could be under construction during the same timeframe as the ARCF project. If construction occurs during the same timeframe water quality could be diminished primarily due to increased turbidity. All projects would be required to coordinate with the RWQCB and overall water quality will be required to meet the Basin Plan objectives. There are no anticipated long-term water quality affects with the implementation of multiple projects.

4.2.2 Vegetation and Wildlife

Implementation of the ARCF project has the potential to remove large amounts of vegetation within the project area. The SRBPP and West Sacramento projects would also require the removal of habitat within the Sacramento Metropolitan area. These affects along with the historical decline of vegetation due to urbanization would result in significant cumulative effects. Additionally, other local projects would be complying with the Corps' vegetation policy and could result in the removal of vegetation along waterways for projects that do not receive a vegetation variance.

The mitigation measures would be implemented in accordance with the recommendations of the Coordination Act Report, however, potential adverse effects on biological resources would remain significant due to the amount of habitat being removed to construct the project and the time lapse before the new plantings would mature to the level of those removed. Once all the mitigation and compensation plantings have matured to the level of those removed, the affects to biological resources would be less than significant because the new habitat would be similar to those removed over the 50 year life of the project.

4.2.3 Fisheries

Potential cumulative effects on fish would include effects associated with other projects proposed to occur on the Sacramento and American Rivers. Cumulative effects were evaluated within the construction area and upstream and downstream of the project within the affected river. The Corps' Sacramento River Bank Protection Project and West Sacramento GRR would both result in direct loss of fish habitat from construction. Direct loss of habitats would still result because of the construction of bank protection measures; however both of these projects are expected to implement mitigation measures, including onsite plantings that would improve long term fish habitat on the Sacramento River. In addition, the completion of the Folsom JFP and the new Water Control Manual Update for Folsom Dam would likely benefit downstream fish species on the American River. The new spillway at Folsom Dam will enable better control of outflows from Folsom Dam, including the ability to release colder water from deeper in the lake, which would improve conditions on the American River for fish species. While short term cumulative effects would be significant from the direct effects associated with construction, the implementation of these projects would in time result in a net benefit to fish from the construction of setback levees and planting berms. The ARCF Project along with many other projects being considered for the region could result in limited opportunities for mitigation of SRA habitat for fish species.

4.2.4 Special Status Species

Valley Elderberry Longhorn Beetle

Concurrent construction of multiple projects over the next 10 to 15 years within the Sacramento Metropolitan area would likely cause mortality to beetles due to construction operations. Construction activities for the multiple projects would occur each year during the flight season of beetles. Since construction activities would be adjacent to known VELB locations it is likely that some mortality may occur. The exact number injured or killed is unknown but would likely be minimal due to the exceptional flight ability of the beetle to avoid construction vehicles. No designated critical habitat would be affected with the construction of any of the projects.

Shrubs within the each project footprint would be transplanted to areas in close proximately to the current locations. Additionally, compensation would be located within the vicinity of impacted shrubs. Transplanting of shrubs and planting of seedlings and natives within the project vicinity would provide connectivity for the beetle. Connectivity is a primary cause of the beetle decline and an important element in the recovery and sustainability for the beetle. The transplanting of shrubs and compensation within the same area as the potential impacts would result in adverse effects to the beetle but not result in jeopardy to the valley elderberry longhorn beetle.

Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp

The ARCF GRR estimates that approximately 0.25 acre of vernal pool habitat could be impacted by project construction. However, the Corps proposes to offset this impact through the purchase of credits at a mitigation bank. None of the other related projects discussed above involve activities in known vernal pool habitats. As a result, the ARCF GRR would not contribute to a cumulative effect on vernal pool fairy shrimp or vernal pool tadpole shrimp, and no additional mitigation beyond the measures discussed in Section 3.8.6 would be required.

Giant Garter Snake

Cumulative effects on GGS and their habitat were evaluated within the construction area, haul routes, borrow sites, and immediately adjacent to construction activities. Because avoidance, minimization, and compensation measures would be implemented in accordance with the requirements of the Federal and State ESA, and other relevant regulatory requirements, and the project would protect habitat in place and create habitat, potential adverse effects on special-status species and on sensitive habitats would be reduced to a less than significant level. Additionally, other projects that could occur in the area would also be implemented in accordance with the requirements of the Federal and State ESA.

Special Status Migratory Bird Species

Concurrent construction of multiple projects over the next 10 to 15 years within the Sacramento Metropolitan area would result in adverse effects to special status migratory bird species such as Swainson's hawk, Western yellow-billed cuckoo, and white-tailed kite through the removal of trees within the riparian corridors. Construction activities for the multiple projects would occur each year during nesting season, which could disrupt nesting birds. No designated critical habitat would be affected with the construction of any of the projects.

Prior to construction, each project would be required to conduct surveys to determine the presence of nesting birds. If nesting birds are present, additional measures would be proposed by each of the projects, which may include biological monitoring and buffers around nesting trees. Additionally, any tree removal would likely occur outside of the nesting season. Each project would be required to compensate for the loss of nesting trees. Planting of seedlings and native trees within the project vicinity would provide some habitat connectivity for these bird species and would likely improve the habitat in the area long-term by filling gaps in the riparian canopy. While the short term impact would be significant, over time these compensation measures within the same area as the potential impacts would result in less than significant effects to migratory birds.

Burrowing Owl

Concurrent construction of multiple projects over the next 10 to 15 years within the Sacramento Metropolitan area could result in adverse effects to burrowing owls through the disturbance of potential burrow habitat within the riparian corridors. Construction activities for the multiple projects would occur each year during nesting season, which could disrupt nesting owls. Prior to construction, each project would be required to conduct surveys to determine the presence of burrowing owls. If nesting owls are present, additional measures would be proposed by each of the projects, which may include biological monitoring and buffers around burrow sites. Additionally, any tree removal would likely occur outside of the nesting season. There is the potential that these projects could result in significant impacts to burrowing owls, including disturbance of nesting owls, and mortality to owls if their presence is unknown. However, with the implementation of appropriate mitigation and minimization measures, it is unlikely that the proposed actions would combine to contribute to a significant cumulative effect to burrowing owls.

Special Status Salmonid Species

Special status salmonid species use the American and Sacramento Rivers for migration, therefore, cumulative effects for fisheries were evaluated based on changes to habitat that could occur at the construction sites and change in conditions downstream of the project areas as a result of construction. Implementation of the project has the potential to contribute to the loss or degradation of sensitive habitats and to adversely affect salmonids. These effects could contribute to the species declines and losses of habitat that have led to the need to protect these species under the Federal and State ESA.

Reciept of a vegetation variance would allow trees to remain in place along the lower one-third of the levee and protect essential habitat for many special-status species. Beyond the existing trees being left in place, plants would be installed within the planting berm and potentially provide habitat where none currently exists due to long term erosion. With various projects being considered in the Sacramento and Delta region, lands available for mitigation and compensation could become difficult to locate. This would be especially true for waterside riparian habitat along the Sacramento River.

Green Sturgeon

Green sturgeon use the Sacramento River for migration, therefore, cumulative effects for fisheries were evaluated based on changes to habitat that could occur at the construction sites and change in conditions downstream of the project areas as a result of construction. Implementation of the project has the potential to contribute to the loss or degradation of sensitive habitats and to adversely affect green sturgeon. These effects could contribute to species decline and losses of habitat that have led to the need to protect this species under the Federal and State ESA.

In particular, the combination of the ARCF GRR, SRBPP, and West Sacramento projects could combine to contribute to adverse effects to green sturgeon in the study area. These projects involve the placement of bank protection to address erosion in the study area, and in doing so could adversely impact the food source of the green sturgeon by covering benthic substrate with rock. However, the extent of impact to this species is not easily defined due to the lack of scientific knowledge in this area of the Sacramento River system. These projects are working to adaptively manage their implementation to minimize impacts on the species through modeling efforts during the design phase, and monitoring during the construction phase of the projects. More information on the Corps' mitigation efforts for green sturgeon is included in the Habitat Mitigation and Monitoring Plan (Appendix I). With the implementation of the Corps' proposed mitigation and compensation efforts for both the West Sacramento and ARCF GRR projects, significant cumulative effects on green sturgeon would be minimized as discussed above and replacement habitat compensation would be created for the remaining unavoidable impacts.

Delta Smelt

With the implementation of site specific designs, the local projects would provide long term net benefits to delta smelt. However, there are four specific significant threats to the delta smelt that have been identified by the USFWS: direct entrainments by State and Federal water export facilities, summer and fall increases in salinity, summer and fall increases in water clarity, or effects from introduced species.

Implementation of the various projects would not affect direct entrainments by State and Federal water export facilities. The only potential effect could result from the release of more water down the Sacramento Bypass into the Yolo Bypass during high water events, as a result of construction of the ARCF GRR project. The excess water that would normally be moving downriver through the Sacramento area would enter the system farther down in the Delta area. Since adult delta smelt are moving up the system to spawn at this time this would not affect entrainment in the water export facilities. Summer and fall increases in salinity is driven more by low flow drought years and water releases in the Sacramento tributaries then site specific designs for erosion protection in the project areas. Summer and fall increases in water clarity are associated with, among other factors, invasive

nonnative clam species and non-native plant species, which are generally located down in the Delta below the project areas, that are filtering out vital chlorophyll and plankton that would normally increase turbidity which helps the delta smelt avoid predators. As mentioned above the erosion repair activities of these combined projects would likely reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, as explained above, from a system sediment perspective, the bank material the ARCF GRR project is protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems. As a result, it is unlikely that the combination of the ARCF GRR, West Sacramento, and SRBPP projects would contribute to cause significant impacts to Delta smelt, with the implementation of proposed mitigation measures to reduce construction-related impacts.

Special Status Plant Species

Concurrent construction of multiple projects over the next 10 to 15 years within the Sacramento Metropolitan area could result in adverse effects to special status plant species, including Sanford's arrowhead and wooly rose-mallow through the disturbance of their habitat. Construction activities could result in disturbance through dust, or even mortality if their presence is not properly established before the commencement of construction activities. Prior to construction, each project would be required to conduct surveys to determine the presence of special status plant species. These surveys would need to occur during the blooming period of each species. If special status plants are present, additional measures would be proposed by each of the projects, which may include biological monitoring and buffers around habitat areas. There is the potential that these projects could result in significant impacts to these species if their presence is unknown. However, with the implementation of appropriate mitigation and minimization measures, it is unlikely that the proposed actions would combine to contribute to a significant cumulative effect to special status plant species.

4.2.5 Cultural Resources

Cumulative impacts to cultural resources would be primarily related to individual ground disturbance sites, with potential regional implications for sites if they are considered as part of a historic district, landscape, or multiple sites that may be ethnographically significant and to other construction projects that could occur during the same timeframe as those considered for this study and within the same vicinity as this study. These projects may include the Lower American River Common Features Project, the Natomas Levee Improvements Project, the Sacramento River Bank Protection Project, the West Sacramento GRR, the Folsom Dam Safety and Flood Damage Reduction Project, the Folsom Dam Water Control Manual Update, and the Folsom Dam Raise. At the time of this analysis there are several ground disturbing construction projects anticipated to modify the Sacramento River levees that would result in similar impacts as those included above. As a result, the cumulative overall impact to non-renewable cultural resources is likely, as well as significant and unavoidable. However, individual

projects would implement separate mitigation measures that would address the effects caused by these projects. This project is addressing affects through the execution of a PA. Resolution of all adverse effects across multiple projects is unlikely considering the nature of finite cultural resources that may be lost or damaged by the implementation of these projects. Although mitigation would minimize these impacts, there is still likely a significant cumulative effect to cultural resources.

4.2.6 Air Quality

Cumulative effects to air resources were evaluated within each air basin. Construction of the proposed alternatives would result in emissions of criteria pollutants; however, with the implementation of mitigation measures these emissions are expected to be below the thresholds of the Federal and State CAA. With the exception of the Folsom Dam WCM Update, which has no construction associated with it, all of the related projects discussed above would cumulatively contribute to emissions of criteria pollutants throughout the region, particularly if they are constructed concurrently, which could have a significant cumulative effect on air quality. It is anticipated that each of these projects would implement their own mitigation plan to reduce the emissions to below the significance levels which would result an overall cumulative effect of less than significant, unless the projects are constructed concurrently.

At this time, it is unknown at what point in time the ARCF project would be under construction, as construction is dependent on Congressional authorization and appropriation. However, it is likely that the ARCF project would be constructed at the same time as the West Sacramento GRR. It would be necessary to ensure that the ARCF and the West Sacramento GRR projects are not constructing at sites in close proximity to one another, such as on opposite sides of the river, at the same time. However, on a regional level, these projects would still contribute to a significant cumulative effect, and coordination with the SMAQMD would need to occur prior to construction to reduce these effects. Coordination with SMAQMD would result in the identification of mitigation measures, such as low emission vehicles, mitigation credits, and dust control measures, to reduce the overall cumulative effects on air quality to less than significant.

4.2.7 Climate Change

It is unlikely that any single project by itself could have a significant impact on the environment with respect to GHGs. However, the cumulative effect of human activities has been linked to quantifiable changes in the composition of the atmosphere, which, in turn, have been shown to be the main cause of global climate change (IPCC 2007). Therefore, the analysis of the environmental effects of GHG emissions is inherently a cumulative impact issue. While the emissions of one single project will not cause global climate change, GHG emissions from multiple projects throughout the world could result in a cumulative effect with respect to global climate change.

At this time, it is unknown at what point in time the ARCF project would be under construction, as construction is dependent on Congressional authorization and appropriation. However, it is likely that the ARCF project would be constructed at the same time as the West Sacramento GRR. It is expected that the primary impacts from these concurrent projects would be due to construction activities. On an individual basis, each of these projects would mitigate emissions below the general reporting threshold. If these projects are implemented concurrently, it is possible that the combined cumulative effects could be above the Federal reporting requirement for major facilities for GHG emissions of 25,000 tons of CO_2e per year. It would be necessary to ensure that the ARCF and the West Sacramento GRR projects are not constructing at sites in close proximity to one another, such as on opposite sides of the river, at the same time. However, on a regional level, these projects would still contribute to a significant cumulative effect, and coordination with the SMAQMD would need to occur prior to construction to reduce these effects.

In addition, the majority of the related projects are flood risk management projects. By implementing these projects, the action agencies would be reducing potential future emissions associated with flood fighting and future emergency actions. The related projects could combine to reduce long-term potential GHG emissions in the Sacramento metropolitan area. As a result, the overall cumulative GHG emissions from these projects are considered to be less than significant.

4.2.8 Noise

This project and the other local projects listed above would result in temporarily increased levels of ambient noise in the study area. Cumulative effects to noise would be limited to the projects that are in a close enough proximity to the ARCF construction sites to contribute to the project's noise and create a cumulative effect to the sensitive receptors impacted by the project. The only project that could contribute to the ARCF construction noise due to proximity is the West Sacramento GRR. The Corps would ensure that both projects are not constructing at the same time on opposite sides of the river in order to avoid these cumulative effects to the extent practicable. With this coordination, there would be no cumulative effects due to noise in the study area.

4.2.9 Recreation

Cumulative impacts to recreation are primarily related to other construction projects that could occur during the same timeframe as those considered for this study and within a close enough proximity to one another that recreationists would be impacted by potential impacts to multiple facilities At the time of this analysis no heavy construction projects are anticipated to occur in the American River Parkway or the East Side Tributaries that would create a cumulative effect on recreation opportunities in those areas. However, the combined impact of West Sacramento and ARCF construction sites on

opposing sides of the Sacramento River could create a nuisance to boaters and other recreationists on the river. It would be necessary to ensure that the ARCF and the West Sacramento GRR projects are not constructing at sites in close proximity to one another, such as on opposite sides of the river, at the same time. With this coordination, there would be no cumulative effects to recreation.

4.2.10 Visual Resources

Cumulative impacts to visual resources are primarily related to other construction projects that could occur within the same visual viewscape as this study and result in loss of visual quality both during construction and after construction. If authorized and constructed Alternative 2 would result in a significant amount of large trees and other vegetation removed along the Sacramento River and the American River. Other projects in the vicinity, such as the West Sacramento Project and the SRBPP could also result in the removal of large trees and other vegetation. Implementation of the ARCF Project, when combined with other future projects in the vicinity, would result in a significant cumulative impact on visual resources, primarily from removal of vegetation. Additionally, the long time period for replanted vegetation to reach a size similar to the vegetation removed as a result of construction would be considered a cumulatively significant affect on visual resources along the Sacramento and American Rivers. No other projects are anticipated in the area of the East Side Tributaries and therefore no cumulative effects would occur.

4.3 Growth Inducing Impacts

NEPA and CEQA both require a discussion of how a project, if implemented, could induce growth. This section presents an analysis of the potential growth-inducing effects of the proposed project. Direct growth inducement would result if a project involved construction of new housing. Indirect growth inducement would result, for instance, if implementing a project results in any of the following:

- Substantial new permanent employment opportunities (e.g., commercial, industrial, or governmental enterprises);
- Substantial short-term employment opportunities (e.g., construction employment) that indirectly stimulates the need for additional housing and services to support the new temporary employment demand; and/or
- Removal of an obstacle to additional growth and development, such as removing a constraint on a required public utility or service (e.g., construction of a major sewer line with excess capacity through an undeveloped area).

Growth inducement may lead to environmental effects, such as increased demand for utilities and public services, increased traffic and noise, degradation of air or water quality, degradation or loss of plant or animal habitats, and conversion of agricultural and open space land to urban uses. Growth within a floodplain area increases the risk to people or property from flooding.

Within the project area, population growth and urban development are driven by local, regional, and national economic conditions. Local land use decisions are within the jurisdiction of the City of Sacramento and Sacramento County. Each of these agencies has adopted a general plan. These general plans provide an overall framework for growth and development within the jurisdiction of each agency, including the project area.

Growth inducing impacts would be the same for both Alternatives 1 and 2 as development in the area protected with implementation of the project is covered by existing general plans and is largely completed. Levees within the project area provide flood control for both the City of Sacramento and Sacramento County and help convey water flowing from the surrounding mountain ranges to the Delta. Construction of these alternatives would reduce the risk of flooding in the study area and help to maintain the integrity of the existing levee system.

There is currently sufficient workforce in the Sacramento metropolitan area to support construction of the project if approved. Implementation of either action alternative would have no significant effect on growth and, therefore, no mitigation is required.

4.4 Unavoidable Adverse Effects

State CEQA Guidelines CCR Section 21100(b)(2)(A) provides that an EIR shall include a detailed statement setting forth "any significant effect on the environment that cannot be avoided if the project is implemented." Chapter 3 provides a detailed analysis of all potentially significant environmental impacts of the ARCF project, feasible mitigation measures that could reduce or avoid the project's impacts, and whether these mitigation measures would reduce these impacts to less-than-significant levels. Cumulative impacts are discussed in Section 4.1 above. If a specific impact cannot be reduced to less-than-significant level, it is considered a significant and unavoidable impact.

The ARCF GRR project would have the following significant and unavoidable environmental effects (direct, indirect, and/or cumulative).

- Temporary increase in traffic on public roadways;
- Loss of vegetation and wildlife habitat on the Sacramento River levees, in the American River Parkway, and along Arcade Creek due to construction of levee improvements;
- Cumulative loss of vegetation and wildlife habitat within the Sacramento Metropolitan area;
- Cumulative short term loss of fisheries habitat due to project construction along the lower American and Sacramento Rivers;
- Temporary closure of recreation facilities including bike trail, walking trails, and boat launches in the American River Parkway during construction;
- Loss of aesthetic and visual resources due to construction related disruption of existing visual conditions in the American River Parkway and along the Sacramento River; and,
- Cumulative loss of aesthetic and visual resources primarily from removal of vegetation along the lower American and Sacramento Rivers.
- Direct, indirect, and/or cumulative effects that result in the loss of historic properties.

Under CEQA, the following impacts would be significant and unavoidable. Mitigation for these impacts would be proposed in accordance with the PA. With the implementation of this mitigation the ARCF GRR project would be in compliance with Section 106 of the NHPA.

- Potential damage or disturbance to known archaeological or architectural resources from ground-disturbance or other construction related activities
- Potential damage to or destruction of previously unidentified or undiscovered cultural resources from ground disturbance or other construction-related activities; and
- Potential discovery of human remains during construction.

4.5 Relationship of Short-Term Uses and Long-Term Productivity

NEPA requires that an EIS include a discussion of the relationship between short-term uses of the environment and long-term productivity. Within the context of the EIS/EIR “short-term: refers to the construction period, while “long-term” refers to the operational life of the project and beyond.

Project construction would result in short-term construction-related effects such as interference with local traffic and recreation facilities, and increased air emissions, ambient noise level, dust generation, and are not expected to alter the long-term productivity of the natural environment. Project implementation would also result in long-term effects, including permanent loss of farmland, changes in visual resources, and adverse effects on existing riparian habitat.

Project implementation would contribute to long-term productivity of the environment by improving the levee system that protects the city of Sacramento by reducing the overall flood risk. The project would also reduce the risk of erosion along the American River Parkway, where bank protection is constructed, during a high flow event and the loss of riparian habitat and recreation facilities.

These long-term beneficial effects of the project would outweigh its potentially significant short-term impacts to the environment.

4.6 Irreversible and Irretrievable Commitment of Resources

NEPA requires that an EIS include a discussion of the irreversible and irretrievable commitments of resources which may be involved should the project be implemented. Similarly, the State CEQA Guidelines require a discussion of the significant irreversible environmental changes that would be caused by the project should it be implemented.

The irreversible and irretrievable commitments of resources are the permanent loss of resources for future or alternative purposes. Irreversible and irretrievable resources are those that cannot be recovered or recycled, or those that are consumed or reduced to unrecoverable forms. Project implementation would result in the irreversible and irretrievable commitments of energy and material resources during project construction and maintenance, including the following:

- Construction materials, including such resources as soil and rocks;
- Land and water area committed to new/expanded project facilities; and
- Energy expended in the form of electricity, gasoline, diesel fuel, and oil for equipment and transportation vehicles that would be needed for project construction, operation, and maintenance.
- The destruction of historic properties or the reduction in their ability to convey their significance is irreversible. Additionally, the loss of information that could be gained by the destruction of historic properties is irretrievable.

The use of these nonrenewable resources is expected to account for only a small portion of the region's resources and would not affect the availability of these resources for other needs within the region. Construction activities would not result in inefficient use of energy or natural resources.

As described throughout this EIS/EIR, without implementation of the Common Features Project, the risk of levee failure would remain high. While a precise quantification of environmental impacts associated with potential levee failure is not possible, there is a potential for a variety of significant environmental impacts. Levee failure and the resulting emergency and reconstruction efforts could expend more energy, overall, than construction of the Common Features Project. A large volume of debris would result from a flood event, such things as cars, appliances, housing materials, and vegetation would all be generated with a flood and would likely have to be disposed of in a landfill. After debris removal is completed, re-building would occur and new materials would be required to construct homes, businesses, roads, and other urban infrastructure. Thus, project implementation preempts potentially substantial future consumption, and is likely to result in long-term energy and materials conservation.

4.7 Resource Agency Recommendations and Responses

4.7.1 USFWS Coordination Act Report Recommendations and Responses

USFWS submitted a draft CAR for the ARCF GRR project in September 2013. The recommendations from that CAR are presented below and the Corps responses follow each recommendation. The draft CAR is included in Appendix A. The USFWS recommends that the Corps:

- Avoid impacts to native trees, shrubs, and aquatic vegetation. Any native trees or shrubs removed with a diameter at breast height of 2 inches or greater should be replaced on-site, in-kind with container plantings so that the combined diameter of the container plantings is equal to the combined diameter of the trees removed. These replacement plantings should be monitored for 5 years or until they are determined to be established and self-sustaining. The planting site(s) should be protected in perpetuity.

  Response: The Corps would avoid impacts to trees, shrubs, and aquatic vegetation to the maximum extent possible through the receipt of a vegetation variance, and the implementation of the SWIF by the LMA. Vegetation would only be removed from the construction footprint. Replacement plantings would be installed either on-site or at an off-site restoration area coordinated with USFWS and monitored per the recommendations.

- Avoid the loss of SRA cover by planting native woody vegetation within the bank protection areas. Work with the Service, NMFS, and CDFW to develop planting and monitoring plans, and with DWR and SAFCA to develop a variance to allow vegetation within the Corps' vegetation free zone to remain in place, especially in areas designed for rock slope protection.

Response: The Corps would avoid the loss of SRA cover through the receipt of a vegetation variance, which would allow large trees to remain on the lower waterside slope of the levee. In addition, where feasible, bank protection sites would be designed with a planting berm, and native woody vegetation would be installed on-site.

- Avoid impacts to migratory birds nesting in trees along the access routes and adjacent to the proposed repair sites by conducting pre-construction surveys for active nests along proposed haul roads, staging areas, and construction sites. This would especially apply if construction beings in spring or early summer. Work activity around active nests should be avoided until the young have fledged.

  Response: The Corps would conduct pre-construction migratory bird surveys along all proposed haul routes, staging areas, and construction sites. If active nests are present, the Corps would coordinate with USFWS regarding avoidance and minimization measures to implement during construction, such as avoiding nesting areas or monitoring.

- Avoid future impacts to the site by ensuring all fill material is free of contaminants.

  Response: The Corps would test potential borrow sites prior to construction to ensure that all borrow material is free from contaminants.

- Minimize project impacts by reseeding all disturbed areas, including staging areas, at the completion of construction with native forbs and grasses. Reseeding should be conducted just prior to the rainy season to enhance germination and plant establishment.

  Response: All disturbed areas would be reseeded with native grasses at the completion of construction per the recommendations above.

- Minimize the impact of removal and trimming of all trees and shrubs by having these activities supervised and/or completed by a certified arborist.

  Response: All tree removal activities would be monitored or completed by a certified arborist.

- Compensate the loss of oak woodland, riparian forest, riparian scrub-shrub, and emergent wetland at a ratio of at least 2:1. If on-site compensation at a ratio of 2:1 is not possible, the Corps should work with the Service and other resource agencies on the development of a suitable off-site compensation area. For the loss of other cover-types, the Corps should work with the Service and other resource agencies on the development of compensation success benchmarks to ensure that goals are achieved.

Response: Compensation for the loss of habitat would be at a 2:1 ratio. Off-site restoration areas would be coordinated with the Service. Success benchmarks are established in the Habitat Mitigation and Monitoring Plan included with this EIS/EIR as Appendix I and would be further coordinated with the resource agencies during the design phase of the project.

- All impacted areas should be planted with a diverse mix of woody and herbaceous riparian vegetation. Sites should be diverse (a mix of riparian forest and scrub-shrub) and fit into the surrounding landscape. The planting plan should take into account what is missing from the surrounding vegetation and attempt to create heterogeneous habitats. The Corps should develop a baseline map of existing vegetation communities. Given the amount of rock already placed and the amount proposed for placement, this can serve to create diverse and heterogeneous habitats.

  Response: The Corps will ensure that the restoration areas are planted with a diverse mix of woody and herbaceous riparian vegetation and will attempt to create diverse, heterogeneous habitats.

- Include within the planting contract a provision for the contractor to plant understory species after some of the woody canopy has established. Studies have shown that planting late successional understory species after woody canopy cover has been established provides better success for establishing these understory plants. Incorporating these species within the planting mix provides more diverse habitat for wildlife species (Johnston 2009).

  Response: The Corps will include a provision in the planting contract for the contractor to plant understory species later in the contracting period, after woody canopy cover has had time to establish.

- Consult with the Service on project effects on the giant garter snake, the delta smelt and its critical habitat, and the valley elderberry longhorn beetle and its critical habitat.

  Response: The Corps has consulted with USFWS on the project and a Biological Opinion is included in Appendix J of this document.

- Contact NMFS for possible effects of the project on Federally listed species under their jurisdiction.

  Response: The Corps has consulted with NMFS on the project and a Biological Opinion is included in Appendix J of this document.

- Contact CDFW regarding possible effects of the project on State-listed species.

  Response: The Corps provided CDFW a copy of this EIS/EIR during the public review period. CDFW provided comments on the analysis and the Corps has addressed those comments, as appropriate. Further coordination with CDFW will occur during the design phase of the project.

4.7.2 NMFS Essential Fish Habitat Recommendations and Responses

NMFS submitted a final BO for the ARCF GRR project on September 9, 2015. The Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) conservation recommendations are presented below with Corps responses.

- Fully implementing these EFH conservation recommendations will protect, by avoiding or minimizing the adverse short-term habitat effects described in Section 3.2 of the BO. The Corps should mitigate for WRI deficits by offsetting the maximum deficits. Below is a summary of WRI that should be mitigated to minimize the adverse effects of the Common Features GRR to Pacific coast salmon species. The Corps should offset deficits either onsite or at a NMFS approvedconservation bank. The mitigation should be at a 1:1 ratio if conducted prior to the compensation timing schedule described in the Analytical Approach section of the BO, or at a 3:1 ratio if carried out any later. (Note from Corps: Please see the NMFS BO in Appendix J for the 23 identified WRI deficits that result from the recommended plan).

  Response: The Corps shall ensure that, for salmon, the 23 maximum Standard Assessment Methodology Weighted Response Indices deficits for each seasonal water surface elevation, as determined appropriate with input from the Interagency Working Group or the Bank Protection Working Group, are fully offset. The effects would be offset through habitat improvements within the ARCF GRR project area or through the purchase of credits at a NMFS approved conservation bank, as described in the Biological Assessment. The Corps will mitigate at a 1:1 ratio if conducted prior to the compensation timing schedule described in the Analytical Approach section of the BO, or at a 3:1 ratio if carried out any later.

5.0 COMPLIANCE WITH APPLICABLE LAWS, POLICIES, AND PLANS

This chapter summarizes the environmental laws and regulations that apply to the ARCF Project and describes the status of compliance with those laws and regulations.

5.1 Federal Laws, Regulations, and Policies

Clean Air Act of 1972, as amended (42 U.S.C. 7401, et seq.)

The Federal 1970 Clean Air Act (CAA) authorized the establishment of national health-based air quality standards, and also set deadlines for their attainment. The Federal Clean Air Act Amendments of 1990 (1990 CAA) made major changes in deadlines for attaining National Ambient Air Quality Standards (NAAQS). State and local agencies, within areas that exceed the NAAQS, are required to develop state implementation plans (SIP) to show how they will achieve the NAAQS for nonattainment criteria pollutants by specific dates. SIPs are not single documents; rather, they are a compilation of new and previously submitted plans, programs (such as monitoring, modeling, permitting, etc.), district rules, state regulations and federal controls. USEPA is responsible for enforcing the NAAQS primarily through reviewing SIPs that are prepared by each state. As required by the Federal CAA, the USEPA has established and continues to update the NAAQS for specific criteria air pollutants: O_3, CO, NO_2, SO_2, PM10, PM2.5, and Pb.

Pursuant to CAA Section 176(c) requirements, USEPA promulgated the General Conformity Rule, which applies to most federal actions, including the ARCF project. The General Conformity Rule is used to determine if Federal actions meet the requirements of the CAA and the applicable SIP by ensuring that pollutant emissions related to the action do not:

- Cause or contribute to new violations of a NAAQS.
- Increase the frequency or severity of any existing violation of a NAAQS.
- Delay timely attainment of a NAAQS or interim emission reduction.

A conformity determination under the General Conformity Rule is required if the Federal agency determines: the action will occur in a nonattainment or maintenance area; that one or more specific exemptions do not apply to the action; the action is not included in the Federal agency's "presumed to conform" list; the emissions from the proposed action are not within the approved emissions budget for an applicable facility; and the total direct and indirect emissions of a pollutant (or its precursors), are at or above the *de minimis* levels established in the General Conformity regulations.

For the ARCF study, the construction reach with the most potential air quality emissions associated with it was selected for analysis under the CAA. For this reach, emissions associated with construction of slurry walls, bank protection, levee raises, and emissions from both construction equipment and barges were analyzed to determine the worst case scenario for air quality impacts. The analysis conducted determined that the emissions associated with construction of this reach would be below *de minimus* levels (Section 3.11 and Appendix D), and thus, with the implementation of mitigation measures to further reduce emissions, this effect would be less than significant. As a result, the ARCF project is considered in compliance with the CAA.

GHG emission management is regulated by Federal, state, and local levels of government. USEPA is responsible for GHG regulation at the Federal level. On December 7, 2009, the Final Endangerment and Cause or Contribute Findings for Greenhouse Gases (endangerment finding), under Section 202(a) of the CAA went into effect. The endangerment finding states those current and projected concentrations of the six key GHGs threaten the public health and welfare of current and future generations. Furthermore, it states that the combined emissions of these GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution which threatens public health and welfare (USEPA 2012a). Under the endangerment finding, the USEPA is developing vehicle emission standards under the CAA. Greenhouse Gases under Section 202(a) of the CAA determines whether project emission sources and emission levels significantly affect air quality based on Federal standards established by the EPA and State standards set by CARB. The ARCF is currently estimated to be well beneath the reporting limits for GHGs. As a result, the project is considered to be in compliance with the CAA.

Clean Water Act of 1972, as amended (33 U.S.C. 1251, et seq.)

The Clean Water Act (CWA) is the primary Federal law governing water pollution. It established the basic structure for regulating discharges of pollutants into waters of the U.S. and gives the USEPA the authority to implement pollution control programs, such as setting wastewater standards for industries (USEPA 2002). In some states, such as California, the USEPA has delegated authority to regulate the CWA to state agencies.

Section 401 of the CWA regulates the water quality for any activity that may result in any in-water work or discharge into navigable waters. These actions must not violate Federal water quality standards. The Central Valley RWQCB administers Section 401 of the CWA in California, and either issues or denies water quality certifications. Water quality certifications typically include project-specific requirements established by the RWQCB to ensure attainment of water quality standards. The Corps will request a Section 401 water quality certification from the Central Valley RWQCB during the preconstruction engineering and design phase of the project due to the level of design detail needed in order to complete this consultation.

Section 404 of the CWA requires that a permit be obtained from the Corps when an action will result in the discharge of dredged or fill material into wetlands and waters of the U.S. Under Section 404, the Corps regulates such discharges and issues individual and/or general permits for these activities. Before the Corps can issue a permit under Section 404, it must determine that the project is in compliance with the CWA Section 404(b)(1) guidelines. The 404(b)(1) guidelines specify that "no discharge of dredged or fill material shall be permitted if there is a practical alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 C.F.R. § 230.10[a]).

When conducting its own civil works projects, the Corps does not issue permits to itself. Rather, the Corps complies with the guidelines and substantive requirements of the Clean Water Act, including Section 404 and Section 401. The ARCF project would require discharge of fill material into Waters of the U.S., therefore a section 404(b)(1) analysis was conducted on the project's alternatives, and is included with this document as Appendix E. The discharge of fill material would comply with the 404(b)(1) guidelines with the inclusion of appropriate measures to minimize pollution or adverse effects on the aquatic ecosystem. Additionally, in the Section 404(b)(1) Analysis, Alternative 2 is identified as the Least Environmentally Damaging Practicable Alternative.

The project would also require an NPDES permit since it would disturb 1 or more acre of land and involve possible storm water discharges to surface waters. Prior to construction, the contractor would prepare a SWPPP and then submit a Notice of Intent form to the Central Valley RWQCB, requesting approval of the proposed work. This storm water plan would identify best management practices to be used to avoid or minimize any adverse effects of construction on surface waters. Once the work is completed, the contractor would submit a Notice of Termination in order to terminate coverage by the NPDES permit.

Endangered Species Act of 1973, as amended (16 U.S.C. 1531, et seq.)

Pursuant to the ESA, USFWS and NMFS have regulatory authority over Federally listed species. Under the ESA, a permit to "take" a listed species is required for any Federal action that my harm an individual of that species. Section 7 of the ESA prohibits Federal agencies from authorizing, funding, or carrying out activities that are likely to jeopardize the continued existence of a listed species or destroy or adversely modify its critical habitat. By consulting with USFWS and NMFS before initiating projects, agencies review their actions to determine if those actions could adversely affect listed species or their habitat. Through consultation, USFWS and NMFS work with Federal agencies to help design their programs and projects to conserve listed and proposed species. Because a number of listed species are potentially affected by Federal activities, USFWS and NMFS coordination with other Federal agencies is important to species conservation and may help prevent the need to list candidate species.

The USFWS is the administering agency for this authority regarding non-marine species and NMFS is the administering agency for fish species. In a letter dated June 27, 2014, the Corps initiated formal Section 7 consultation with USFWS and NMFS and submitted a biological assessment that includes the Corps' determination of may affect, likely to adversely affect listed species (salmonids, steelhead, green sturgeon, Delta smelt, valley elderberry longhorn beetle, vernal pool fairy shrimp, vernal pool tadpole shrimp, Western yellow-billed cuckoo, and giant garter snake) and their critical habitat (Appendix G). The regulatory agencies reviewed the assessment and determined that additional information was required. On July 23, 2014, the Corps received a request for additional information from USFWS. On September 9, 2014, the Corps received a request for additional information from NMFS. The updated biological assessment was resubmitted to the resource agencies in April 2015. The Biological Opinion from NMFS was received on September 9, 2015. The Biological Opinion from USFWS was received on September 11, 2015. With receipt of these opinions from the services, and implementation of the enclosed reasonable and prudent measures and terms and conditions, the ARCF GRR is in full compliance with the Federal ESA.

Fish and Wildlife Coordination Act of 1958, as amended (16 U.S.C. 661, et seq.)

The Fish and Wildlife Act (FWCA) ensures that fish and wildlife receive consideration equal to that of other project features from projects that are constructed, licensed, or permitted by Federal agencies. The FWCA requires federal agencies that construct water resource development projects to consult with USFWS, NMFS, and the applicable state fish and wildlife agency (CDFW) regarding the project's impacts on fish and wildlife and measures to mitigate those impacts. The USFWS and CDFW have participated in evaluating the proposed project, and the Coordination Act Report (CAR) is provided in Appendix A. The Corps has considered all recommendations provided in the CAR. The USFWS' recommendations and the Corps response are provided in Section 4.7 of this document.

Magnuson-Stevens Fishery Conservation and Management Act (16. U.S.C. 1801, et seq.)

The Magnuson-Stevens Act requires that all Federal agencies consult with NMFS regarding actions or proposed actions permitted, funded, or undertaken that may adversely affect essential fish habitat. Essential fish habitat is defined as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Both the American and Sacramento Rivers are designated as essential fish habitat for salmon (winter, fall/late fall, and spring-run). The ARCF project and its potential effects to EFH are being coordinated with the NFMS under the Magnuson-Stevens Act, and the Corps received EFH conservation recommendations from NMFS on September 9, 2015. On September 24, 2015, the Corps transmitted a letter to NMFS responding to the recommendations from NMFS. As a result, the ARCF GRR project is in full compliance with the Magnuson-Stevens Act.

Migratory Bird Treaty Act of 1936, as amended (16 U.S.C. 703, et seq.)

The Migratory Bird Treaty Act implements various treaties and conventions between the United States, Canada, Japan, Mexico, and Russia, providing protection for migratory birds as defined in 16 U.S.C. § 715j. The project is in very urbanized areas where traffic congestion and human activities are very common. Birds in these areas have adjusted to the human environment and continue to nest in areas with multiple human activities occurring. To ensure that the project does not affect migratory birds, preconstruction surveys would be conducted by a qualified biologist in areas adjacent to the project construction site. If breeding birds are found in the area where construction is expected to occur, a protective buffer would be delineated and USFWS and CDFG would be consulted for further actions. With the implementation of these surveys, and subsequent avoidance of nesting birds, the project would be in compliance with this Act.

Executive Order 11988, Flood Plain Management

The objective of this Executive Order (EO) is the avoidance, to the extent possible, of long- and short-term adverse effects associated with the occupancy and modification of the base flood plain (1% annual event) and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative. In the GRR, an EO 19988 consistency analysis was conducted in addition to an evaluation of residual flood damage. It was concluded that there is substantial evidence that Alternative 2 would accommodate anticipated growth in the project area in a manner that would be consistent with adopted local and regional growth management plans and with the State's emerging State Plan of Flood Control. There is substantial evidence that the Recommended Plan would accommodate planned regional growth in a manner that would be consistent with emerging smart growth principles. Thus, the project, while accommodating planned regional growth, is not growth inducing itself and is compliant with EO 11988.

The objective of the study is to reduce flood risk and its associated consequences on the public health, safety, and property in the study area. In order to achieve this objective, the study recommends improvements to the ARS and ARN basin levees. These two basins are essentially built-out; however, infill development is ongoing. There are no development restrictions in these basins and so this infill development would occur even without implementation of this recommended plan. Therefore, the project does not trigger or induce development that would not otherwise occur.

Alternative 2 is consistent with the requirements of the EO 11988 since there is no practicable alternative to improving the levees, which are the first line of defense for reducing the risk of flooding in the established urban area. The consistency of these recommendations is further demonstrated by the reduction in the probability of flooding in the study area and the associated societal, economic, and environmental hazards posed by flooding. Alternative 2 would reduce the risk associated with floods thereby minimizing the impacts of floods on human safety, health, and welfare. Alternative 2 also recommends widening the Sacramento Weir and Bypass which would assist in the restoration and

preservation of the natural and beneficial values of the base floodplain. As a result, the proposed project is in compliance with this EO.

Executive Order 11990, Protection of Wetlands

This EO directs Federal agencies, in carrying out their responsibilities, to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. As discussed in Section 3.6, Vegetation and Wildlife, reasonable effort will be taken in the detailed design of the project to avoid disturbance to existing wetlands and implementation of environmentally sustainable designs. Any destruction, loss, or degradation of wetlands would be compensated through creation of new wetland habitat.

Executive Order 12989, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

This EO states that Federal agencies are responsible for conducting their programs, policies, and activities that substantially affect human health of the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons from participation in, denying persons the benefits of, or subjecting persons to discrimination under such programs, policies, and activities because of their race, color, or national origin. The ARCF project levees have been designed to convey the 160,000 cfs released from Folsom Dam. All levees within the study area will be constructed to the same criteria and standard. The benefits of the ARCF project would extend to all of the Sacramento Metropolitan area; therefore it would not provide disproportionate benefits or effects to any minority or low income populations and is in compliance with EO 12989.

Executive Order 13112: Invasive Species

EO 13112, signed February 3, 1999, directs all Federal agencies to prevent and control the introduction of invasive species in a cost-effective and environmentally sound manner. The order established the National Invasive Species Council, which is composed of Federal agencies and departments, and the supporting Invasive Species Advisory Committee, which is composed of state, local, and private entities. The Council's national invasive species management plan recommends objectives and measures to implement this EO and to prevent the introduction and spread of invasive species (National Invasive Species Council, 2008). EO 13112 requires consideration of invasive species in NEPA analyses, including their identification and distribution, their potential effects, and measures to prevent or eradicate them. This discussion is included in Section 3.6, Vegetation and Wildlife, including proposed measures to prevent the spread of invasive species during construction of the proposed alternative. As a result, the ARCF GRR is in compliance with this EO.

Farmland Protection Policy Act (7 U.S.C. 4201, et seq.)

This Act requires a Federal agency to consider the effects of its actions and programs on the Nation's farmland. There is a small portion of land adjacent to the Sacramento Bypass that would be removed from production and is currently considered Prime Farmland under the Williamson Act, as discussed in the State laws below. The effects of the removal of the small piece of land are discussed in the Land Use Section of this report. The minimal amount of land which would be converted from agricultural land to open space would be considered less than significant because it is less than 1% of the total Prime Farmland in Yolo County. The Corps has completed NRCS Form DA 1006 and included it as Appendix K of this document. As a result, the ARCF project is in full compliance with this Act.

National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321, et seq.)

NEPA applies to all Federal agencies and most of the activities they manage, regulate, or fund that affect the environment. This act requires full disclosure of the environmental effects, alternatives, potential mitigation, and environmental compliance procedures of proposed actions. NEPA requires the preparation of an appropriate document to ensure that Federal agencies accomplish the law's purposes. Full compliance will be achieved when this final EIS/EIR and Record of Decision are filed with the USEPA.

National Flood Insurance Program

The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 were intended to reduce the need for large, publicly funded flood control structures and disaster relief by restricting development on floodplains. The Federal Emergency Management Agency (FEMA) manages the National Flood Insurance Program (NFIP) to subsidize flood insurance to communities that comply with FEMA regulations limiting development in floodplains. FEMA issues Flood Insurance Rate Maps (FIRMs) for communities participating in the NFIP. These maps delineate flood hazard zones in the community. The maps are designed for flood insurance purposes only and do not necessarily show all areas subject to flooding. The maps designate lands likely to be inundated during a 1% (100-year) storm event and elevations of the base flood. They also depict areas between the limits affected by 1% (100-year) and 0.2 % (500-year) events and areas of minimal flooding. FIRMs are often used to establish building pad elevations to protect new development from flooding effects. The preferred alternative would bring the American River South Basin to a 1 in 147 Annual Exceedance Probability (AEP)and the American River North Basin to a 1 in 256 AEP.

National Historic Preservation Act of 1966, as amended (54 U.S.C. 300101)

Section 106 of the National Historic Preservation Act (NHPA) requires Federal agencies to take into account the effects of a proposed undertaking on properties that have been determined to be eligible for, or included in, the National Register of Historic Places (NRHP). If cultural resource(s) have been identified during a survey, a records and literature search, through consultation, or by other means, the federal agency overseeing the project begins the process to determine whether the cultural resources is/are eligible for listing in the NRHP. Section 106 of the NHPA as amended, mandates the evaluation process. The implementing regulations for Section 106 are at 36 C.F.R. § 800 et seq.

Inventory, evaluation for listing in the NRHP, and determinations of effects to cultural resources are made by Federal agencies for cultural resources within a project's APE. For purposes of complying with Section 106 of the NHPA, a Federal agency will make a determination of the APE for the project or undertaking. The APE is defined as "the geographic areas or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." Additionally, the APE "is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking."

The APE for an undertaking may extend beyond the physical impacts associated with a project. Depending on the scale and nature of the undertaking and the known and anticipated types of cultural resources, the direct or indirect effects may include physical modification, intrusion to the visual or esthetic characteristics of landscapes or features, or even access to a historic property.

After a cultural resource has been determined eligible for listing in the NRHP, it is regarded the same as any other property that is listed and becomes formally known as a "historic property," regardless of age. The term "historic property" refers exclusively to NRHP listed or eligible properties.

For a federal project to be in compliance with Section 106, one of the following five scenarios will occur: (1) no historic properties exist in the APE; (2) the undertaking does not have the potential to affect historic properties; (3) there are known historic properties in the APE but the undertaking will not adversely affect them; (4) known historic properties will be adversely affected by the project and a memorandum of agreement (MOA) or programmatic agreement (PA) may be executed that will guide the mitigation or resolution of adverse effects; or (5) adverse effects are not known and a PA may be executed that will guide the inventory and identification of historic properties, evaluation of potential adverse effects to historic properties, and mitigation or resolution of adverse effects. For this undertaking, a PA was executed to manage the inventory and evaluation of cultural resources and mitigation of historic properties.

MOAs and PAs are negotiated between the Federal agency, the State Historic Preservation Officer (SHPO), and possibly the Advisory Council on Historic Preservation. Other entities such as the local sponsor, historic preservation groups, and Native American tribes may be invited to participate as concurring parties to MOAs and PAs. A record of the consultation for this project as it relates to compliance with Section 106 is included in Appendix C.

SHPO Consultation

In a letter dated February 2, 2012, the Corps initiated consultation with the SHPO, informing the SHPO of the proposed project and asking for comments on the determination of the APE, the proposed development of a PA, and the proposed efforts to identify historic properties within the APE. The Corps followed that consultation letter with a letter dated July 12, 2012, which transmitted the draft PA for review and comment, refined the previous determination of the APE, and informed the SHPO of the Corps' determination of the potential that the project may adversely affect historic properties, as well as the resolution of adverse effects through the execution of a PA. The Corps requested comments and proposed a meeting to discuss the project and the PA. After the formal letter sent in July, the Corps followed up with emails to the SHPO and consultation meetings with the SHPO in October and November 2012, and transmittal of the draft PA and supporting documents for the PA and the project. The draft PA and attachment was again transmitted in a letter dated June 12, 2014 and the Corps requested comments from the SHPO. The SHPO provided comments on the draft PA on August 8, 2014 and those comments have been considered for incorporation into the draft PA appended to the DEIS/DEIR. Additional comments from the SHPO provided in August and September 2015 were incorporated into the final PA, which was signed and executed by the Corps and the SHPO on September 10, 2015. Consultation with the SHPO is included in Appendix C.

ACHP Consultation

In a letter dated February 2, 2012, the Corps initiated consultation with the ACHP, informing the ACHP of the project, the planned process to comply with Section 106, and asked the ACHP to participate in the development of the PA. The Corps followed that consultation letter with a letter dated July 16, 2012, transmitting the draft PA for review and comment, and requesting that the ACHP notify the Corps if they plan to participate in the project and the PA. The ACHP responded in a letter dated August 7, 2012, by acknowledging the letters sent previously and declining to participate in the project or the PA. The ACHP requested that the final PA be filed with the ACHP once executed. The final PA was filed with the ACHP on October 30, 2015 and the ACHP acknowledged receipt in a letter dated November 2, 2015. Consultation with the ACHP is included in Appendix C.

Programmatic Agreement Development

In accordance with 36 CFR § 800.14(b), when the potential effects of a Federal agency's undertaking cannot be determined prior to approval a PA may be developed for a project. Because the Corps cannot fully determine the effects of the Undertaking on Historic Properties [36 C.F.R. § 800.14(b)(1)(ii)], for all phases and segments of the ARCF GRR at this time, in order to provide a framework for the Corps to identify cultural resources, evaluate cultural resources for their eligibility for inclusion in the NRHP, determine possible effects to historic properties, and mitigate effects to historic properties as a result of the project, the Corps determined that a PA was the appropriate means to comply with Section 106 of the NHPA for the ARCF GRR. The PA was developed in consultation with the SHPO and ACHP, and comments from DWR, the CVFPP, and SAFCA were requested. The PA was sent to potentially interested Native Americans, requesting their comments and interest in signing the PA as concurring parties. All comments from all parties were considered in the development of the PA. The executed PA is included in Appendix C.

Native American Consultation

A list of potentially interested Native Americans was obtained from the California Native American Heritage Commission in February 2011 and updated in September 2011 and February 2013. Those individuals were contacted on multiple occasions in 2011, 2012, 2013, and 2014 regarding the project and the Corps' efforts to identify cultural resources within the study area. In 2012 and 2013, the Corps met with the United Auburn Indian Community of the Auburn Rancheria, the Shingle Springs Band of Miwok Indians, and the Buena Vista Rancheria to discuss the project. In 2014, the Corps began to meet with the United Auburn Indian Community of the Auburn Rancheria and the Shingle Springs Band of Miwok Indians on a regular, quarterly basis to discuss the project. Some of the concerns brought up by Native Americans included the treatment of American Indian remains discovered during construction of the project, involvement of American Indian tribal monitors during construction, the opportunities for Native Americans to review and comment on archaeological survey reports and determinations of eligibility and affect, and the involvement of Native Americans in the identification of cultural resources sites of tribal interest, such as TCPs. The draft PA was transmitted to potentially interested Native Americans in letters dated April 5, 2013, June 6, 2013, and June 2014 requesting review and involvement from interested tribes and individuals. In letters dated December 7, 2015, the executed PA was transmitted to Native Americans, inviting them to sign the PA as concurring parties. Consultation with American Indian tribes and individuals is included in Appendix C. As part of the Section 106 compliance efforts, the PA includes stipulations for continual involvement by Native Americans throughout the implementation of the PA.

Public Involvement

In April 2013, letters to 100 historical societies, museums, state historic parks, associations with historic interests, local city and county groups, and groups of various prehistoric and historic interests were sent providing a description and map of the project and requesting information on cultural resources within the study area (Appendix C). One response, from the Center for Sacramento History, was received, noting they would keep the Corps' letter on file. In letters dated December 7, 2015, the executed PA was transmitted to selected organizations, inviting them to sign the PA as concurring parties.

Compliance with Section 106

In accordance with 36 CFR § 800, the implementing regulations of Section 106 of the NHPA, the Corps has determined that the ARCF GRR will likely result in adverse effects to historic properties. In order to take into account the effects of a proposed undertaking on historic properties, the Corps has executed a PA. The Corps has consulted with interested parties, the SHPO, the ACHP, DWR, the CVFPP, SAFCA, and American Indian tribes and individuals in the development of the PA. The PA was executed and signed by the Corps and the SHPO on September 10, 2015 and evidences the legal commitment by the Corps as the lead Federal agency to comply with Section 106 of the NHPA. With the execution of the PA the Corps is in compliance with Section 106.

Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (49 CFR Part 24)

The Uniform Relocation Act ensures the fair and equitable treatment of persons whose real property is acquired or who are displaced as a result of a Federal or Federally assisted project. All or portions of parcels within the ARCF Project footprint would need to be acquired for project construction. Federal, state, local government agencies, and others receiving Federal financial assistance for public programs and projects that require the acquisition of real property, must comply with the policies and provisions set forth in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended in 1987 (42 USC § 4601 et seq.) (Uniform Act), and implementing regulation, 49 C.F.R. Part 24. Relocation advisory services, moving costs reimbursement, replacement housing, and reimbursement for related expenses and rights of appeal are provided for in the Uniform Act.

ARCF Project implementation would require acquisition of property in the footprint to construct flood risk management facilities and improvements. Additionally, temporary relocation of residents may occur during portions of construction. Property acquisition and relocation services, compensation for living expenses for temporarily relocated residents, and negotiations regarding any compensation for temporary loss of business would be accomplished in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act.

Wild and Scenic Rivers Act (16 U.S.C. 1217, et seq.)

This act was enacted to preserve selected rivers or sections of rivers in their free-flowing condition in order to protect the quality of river waters and to fulfill other national conservation purposes. The Lower American River, below Nimbus Dam, has been included in the Federal Wild and Scenic Rivers system since 1981. The ARCF project is consistent with the land use management, flood risk reduction, and levee protection policies of the American River Parkway Plan, the management plan for the Wild and Scenic Rivers Act. These policies require that flood management agencies maintain and improve the existing flood control system, and manage vegetation in the Parkway to maintain the structural integrity and conveyance capacity of the flood control system, consistent with the need to provide a high level of flood risk reduction (Sacramento County 2008). However, due to the significant impacts to the recreation facilities within the American River Parkway, there would be direct and adverse effects to the recreational outstandingly remarkable value which is designated for the river under the Wild and Scenic Rivers Act. There would be a direct effect to the extraordinary fisheries value due to construction-related impacts, but the fisheries habitat would improve over the baseline condition with the implementation of the project due to the planting berms and additional SRA habitat that is designed into the bank protection sites. The National Park Service issued comments on the draft EIS/EIR and their comments were addressed in this final EIS/EIR, as appropriate. The final EIS/EIR will be submitted back to the National Park Service, in coordination under this Act.

5.2 State of California Laws, Regulations, and Policies

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (California PRC Sections 2621–2630) was passed by the California Legislature in 1972 to mitigate the hazard of surface faulting to structures. The Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. Local agencies must regulate most development in fault zones established by the State Geologist. Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults. As discussed in Section 3.2, the ARCF GRR study area does not contain any Alquist-Priolo Earthquake Fault Zones.

California Clean Air Act

The California Clean Air Act was signed into law in 1988 and, clearly spells out in statute California's air quality goals, planning mechanisms, regulatory strategies, and standards of progress. The California Clean Air Act provides the State with a comprehensive framework for air quality planning regulation.

The California Clean Air Act requires attainment of state ambient air quality standards by the earliest practicable date. For air districts in violation of the state ozone, carbon monoxide, sulfur dioxide, or nitrogen dioxide standards, attainment plans were required by July 1991. CARB is responsible for the development, implementation, and enforcement of California's motor vehicle pollution control program, GHG statewide emission estimates and goals, and development and enforcement of GHG emission reduction rules. A summary of the major California GHG regulations that will affect the project's GHG emissions are presented in Section 3.12. Section 202(a) of the California Clean Air Act requires projects to determine whether emission sources and emission levels significantly affect air quality based on Federal standards established by the USEPA and State standards set by CARB. Compliance with the California Clean Air Act for GHG emissions is expected with incorporated mitigation specified in Section 3.12.6. As a result, full compliance with this Act is expected with coordination with SMAQMD and preconstruction permitting.

California Endangered Species Act

This Act requires the non-Federal partner to consider the potential adverse affects to State-listed species. As a joint NEPA/CEQA document, this EIS/EIR has considered the potential effects to State-listed species, as discussed in Section 3.8. There is the potential for the ARCF project to impact the State-listed giant garter snake, however, impacts to giant garter snake are primarily addressed through Federal ESA coordination with USFWS. Additionally, the project has the potential to effect State-listed bird species, such as Swainson's hawk, burrowing owl, and purple martin, if nests are present at the construction sites. Prior to construction of any site, the Corps and the State would conduct preconstruction surveys to determine the presence of nests at construction sites. If nests are present, coordination with CDFW would occur to determine any avoidance or minimization measures that would need to be implemented to protect State-listed species. The Corps anticipates that implementation of these measures would avoid the need for any additional permits or incidental take statements from CDFW. As a result, the ARCF would be in full compliance with this Act once these surveys are conducted and coordination has occurred.

California Environmental Quality Act

CEQA requires that State and local agencies identify the significant environmental impacts of their actions, and avoid or mitigate those impacts, when feasible. The CEQA amendments of December 30, 2009, specifically require lead agencies to address GHG emissions in determining the significance of environmental effects caused by a project, and to consider feasible means to mitigate the significant effects of GHG emissions (California Natural Resources Agency 2012). The CVFPB, as the non-Federal partner, will undertake activities to ensure compliance with the requirements of this Act. CEQA requires the full disclosure of environmental effects, potential mitigation, and environmental compliance for the proposed project. The CVFPB will consider certifying the final EIR and adopting its findings. Certification of the final EIR by the CVFPB would provide full compliance with CEQA.

California Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act of 1990 (California Public Resources Code [PRC] Sections 2690–2699.6) addresses seismic hazards other than surface rupture, such as liquefaction and induced landslides. The Seismic Hazards Mapping Act specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites, and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils. The closest active fault to the ARCF GRR project is located approximately 30 miles to the northwest, as discussed in Section 3.2. As a result, there would be no significant effects on the project due to seismicity, and the ARCF study is in full compliance with this Act.

California Surface Mining and Reclamation Act

The Surface Mining and Reclamation Act of 1975 (SMARA) (PRC Sections 2710–2719) is the principal legislation addressing mineral resources in California. Surface mining operations include, "…borrow pitting, streambed skimming, segregation and stockpiling of mined materials (and recovery of the same) …" (CCR, Title 14, Section 3501). Section 3501 further defines excavations for on-site construction as "earth material moving activities that are required to prepare a site for construction of structures, landscaping, or other land improvements (such as excavation, grading, compaction, and the creation of fills and embankments), or that in and of themselves constitute engineered works (such as dams, road cuts, fills, and catchment basins)." SMARA was enacted in response to land use conflicts between urban growth and essential mineral production. Its stated purpose is to provide a comprehensive surface mining and reclamation policy that will encourage the production and conservation of mineral resources while ensuring that; significant environmental effects of mining are prevented or minimized, mined lands are reclaimed and residual hazards to public health and safety are eliminated, and consideration is given to recreation, watershed, wildlife, aesthetic, and other related values.

The SMARA statute requires mitigation to reduce adverse impacts on public health, property, and the environment. Because borrow activities associated with the ARCF GRR project, would disturb more than 1 acre or remove more than 1,000 cubic yards of material through surface mining activities, including the excavation of borrow pits for soil material, the project proponent(s) must comply with SMARA. SMARA governs the use and conservation of a wide variety of mineral resources, although some resources and activities are exempt from its provisions, including excavation and grading conducted for farming, construction, or recovery from flooding or other natural disaster.

The State Mining and Geology Board reviews the local ordinances to ensure that they meet the procedures established by SMARA. In general, SMARA permitting requires lead agency approval of a permit, a reclamation plan, and the posting of approved financial assurance for the reclamation of mined land. Cities and counties have the authority to enforce SMARA and create additional regulations.

Sacramento, Sutter, and Yolo Counties are the SMARA lead agencies for surface mining operations in their respective counties within the ARCF GRR study area. Compliance is achieved by either obtaining a SMARA permit or exemption.

Plate 6 displays all potential borrow sites that would supply soil borrow for the Common Features project construction. SMARA permits or exemptions would be obtained, as appropriate, for selected borrow sites. Excavation activities would not commence until all regulatory and compliance requirements for borrow activities have been met.

California Water Code

The ARCF study is located within the jurisdiction of the Central Valley RWQCB, within the greater Sacramento Valley watershed. The preparation and adoption of water quality control plans, or Basin Plans, and statewide plans, is the responsibility of the SWRCB. State law requires that Basin Plans conform to the policies set forth in the California Water Code beginning with Section 13000 and any State policy for water quality control. These plans are required by the California Water Code (Section 13240) and supported by the Federal CWA. Section 303 of the CWA requires states to adopt water quality standards which "consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses." According to Section 13050 of the California Water Code, Basin Plans consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected and water quality objectives to protect those uses. Adherence to Basin Plan water quality objectives protects continued beneficial uses of water bodies. Because beneficial uses, together with their corresponding water quality objectives, can be defined per Federal regulations as water quality standards, the Basin Plans are regulatory references for meeting the State and Federal requirements for water quality control (40 CFR 131.20). The potential effects of the proposed project on water quality have been evaluated and are discussed in Section 3.5. Compliance with the California Water Code will be accomplished by obtaining certifications from the Central Valley RWQCB and 404 review internally by the Corps.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act of 1970 established the SWRCB and nine RWQCBs within the State of California. These groups are the primary state agencies responsible for protecting California water quality to meet present and future beneficial uses and regulating appropriative surface rights allocations. The preparation and adoption of water quality control plans, or Basin Plans, and statewide plans, is the responsibility of the SWRCB. State law requires that Basin Plans conform to the policies set forth in the California Water Code beginning with Section 13000 and any State policy for water quality control. These plans are required by the California Water Code (Section 13240) and supported by the Federal CWA. Section 303 of the CWA requires states to adopt water quality standards which "consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses." According to Section 13050 of the California Water

Code, Basin Plans consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected and water quality objectives to protect those uses. Adherence to Basin Plan water quality objectives protects continued beneficial uses of water bodies. The potential effects of the proposed project on water quality have been evaluated and are discussed in Section 3.5. This project expects to achieve full compliance with the Water Quality Control act by achieving compliance with RWQCB certification mandates for Section 401 of the Federal CWA.

6.0 CONSULTATION AND COORDINATION

This chapter summarizes public and agency involvement activities undertaken by the Corps, CVFPB, and SAFCA that have been conducted to date, are ongoing, and/or will be conducted for this project, and which satisfy NEPA and CEQA requirements for public scoping and agency consultation and coordination. Additionally, Native American consultation activities are described.

6.1 Public Involvement Under NEPA and CEQA

The Lead Agencies have implemented a comprehensive public participation program to fully inform and engage potentially affected agencies, stakeholders and communities. This section describes public involvement to date and future steps to be taken with the public.

6.1.1 Notice of Intent, Notice of Preparation, and Scoping Meetings

To announce the start of the Common Features General Reevaluation Study, a notice of intent (NOI) to prepare the ARCF GRR EIS was posted in the Federal Register (Vol. 73, No. 41) on February 29, 2008. The CVFPB published the NOP with the State Clearinghouse on February 27, 2008. The recipients were invited to comment on the results of the earlier completed reconnaissance study and to provide input to the feasibility study, including the scoping of the environmental issues that should be addressed throughout the study. A series of public scoping meetings were held in March 2008 to present information to the public and to receive public comments on the scope of the EIS. The meeting locations, dates and times were as follows:

- March 5, Scottish Rite Center—6 151 H Street, Sacramento (5 to 7 p.m.).
- March 10, Library Galleria—828 I Street, Sacramento (3 to 6 p.m.).
- March 12, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5 to 7 p.m.).
- March 13, Sierra Health Foundation— 1321 Garden Highway, Sacramento (5 to 7 p.m.).

There is no mandated time limit to receive written comments in response to the NOI under NEPA. Appendix F contains the NOI, NOP, the one comment letter received in 2008 (which is also summarized in Table 52), and copies of the posters for the March 2008 scoping meetings.

Table 52. Written Comments Received on the NOI.

Commenter	Date
California Department of Transportation	April 1, 2008
• Requests clarification as to which portions of the project will use trucks to haul materials and which will use waterside barges for hauling materials. • Requests a Traffic Management Plan including necessary mitigation, haul routes, dates of operation, and truck trip volumes be prepared in order for review. • Notes that an encroachment permit will be required if electronic warning signs will be used within State right-of-way at work sites to warn public of trucks entering or leaving state highways. • Expresses concern about piezometer locations and wells near the subgrade section of I-5 (the Boat Section) and requests these sites be identified and not be disturbed during levee improvement. • Requests maps describing the project "activity areas" and clarification of the scope of the project and potential impacted highway and bridge structure areas. • Requests identification and notification of any work near State right-of-way.	

The Corps considered CalTrans' scoping comments in the following ways:

- The Corps is considering the use of waterside barges to construct the bank protection sites on the Sacramento River in order to reduce damages to roadways associated with the hauling of rock.
- Maps of the study area were provided to CalTrans through the submittal of the draft EIS/EIR to public review, as discussed in Section 6.1.2 below.
- A Traffic Management Plan and all appropriate permits would be prepared and coordinated during the project's design phase and would be in place, as appropriate, prior to the start of construction.

6.1.2 Public Review

The draft GRR and EIS/EIR were circulated for public review beginning on March 13, 2015. The notice of availability (NOA) was published in the Federal Register on March 13, 2015. The draft GRR and EIS/EIR were made available both on the Sacramento District, Corps of Engineers website as well as on the website for the Central Valley Flood Protection Board. Hard copies of the draft GRR and EIS/EIR were provided to area libraries. Letters and/or DVD copies of the GRR and EIS/EIR were sent to interested parties, local residents, and to the agencies and elected officials listed in Section 6.4 of the EIS/EIR. Public workshops were held during the review period to provide additional opportunities for comments on the draft documents. All comments received during the public review period were considered and incorporated into the final GRR and EIS/EIR as appropriate. The meeting locations, dates and times were as follows:

- April 8, Hagginwood Community Center—3270 Marysville Blvd, Sacramento (5 to 7 p.m.).
- April 9, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5 to 7 p.m.).
- April 15, Library Galleria—828 I Street, Sacramento (3 to 5 p.m.).
- April 17, Arden-Dimick Library— 891 Watt Ave., Sacramento (5 to 7 p.m.).

A total of 137 people attended the four meetings. Comments were solicited at the meetings and documented through the use of court reporters and comment cards at the meetings. Additionally, comments could be submitted through mail or electronic mail. Oral and written comments were submitted throughout the series of meetings by local, State, and Federal agencies, community organizations, and individuals.

The most significant public comments on the draft documents focused on: 1) access to recreational features during and after construction; 2) design, placement and justification for rock erosion protection along the American and Sacramento Rivers; 3) effects to vegetation as a result of the recommendations; 4) clear presentation of the anticipated level of the performance of the project; and 5) coordination with stakeholders in future phases of the project. The full array of comments and the associated responses to them are included in the Public Involvement Appendix (Appendix F).

Comments on the draft documents received from reviewers and the public were incorporated in to the final documents as appropriate. Many of the comments requested greater clarity and the documents were modified in response to these requests. The comments did not result in a recommendation of a different plan.

6.1.2 Next Steps in the Environmental Review Process

A Notice of Availability will be published in the Federal Register and local newspapers, indicating that the final EIS will be available for a 30-day review period before the Corps makes a final decision on the preferred alternative, which would be submitted to Congress for authorization. Additionally, the Final EIS will be distributed to all individuals and agencies who commented on the draft EIS. After considering any additional comments, the Corps will sign a Record of Decision (ROD) for the project. The ROD is a written, public record explaining why the Corps chose a particular course of action. The selected action and any practicable mitigation measures will be identified in the ROD. The proposed action cannot be initiated before the ROD is signed. In addition, project construction is also contingent on congressional authorization of the project and subsequent appropriation of funds to design and construct the project.

6.1.3 Major Areas of Controversy

Based on the comments received, the major areas of public controversy associated with the project are:

- Temporary construction related effects on residents and businesses adjacent to the project levees;
- Construction related impacts on cultural and biological resources;
- Vegetation and tree removal;
- Impacts to recreation facilities;
- Impacts to endangered species and their habitat;
- Impacts to cultural resources and tribe/tribal concerns.

6.2 Native American Consultation

A list of potentially interested Native Americans was obtained from the California Native American Heritage Commission in February 2011 and updated in September 2011 and February 2013. Those individuals were contacted on multiple occasions in 2011, 2012, 2013, and 2014 regarding the project and the Corps' efforts to identify cultural resources within the study area. In 2012 and 2013, the Corps met with the United Auburn Indian Community of the Auburn Rancheria, the Shingle Springs Band of Miwok Indians, and the Buena Vista Rancheria to discuss the project. In 2014, the Corps began to meet with the United Auburn Indian Community of the Auburn Rancheria and the Shingle Springs Band of Miwok Indians on a regular, quarterly basis to discuss the project. Some of the concerns brought up by Native Americans included the treatment of American Indian remains discovered during construction of the project, involvement of American Indian tribal monitors during construction, the opportunities for Native Americans to review and comment on archaeological survey reports and determinations of eligibility and affect, and the involvement of Native Americans in the identification of cultural resources sites of tribal interest, such as TCPs. The draft PA was transmitted to potentially interested Native Americans in letters dated April 5, 2013, June 6, 2013, and June 2014 requesting review and involvement from interested tribes and individuals. Documents pertaining to consultation with American Indian tribes and individuals is included in Appendix C. As part of the Section 106 compliance efforts, the PA includes stipulations for continual involvement by Native Americans throughout the execution of the PA.

6.3 Coordination with Other Federal, State, and Local Agencies

Chapter 5.0 "Compliance with Applicable Laws, Policies, and Plans" describes the project's compliance with applicable Federal laws and regulations, including consultation to date with various Federal agencies. The following briefly summarizes these consultation and coordination efforts. See Chapter 5.0 for additional details.

The Corps has coordinated with USFWS throughout the planning phase of the study to help analyze potential effects to endangered species and biological resources under the Fish and Wildlife Coordination Act. The CAR is included as Appendix A of this document. A biological assessment was prepared and transmitted to USFWS and NMFS on April 3, 2015 (Appendix G). Consultation pursuant to Section 7 of the Endangered Species Act (ESA) has been on-going as part of the ARCF GRR study phase. The Biological Opinion from NMFS was received on September 9, 2015. The Biological Opinion from USFWS was received on September 11, 2015. With receipt of these opinions from the services, and implementation of the enclosed reasonable and prudent measures and terms and conditions, the ARCF GRR is in full compliance with the Federal ESA. In addition, the Corps coordinated with NMFS under the Magnuson-Stevens Fishery and Conservation Act to address impacts to Essential Fish Habitat. The final Biological Opinions from both agencies are included with this document as Appendix J.

This document has been coordinated with the CVFPB and SAFCA as the non-Federal and local sponsors to ensure that the project is supportable by both agencies, and to ensure appropriate compliance with State and local laws and regulations.

Coordination with the SHPO was conducted during the early planning phase of this study and has continued through development of this document and the PA to comply with Section 106 of the NHPA..

Coordination with the SMAQMD occurred regularly throughout the planning phase to ensure that the project was addressing all appropriate air quality laws and regulations. In addition, coordination occurred with the U.S. EPA during the public review period.

The draft EIS/EIR was provided to the National Park Service for review under the Federal Wild and Scenic Rivers Act. The National Park Service issued comments on the draft EIS/EIR and the Corps has included responses to their comments in Appendix F. Additional analysis of effects to the American River Parkway in accordance with the Federal Wild and Scenic Rivers Act has been included throughout the final EIS/EIR. The Corps will coordinate further with the National Park Service during site-specific design development on the American River in order to ensure compliance with the Federal Wild and Scenic Rivers Act.

This document was circulated to those listed in Section 6.4 for public comments. Comments received were incorporated, as appropriate. The officials and agencies listed in Section 6.4 will also receive a copy of the final EIS/EIR upon its release.

6.4 List of Recipients

The following Federal, State, and local agencies and organizations received copies of the draft EIS/EIR or a notification of the document's availability. Individuals who may be affected by the project or who have expressed interest through the public involvement process will also be notified. These agencies and representatives will also receive copies of the final EIS/EIR during the 30-day public review period.

6.4.1 Elected Officials and Representatives

Governor of California
- Honorable Edmund G. Brown, Jr.

United States Senate
- Honorable Barbara Boxer
- Honorable Dianne Feinstein

United States House of Representatives
- Honorable Doris Matsui
- Honorable Michael Thompson
- Honorable Ami Bera
- Honorable Tom McClintock

California State Senate
- Honorable Richard Pan
- Honorable Ted Gaines
- Honorable Lois Wolk

California State Assembly
- Honorable Kevin McCarty
- Honorable Bill Dodd
- Honorable Jim Cooper

Sacramento County

Supervisor Phil Serna
Supervisor Patrick Kennedy
Supervisor Susan Peters
Supervisor Roberta MacGlashan
Supervisor Don Nottoli

Yolo County

Supervisor Oscar Villegas
Supervisor Don Saylor
Supervisor Matt Rexroad
Supervisor Jim Provenza
Supervisor Duane Chamberlain

City of Sacramento

Mayor Kevin Johnson
Councilmember Angelique Ashby
Councilmember Allen Warren
Councilmember Jeff Harris
Councilmember Steven Hansen
Councilmember Jay Jennings, II
Councilmember Larry Carr

6.4.2 Government Departments and Agencies

Federal Government Agencies

- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Federal Emergency Management Agency
- U.S. Geological Survey
- Natural Resources Conservation Service
- U.S. Bureau of Reclamation
- National Park Service

State of California Government Agencies

- California Air Resources Board
- Delta Stewardship Council
- Delta Protection Commission
- Central Valley Flood Protection Board
- Central Valley Regional Water Quality Control Board
- California Department of Conservation
- California Department of Fish and Wildlife
- California Department of Parks and Recreation
- California Department of Transportation
- California Department of Water Resources
- Native American Heritage Commission
- California State Office of Historic Preservation
- California State Clearinghouse
- California State Lands Commission
- California State Water Resources Control Board
- Governor's Office of Emergency Services

Regional, County, and City Agencies

- American River Flood Control District
- Sacramento Area Flood Control Agency
- City of Sacramento
- Sacramento County
- Yolo County
- City of West Sacramento
- Sacramento Metropolitan Air Quality Management District
- Sacramento Municipal Utility District
- Yolo-Solano Air Quality Management District

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8.0 LIST OF PREPARERS

This EIS/EIR was prepared by the U.S. Army Corps of Engineers, Sacramento District. The following is a list of individuals representing the Corps who prepared sections of the EIS/EIR, provided significant background materials, provided project description engineering details, participated in preparing the EIS/EIR, or conducted internal technical reviews of the EIS/EIR.

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The following individuals participated in the preparation of the EIS/EIR, provided background materials or technical information, and reviewed the EIS/EIR for the non-Federal and local sponsors of the project.

Table 54. Sponsors' List of Preparers.

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PLATES

Plate 1. Watershed Map

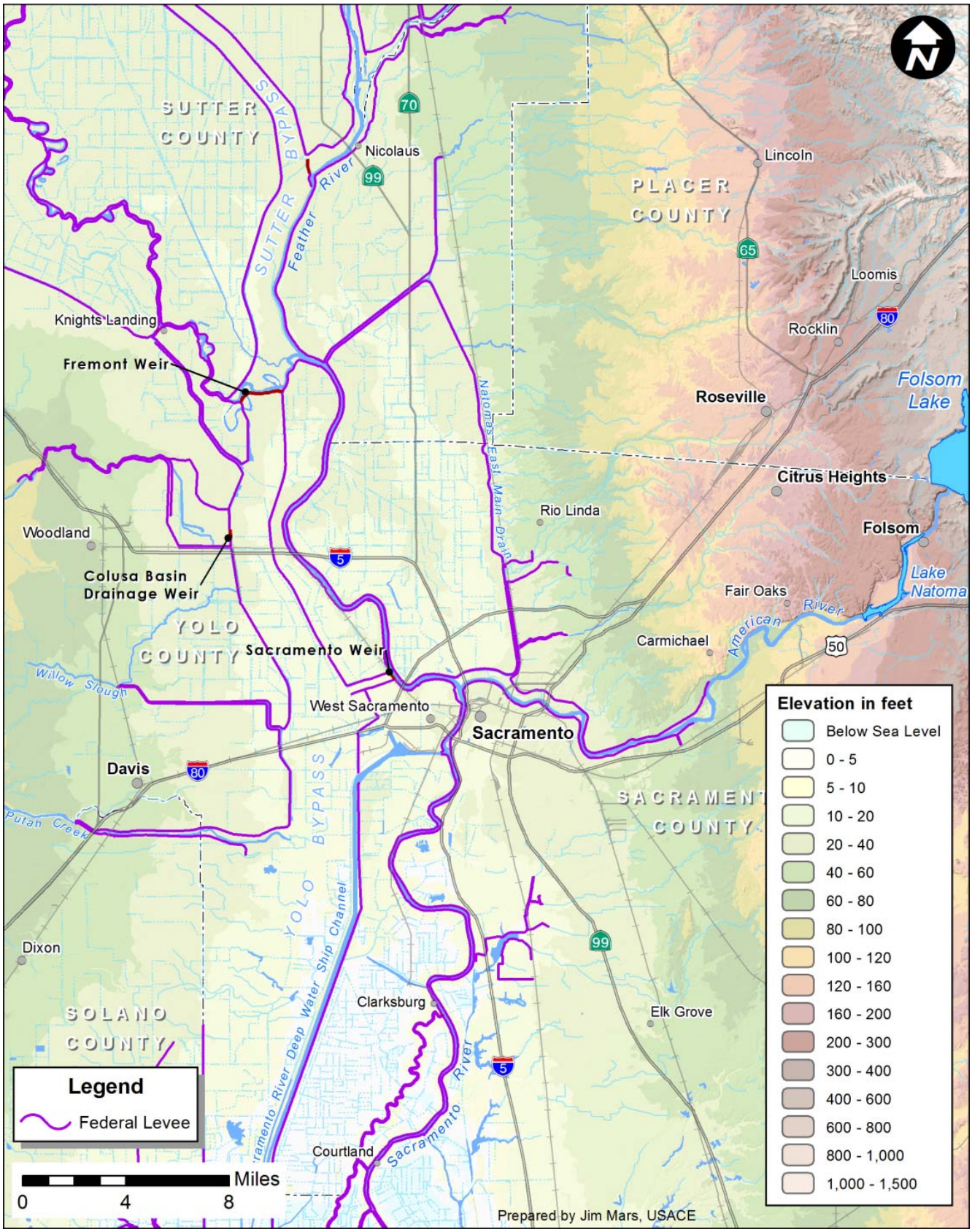
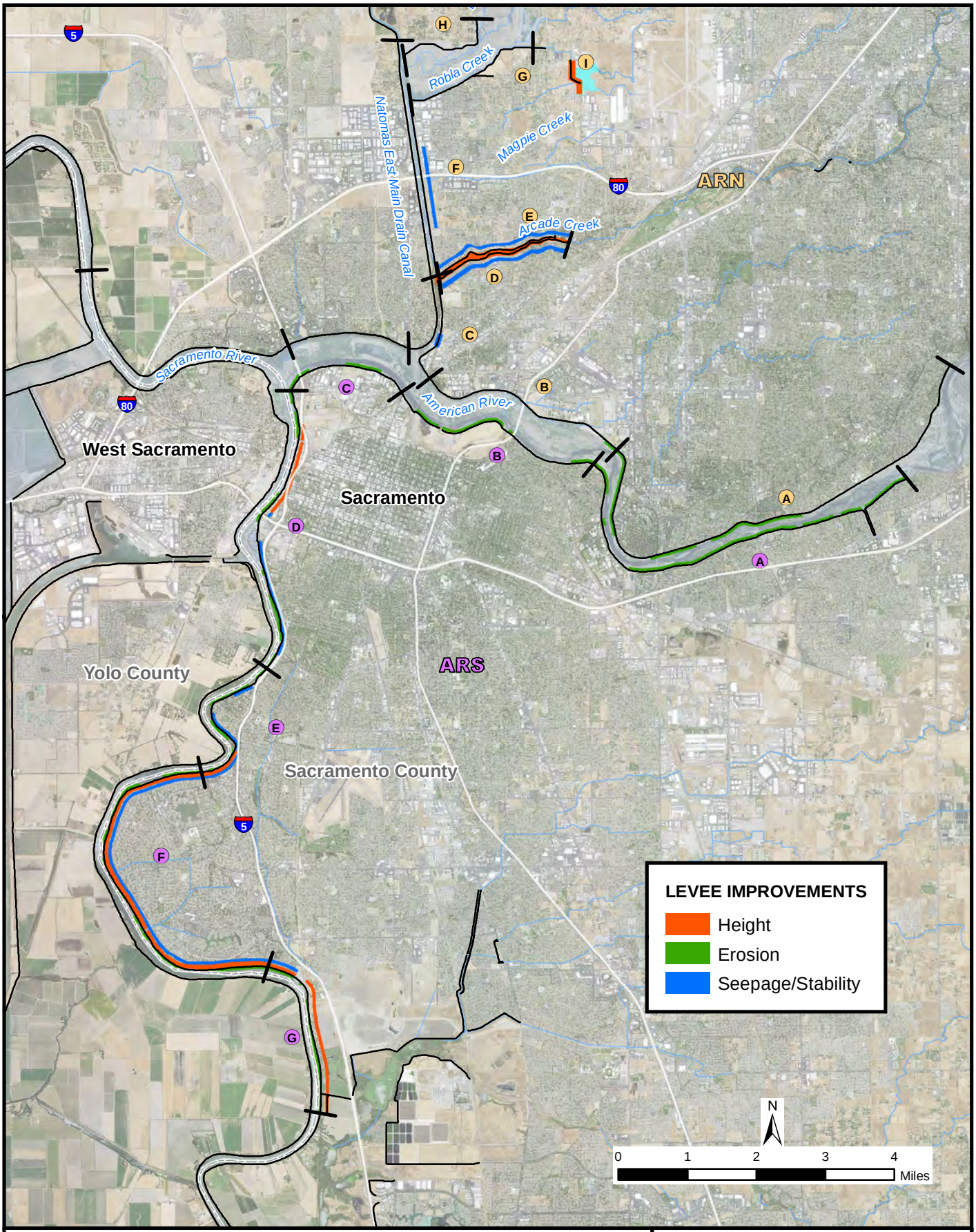


Plate 2. Study Area Map.



Legend

- Levee
- County Lines
- Magpie Creek 100 Yr Floodplain
- Floodways
- B Reaches

PLATE 3

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

LEVEE IMPROVEMENTS ALTERNATIVE 1

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

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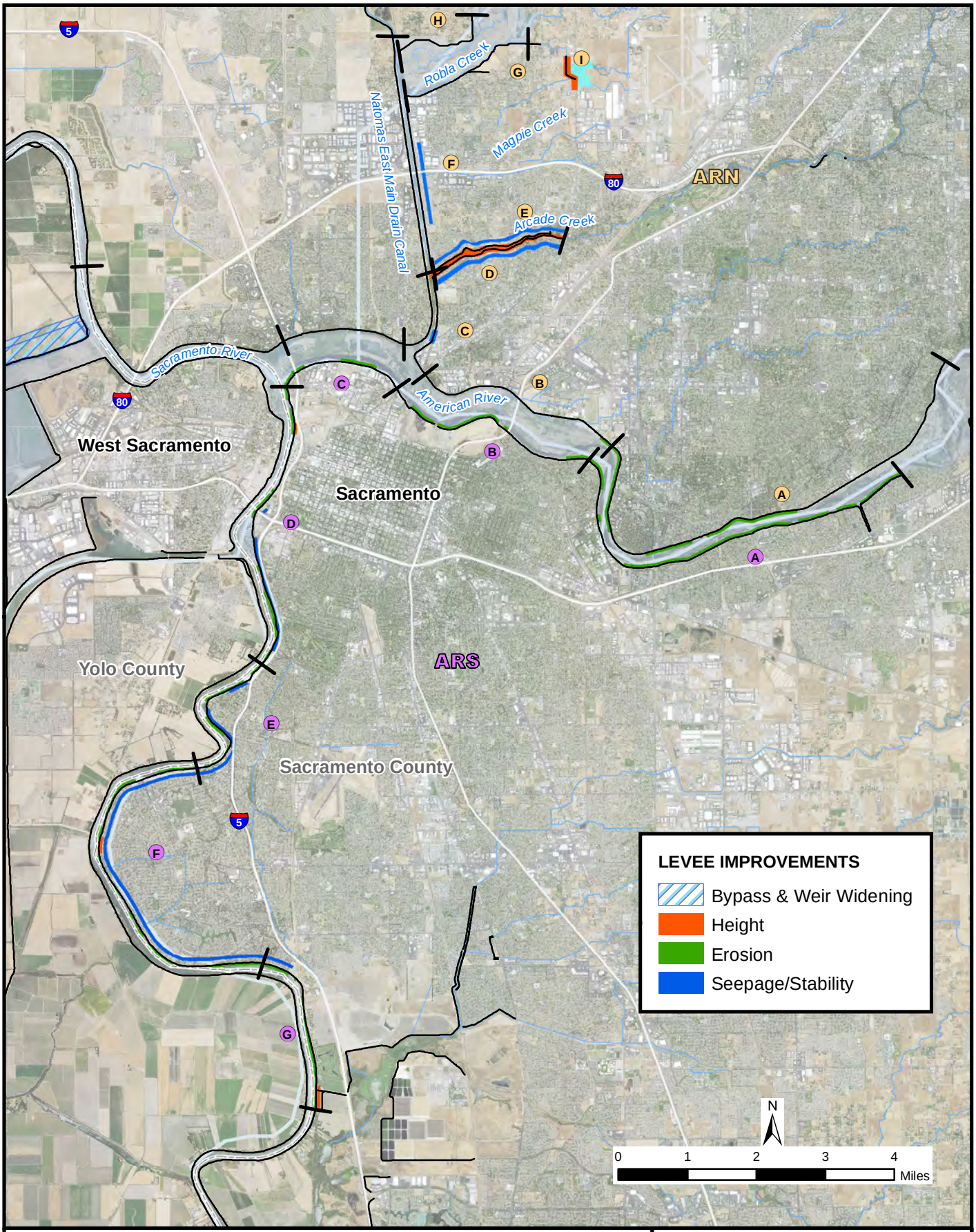

Legend

- Levee
- County Lines
- Magpie Creek 100 Yr Floodplain
- Floodways
- Reaches (B)

PLATE 4

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

LEVEE IMPROVEMENTS
ALTERNATIVE 2

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

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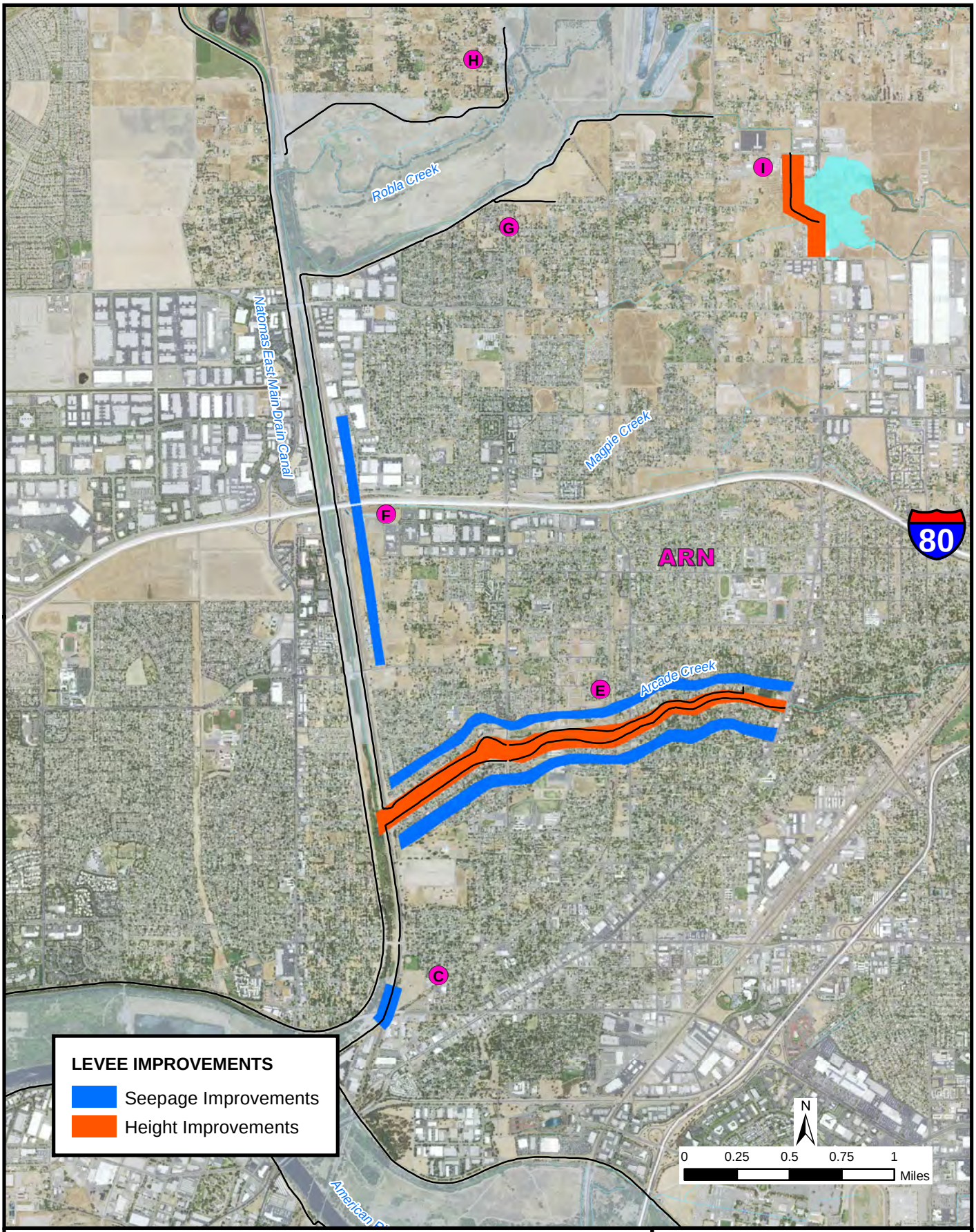

Legend

- Levee
- Floodways
- County Lines
- Magpie Creek 100 Yr Floodplain
- B Reaches

PLATE 5

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER NORTH LEVEE IMPROVEMENTS NEMDC, ARCADE, DRY, ROBLA, & MAGPIE CREEKS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

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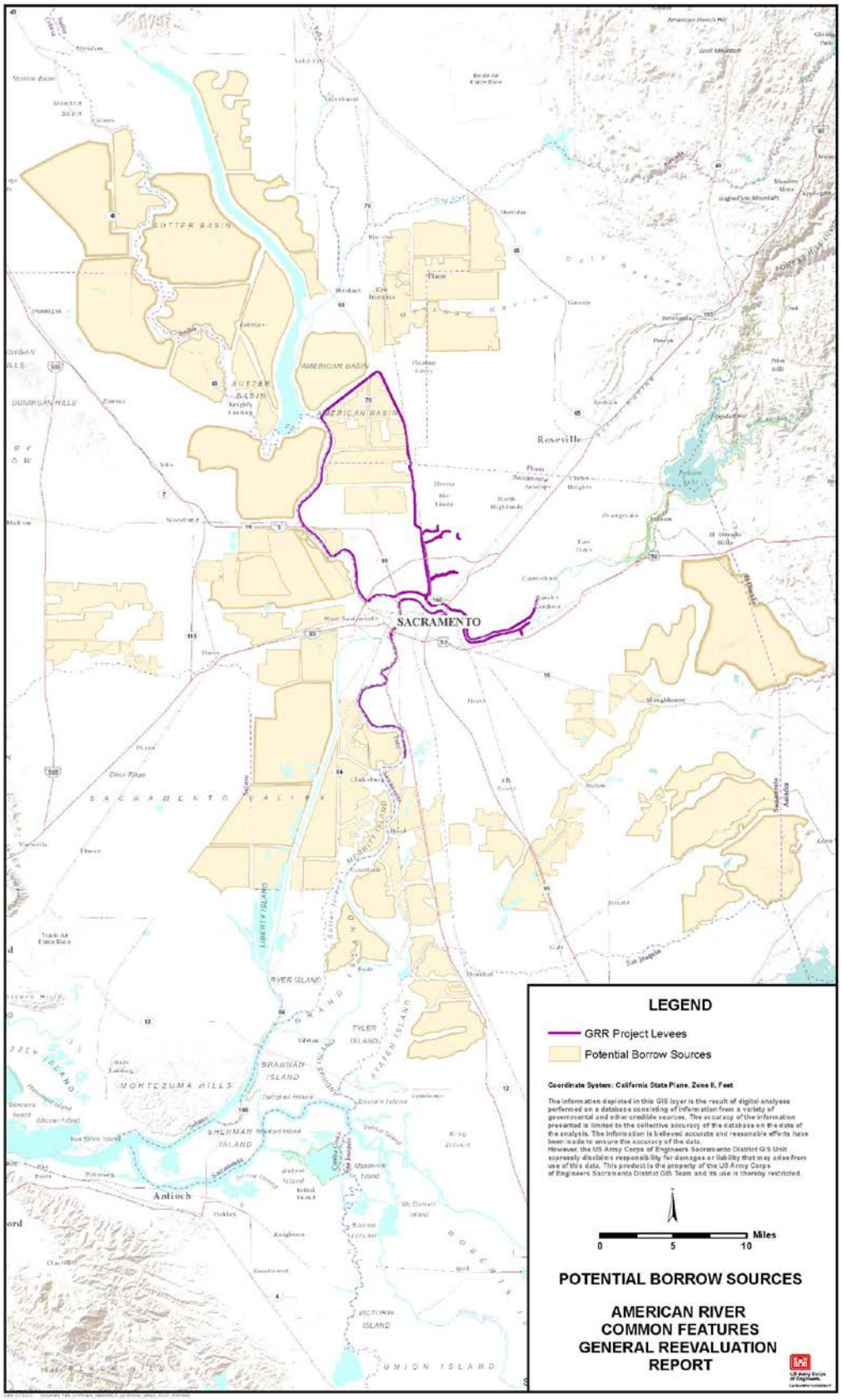
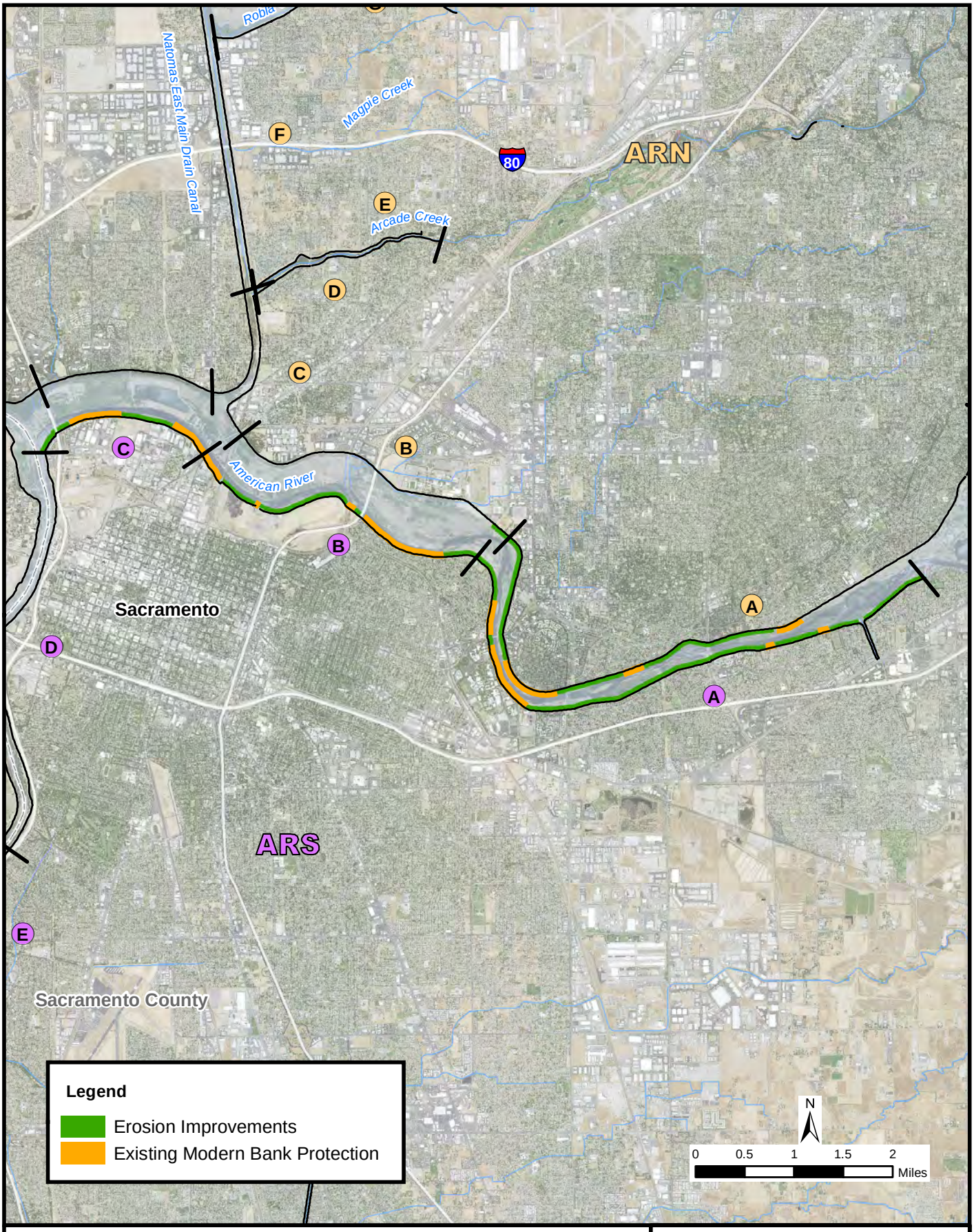


Plate 6. Potential Borrow Sites.



Legend

- Levee
- Floodways
- County Lines
- B Reaches

PLATE 7

AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA

AMERICAN RIVER
LEVEE IMPROVEMENTS
ALTERNATIVE 2

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825-1846

In Reply Refer to:
08ESMF00-
2013-CPA-0020

OCT - 5 2015

Alicia E. Kirchner
Chief, Planning Division
Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814-2922

Dear Ms. Kirchner:

The U.S. Army Corps of Engineers' (Corps) has requested coordination under the Fish and Wildlife Coordination Act (FWCA) for the American River Common Features General Re-evaluation Report (GRR) project. The proposed flood risk management construction would occur along the lower American River and the Sacramento River in Sacramento County, California. The enclosed report constitutes the U.S. Fish and Wildlife Service's draft FWCA report for the proposed project. A draft FWCA report was provided to the Corps and other state and federal resource agencies on September 20, 2013. We did not receive any comments on the draft FWCA report.

If you have any questions regarding this report on the proposed project, please contact Jennifer Hobbs, Fish and Wildlife Biologist, at (916) 414-6541.

Sincerely,

for Jennifer M. Norris
Field Supervisor

Enclosure:

cc:
Anne Baker, COE, Sacramento, CA
Amy Kennedy, CDFW, Rancho Cordova, CA
Howard Brown, NOAA Fisheries, Sacramento, CA
Steve Schoenberg, Bay Delta Fish and Wildlife Office, Sacramento, CA

OCT - 5 2015

FISH AND WILDLIFE COORDINATION ACT REPORT
AMERICAN RIVER COMMON FEATURES
GENERAL RE-EVALUATION REPORT PROJECT

OCTOBER 2015

BACKGROUND

In February 1986, major storms in northern California caused record flows along the American River. Water releases from Folsom Reservoir into the American River, in combination with high flows on the Sacramento River, almost caused catastrophic flooding to the city of Sacramento and surrounding areas. The result of the February 1986 storms raised concerns over the adequacy of the existing flood control system, which led to a series of investigations to provide additional flood protection to the Sacramento area.

The U.S. Army Corps of Engineers (Corps) completed an initial feasibility study in December 1991 for the American River and Natomas Basin areas. The feasibility report recommended the construction of a concrete gravity flood detention dam just downstream of the confluence of the North and Middle Forks of the American River, and for levee improvements downstream of Folsom Dam. Due to environmental and cost concerns, Congress chose not to authorize the proposed detention dam and instead directed the Corps to supplement the analysis of flood control options considered in the 1991 study.

A supplemental study was completed and presented in the *Supplemental Information Report American River Watershed Project, California*, dated March 1996. The report presented three possible flood control plans: (1) the construction of the concrete gravity flood detention dam recommended in the 1991 report; (2) Folsom Dam improvements; and (3) a stepped release plan for Folsom Dam releases. The report also concluded that levee improvements downstream of Folsom Dam were needed and that these levee improvements were "common" to all three plans. Under the Water Resources Development Act of 1996 (WRDA 96), Congress authorized the American River Common Features Project (Common Features Project), which included levee modifications on both banks of the American River, levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal, installation of streamflow gauges upstream from Folsom Reservoir, modification of the flood warning system along the lower American River, and continued interim reoperation of Folsom Reservoir for flood control.

In 1999, Congress decided to authorize improvements to Folsom Dam to control a 200-year flood event with a peak release of 160,000 cubic feet per second (cfs) from the dam. By doing this, improvements to levees downstream of Folsom Dam could be fine-tuned to work closely with the Folsom Dam improvements being discussed by Congress. Subsequently, the Common Features Project was modified by the Water Resources Development Act of 1999 (WRDA 99) to include additional features so the American River could safely convey an emergency release of 160,000 cfs. Also authorized under WRDA 99 was the Folsom Dam Modification project, which would allow for larger releases from Folsom Dam earlier in a flood event. At the same time, Congress also directed the Corps to review additional modifications to the flood storage of Folsom Dam to maximize the use of the dam for flood damage reduction prior to consideration of any additional storage on the American River. The Folsom Dam Raise project was subsequently authorized by Congress in 2004.

Major construction components for the Common Features Project under the WRDA 96 authorization include construction of seepage remediation along about 22 miles of the American River levees. Under the WRDA 99 authorization, the major construction components include construction of seepage remediation and levee raises along four stretches of the American River. All Common Features Project features authorized under WRDA 96 and WRDA 99 have been constructed or are in design analysis for construction, and the U.S. Fish and Wildlife Service (Service) has previously coordinated with the Corps on the various aspects of the Common Features Project.

Deep under-seepage became a significant concern along the American River levees following a flood event in 1997. Since the levee improvements along the American River were still in the design phase, remediation of deep under-seepage needed to be included in the design plans. This additional effort led to considerable cost increases over what was originally authorized by Congress for the Common Features Project, including the WRDA 99 improvements that had already increased the cost of the original WRDA 96 authorization.

The Folsom Dam Post Authorization Change Report and the Economic Re-evaluation Report for Folsom Dam Improvements revealed that additional levee improvements were needed on the American and Sacramento Rivers in order to truly capture the benefits of the Folsom Dam projects. These levee deficiencies consisted primarily of erosion concerns on the American River, and seepage, stability, erosion, and height deficiencies on the Sacramento River downstream of its confluence with the American River. However, the full extent of these levee deficiencies was not known and additional re-evaluation studies were needed for the flood basins that comprise the city of Sacramento.

The purpose of the Common Features Project is to reduce the flood risk for the city of Sacramento. The following problems were identified within the Sacramento levee system:

- seepage and underseepage;
- levee erosion;
- levee stability;
- levee overtopping;
- access for maintenance and flood fighting;
- vegetation and encroachments;
- releases from Folsom Dam;
- floodplain management; and
- additional upstream storage from existing reservoirs.

DESCRIPTION OF PROJECT AREA

The project area is located along the Sacramento and American River watersheds. The Sacramento River watershed covers 26,000 square miles in central and northern California. Major tributaries of the Sacramento River include the Feather, Yuba, and American Rivers. The American River watershed covers about 2,100 square miles northeast of Sacramento and includes portions of Placer, El Dorado, Alpine, and Sacramento counties. The American River watershed includes Folsom Dam and Folsom Reservoir; inflowing rivers and streams, including the North, South and Middle forks of the American River; and the American River downstream to its confluence with the Sacramento

River in the city of Sacramento. The Sacramento and American rivers form a floodplain covering roughly 110,000 acres at their confluence. This floodplain includes most of the developed portions of the city of Sacramento.

The American River Common Features GRR study area includes: about 12 miles of the north and south banks of the American River immediately upstream of its confluence with the Sacramento River; the east bank of the Natomas East Main Drainage Canal (NEMDC), Dry Creek, Robla Creek, Arcade Creek, and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); the east bank of the Sacramento River downstream from the American River to the town of Freeport, where the levee ties into the Beach Lake levee; and the Sacramento Weir and Bypass, which is located along the north edge of the city of West Sacramento.

Within the greater project area, there are four distinct flood basins: the American River North Basin, the American River South Basin, the Sacramento Bypass and the Natomas Basin. These basins are described in further detail below.

The American River North Basin is located north of the American River and east of the city of Natomas, and includes the North Sacramento and Arden Arcade communities. Project construction in this basin includes the levees on the north bank of the American River, levees on the east bank of NEMDC, and levees along Arcade Creek, Dry/Robla Creek, and the Magpie Creek Diversion Channel.

The American River South Basin is located south of the American River and east of the Sacramento River. Communities protected by these project levees include Downtown Sacramento, Land Park, Pocket-Meadowview, East Sacramento, South Sacramento and Rancho Cordova. Project construction in this basin would be limited to the south bank of the American River and the east bank of the Sacramento River.

The Sacramento Bypass is located in Yolo County, about 4 miles west of the city of Sacramento and along the northern edge of the city of West Sacramento. The Sacramento Weir runs along the west bank of the Sacramento River and connects the river to the Bypass. The Bypass is located in a rural area owned by the State of California and operated as the Sacramento Bypass Wildlife Area.

The Natomas Basin is located in the northern portion of the study area and is located east of the Sacramento River, west of NEMDC, and north of the American River. The Natomas Basin is considered to be a part of the study area, as described by the GRR; however, the proposed measures to raise the height of the Natomas Basin levees were previously analyzed in the Natomas Levee Improvement Program, Phase 4b Landside Improvements Project (NLIP Phase 4b Project) in 2010. Therefore, the Natomas Basin will not be analyzed in this document.

PROJECT DESCRIPTION

The purpose of the Common Features GRR is to determine if there is a Federal interest in modifying the authorized Common Features Project for flood risk management in the greater Sacramento area. National Environmental Policy Act (NEPA) evaluation is required when a major Federal action is under consideration and may have impacts on the quality of the natural and human environment. The Corps has determined that the proposed project may have significant effects on the environment and therefore, an EIS is required.

The Common Features GRR has identified a number of problems associated with the flood risk management system protecting the city of Sacramento and surrounding areas. There is a high probability that flows in the American and Sacramento Rivers would stress the network of levees protecting Sacramento to the point that levees could fail. The consequences of such a levee failure would be catastrophic since the area inundated by flood water is highly urbanized and the flooding could be up to 20 feet deep.

A wide variety of management measures were developed and then evaluated and screened to address the planning objectives to remedy the Sacramento area levee problems. Formulation strategies were then developed to address various combinations of the planning objectives and planning constraints. The formulation strategies used to address the objectives and constraints included measures to reduce flood stages, address seepage and underseepage, address stability, address erosion, address maintenance/emergency response access, and achieve the urban levee level of protection. Based upon these strategies, various combinations of the measures were assembled to form an array of preliminary plans. The preliminary plans were then evaluated, screened, and reformulated, resulting in a final array of alternatives. From this final array of alternatives, a tentatively selected plan was identified.

No Action Alternative

The Corps is required to consider a No Action Alternative as one of the alternatives for selection in order to comply with the requirements of NEPA. With the No Action Alternative, it is assumed that no additional features would be implemented by the Corps or by local interests to achieve the planning objectives over and above those elements of the previously authorized Common Features Project.

Under the No Action Alternative the Corps would not conduct any additional work to address seepage, slope stability, overtopping, or erosion concerns in the Sacramento metropolitan area. As a result, if a high flow event were to occur, the Sacramento area would remain at risk of a possible levee failure.

The urban development within the project area would continue to be at risk of flooding and lives would continue to be threatened. The levees within the study area could fail and result in a catastrophic disaster. If a levee failure were to occur, major government facilities would be impacted until the flood waters recede. Within the study area are many transportation corridors that could be flooded as well if the levees were to fail.

Alternative 1: Fix Levees in Place

Alternative 1 involves the construction of fix-in-place levee remediation measures to address seepage, stability, erosion, and overtopping concerns identified for the American and Sacramento river levees, and the East Side Tributaries. In addition, Alternative 1 would include levee raises for the Natomas Basin, which were analyzed under NEPA in the NLIP Phase 4b Project EIS/EIR in 2010. As a result, this FWCA report incorporates the analysis of the levee raise by reference, but is not discussed within this report.
Due to the urban nature and proximity of existing development within the American River North and South Basins, Alternative 1 proposes fix in place remediation. The purpose of this alternative would be to improve the flood damage reduction system to safely convey flows to a level that

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The urban development within the project area would continue to be at risk of flooding and lives would continue to be threatened. The levees within the study area could fail and result in a catastrophic disaster. If a levee failure were to occur, major government facilities would be impacted until the flood waters recede. Within the study area are many transportation corridors that could be flooded as well if the levees were to fail.

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Due to the urban nature and proximity of existing development within the American River North and South Basins, Alternative 1 proposes fix in place remediation. The purpose of this alternative would be to improve the flood damage reduction system to safely convey flows to a level that

maximizes net benefits. Table 1 summarizes the levee problems discussed above and the proposed remediation measure for each waterway.

Table 1. Alternative 1 Proposed Levee Improvement Measures by Waterway

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	—	—	Bank Protection, Launchable Rock Trench	—
Sacramento River	Cutoff Wall	Cutoff Wall	Bank Protection, Launchable Rock Trench	Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	—	Floodwall
Arcade Creek	Cutoff Wall	Cutoff Wall	—	Floodwall
Dry and Robla Creeks	—	—	—	Floodwall
Magpie Creek	—	—	—	Floodwall

In addition to the proposed levee improvement measures shown in Table 1, the following measures and policies would be addressed during construction.

- The Corps' standard levee footprint would be established during construction of structural improvements on all levees that are out of compliance. The standard levee footprint consists of a 20 foot crown width, a 3H:1V waterside slope, and a 2H:1V landside slope, when possible. If the 3H:1V waterside slope is not possible, than a minimum 2H:1V waterside slope would be established instead.

- A 10 foot landside maintenance access would be established, when possible.

- Compliance with Corps levee vegetation requirements would be established. The vegetation requirements include a 15 foot waterside, landside and vertical vegetation-free zone. When possible, a variance would be sought to allow vegetation to remain. If granted, the variance would allow for vegetation to remain on the lower waterside slope and within the waterside 15 foot vegetation-free zone. No vegetation would be permitted on the landside slope.

    - A vegetation variance would be requested to provide compliance for the Sacramento River portion of this project.

    - The erosion measures on the American River is not considered a structural fix, as these measures do not impact the structure of the levee, therefore the vegetation in this portion of the project would not be addressed under the Common Features GRR project. American River vegetation compliance would occur under a System-

1 Seepage, stability, and overtopping measures were addressed in the American River Common Features WRDA 96 and WRDA 99 construction projects.

Wide Improvement Framework by the local sponsors.

  - The East Side Tributaries would be brought into vegetation compliance during construction in those levee reaches.

- Utility encroachments would be brought into compliance with Corps policy. Utilities that penetrate the levee would be removed and replaced with one of two fixes: a surface line over the levee prism or a through-levee line equipped with positive closure devices.

- Private encroachments would be removed by the non-Federal local sponsor or property owner prior to construction.

There would be no proposed measures under Alternative 1 for the Sacramento Bypass. The following sections contain more detailed information on the specific measures proposed by waterway under Alternative 1.

American River

Levees along the American River under Alternative 1 require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion to the river bank and levee, which could potentially undermine the levee foundation. There are two measures proposed to address erosion on the American River levees: bank protection and a launchable rock trench. Both of these measures are described in detail in the subsections below. These measures would be implemented for all of the proposed alternatives discussed in this document.

Bank Protection

This measure consists of placing rock protection on the river's bank, and in some locations, on the levee slope to prevent erosion. The location of rock placement would be based on site-specific analysis. When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and deleterious materials would be removed. In most cases large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked to the site.

Revetment would be imported from an offsite location via haul trucks and temporarily stored at a staging area located in the immediate vicinity of the construction site. A loader would be used to move revetment from the staging area to the excavator that would be placing material. The revetment would be placed at a slope varying from 2V:1H to 3V:1H, depending on the site specific conditions. A large rock berm would be placed in the water up to an elevation slightly above the mean summer water surface and a planting trench would be established on the rock berm surface for re-vegetation purposes. An excavator would either be working from the top of bank placing revetment on the bank and in the water, or from on top of the rock berm that is established.

Launchable Rock Trench

The launchable rock filled trench is designed to deploy once erosion has removed the bank material beneath it. All launchable rock trenches would be constructed outside of the natural river channel. The vegetation would be removed from the footprint of the trench and the levee slope prior to excavation. The trench configuration would include a 2H:1V landslide slope and a 1H:1V waterside slope, and would be excavated at the toe of the existing levee. All soil removed during trench excavation would be stockpiled for reuse or disposed of. The bottom of the trench would be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and the amount of rock required.

After excavation, the trench would be filled with revetment that would be imported from an off-site location via haul trucks. After rock placement, the trench would be covered with a minimum of 3 feet of stockpiled soil for a planting berm. Rock placed on the levee slope would be covered with 2 feet of stockpiled soil. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Trees would be permitted on the berm if planted outside the specified vegetation free zone.

Sacramento River

Levees along the Sacramento River require improvements to address seepage, stability, and erosion. In addition, these levees require height improvements in order to convey additional flows that exceed the current design levels. To provide access for levee construction, inspection, maintenance, monitoring, and flood-fighting, some properties would need to be acquired.

Where the existing levee does not meet the levee design requirements, slope flattening, crown widening, and/or a levee raise is required. This improvement measure addresses problems with slope stability, geometry, overtopping, and levee access. To begin levee embankment grading, the area would be cleared, grubbed, stripped, and where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material from nearby borrow sites would be stockpiled at staging areas. Haul trucks and front end loaders would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans.

The existing levee centerline would be shifted landward, where necessary, in order to meet the Corps' current levee footprint requirements; or, in order to construct the levee to the existing footprint, a retaining wall may be constructed at the landside levee toe. This measure would raise the levee landward of the existing levee without reducing the levee crown width or disturbing the waterside slope. Retaining walls would range from 4 to 6 feet high and would require landside slope benching to establish the additional fill into the levee section. The levee crown patrol road would be re-established and a new road at the levee toe would be added 10 feet landward of the retaining wall.

Cutoff Walls

To address seepage concerns, a cutoff wall would be constructed through the levee crown. The cutoff wall would be installed by one of two methods: conventional open trench cutoff walls or deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address seepage. The open trench method can be

used to install a cutoff wall to a depth of about 85 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of the cutoff wall, the construction site and staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded to about half of the levee height to create a large enough working platform (about 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.

Open Trench Cutoff Walls

Under the open trench method, a trench 3 feet wide would be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it is filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves the use of a crane that supports a set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of about 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout would be injected through the augers and mixed with native soils. An overlapping series of mixed columns would be drilled to create a continuous seepage cutoff barrier. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

Bank Protection

Bank protection on the Sacramento River would be addressed by construction of the launchable rock trench method described for the American River above, or by standard bank protection, which consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, when necessary, and installing revetment along the waterside levee slope and streambank, from the streambed to a height determined by site-specific analysis. The sites would be prepared by removing vegetation along the levee slopes at either end of the site for construction of a temporary access ramp if needed. The ramp would then be constructed using imported borrow material that would be trucked onsite.

The placement of rock onto the levee slope would occur from atop the levee and/or from the waterside by means of barges. Rock required within the channel, both below and slightly above the water line at the time of placement, would be placed by an excavator located on a barge. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes. Rock required on the upper portions of the slopes would be placed by an excavator located on top of the levee. Rock placement from atop the levee would require one excavator and one loader for each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the

construction area. The excavator then moves the rock from the stockpile to the waterside of the levee.

The revetment would be placed via the methods discussed above on existing banks at a slope varying from 2V:1H to 3V:1H, depending on site specific conditions. After revetment placement has been completed, a small planting berm would be constructed in the rock, when feasible, to allow for some re-vegetation of the site.

NEMDC

The east levee of the NEMDC requires improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A conventional open trench cutoff wall would be constructed at these locations to address these problems. The open trench cutoff walls would be constructed as described for the Sacramento River levee described above.

The NEMDC east levee also has height issues which would be addressed by construction of a floodwall. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown construction. The heights of the floodwalls vary from 1 to 4 feet, as required by water surface elevations. Constructing the floodwall raise would require doweling into the existing concrete floodwall and adding reinforced concrete to the floodwall section. The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the flood event exceeds the current design. A cutoff wall would also be constructed to address seepage for portions of the creek. There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path and could affect the stability of the levee. The ditch would be replaced with a conduit or box culvert and then backfilled. This would lengthen the seepage path and improve the stability of the levee.

The majority of the levees on Arcade Creek have existing floodwalls; however, there remains a height issue in this reach. A 1 to 4 foot floodwall raise would allow the levees to pass flood events greater than the current design level. Construction of the floodwall would be consistent with the description for NEMDC above.

Dry and Robla Creeks

The Dry Creek and Robla Creek levees require improvements to address overtopping for when flood events exceed the design level. Height improvements would be made with a floodwall raise. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown construction. The height of the floodwalls would vary from 1 to 4 feet as required by water surface elevations. Construction of the floodwall would be consistent with the description for NEMDC above. The waterside slope would be re-established to its existing slope and the levee crown would be graded away from the wall and be surfaced with aggregate base.

Magpie Creek Diversion Channel

A number of features are proposed for the Magpie Creek Diversion Channel under Alternative 1. These features include the following:

- Strengthening the existing project levee;
- Construction of a 3 to 4 foot tall floodwall along the top of the existing levee for a distance of about 2,100 feet. Construction of the floodwall would be consistent with the description for NEMDC above;
- Construction of a new 1,000-foot-long levee along Raley Boulevard, south of the Magpie Creek bridge;
- Construction of a 79 acre flood detention basin on both sides of Raley Boulevard, primarily through the purchase of properties to preserve the existing floodplain; and
- Raley Boulevard improvements, including widening the Magpie Creek Bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

Alternative 2: Fix Levees in Place and Widen the Sacramento Weir and Bypass

Alternative 2 would include all of the levee improvements discussed in Alternative 1 above, except for the levee raises along the Sacramento River. Instead of the levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The levees along the American River, NEMDC, Arcade Creek, Dry Creek, Robla Creek, and the Magpie Creek Diversion Channel would be improved to address identified seepage, stability, erosion, and height concerns through methods described under Alternative 1 above. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns through the measures described under Alternative 1 above. Due to the urban nature of the project area and proximity of development to the levees, the majority of the levee repairs would be fixed in place.

In addition, Alternative 2 would include levee raises for the Natomas Basin. The Natomas Basin levee raises are proposed under the Common Features Project GRR for authorization; however, these measures were analyzed under NEPA for the NLIP Phase 4b Project EIS/EIR in 2010.

The following sections contain more detailed information on the specific features and reaches included in this alternative. Table 2 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 2. Alternative 2 Proposed Remediation Measures by Waterway

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[2]	–	–	Bank Protection, Launchable Rock Trench	–
Sacramento River	Cutoff Wall	Cutoff Wall	Bank Protection, Launchable Rock Trench	Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	–	Floodwall
Arcade Creek	Cutoff Wall	Cutoff Wall	–	Floodwall
Dry and Robla Creeks	–	–	–	Floodwall
Magpie Creek	–	–	–	Floodwall, Levee Raise

Sacramento Weir and Bypass

The existing Sacramento Weir and Bypass, which allow high flows in the Sacramento River to be diverted into the Yolo Bypass, would be expanded to roughly twice the current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass would be degraded and a new levee would be constructed about 1,500 feet to the north. The existing Sacramento Weir would be expanded to match the wider bypass. The new north levee of the bypass would include a 300-foot-wide seepage berm on the landside, with a system of relief wells. An existing high tide relief well site near the existing north levee would be remediated by the non-Federal sponsor prior to construction.

American River

Measures for the American River levees under Alternative 2 would address erosion. These measures were identified and described under Alternative 1 and would also be included in Alternative 2. Implementation of these measures under Alternative 2 would be consistent with the description in Alternative 1.

East Side Tributaries

Measures for NEMDC, Arcade Creek, Dry Creek, Robla Creek, and the Magpie Creek Diversion Channel under Alternative 2 would address seepage, slope stability, and erosion control. These measures were identified and described in Alternative 1 and would also be included in Alternative 2. Implementation of these measures under Alternative 2 would be consistent with the description in Alternative 1.

2 Seepage, stability, and overtopping measures were addressed in the American River Common Features WRDA 96 and WRDA 99 construction projects.

Sacramento River

The measures for the Sacramento River levees under Alternative 2 would be consistent with Alternative 1, with one exception. Under Alternative 1, Sacramento River levee remediation measures were proposed to address seepage, stability, erosion control, and levee height problems. Under Alternative 2, there would be no need to address the levee height problems. Therefore, the measures from Alternative 1 that would be implemented under Alternative 2 for the Sacramento River levees would include: (1) installation of cutoff walls to address seepage concerns; (2) slope reshaping to address stability concerns; and (3) bank protection or launchable rock trench measures to address erosion. The description of these measures can be found above under Alternative 1 for the Sacramento River.

BIOLOGICAL RESOURCES

American River

The American River Parkway (Parkway) contains many vegetation types including riparian scrub, riparian forest, oak woodland, open water, grasslands, and some agriculture. Along the river channel, vegetation is primarily considered shaded riverine aquatic (SRA) cover. Trees adjacent to the channel are mainly oaks and cottonwoods with a thick understory of vines, shrubs, and herbaceous vegetation.

The levee slopes along the American River are primarily covered with grasses and a few scattered trees within the levee structure. Several areas within the Parkway have been used as mitigation sites for the Corps and other agency projects for valley elderberry longhorn beetle. There are also some areas within the Parkway that have been used to compensate for loss of riparian habitat or oak woodlands from projects. Vegetation on the landside of the levee is mostly non-native ornamentals and landscape plantings that were planted beyond the legal property and fence lines of residents.

Habitats in the project area around the American River support various wildlife species. Mammal species include mule deer, coyote, black-tailed jackrabbit, striped skunk, and a variety of rodents. Common bird species include American robin, spotted towhee, dark-eyed junco, black phoebe, California towhee, ash-throated flycatcher, northern flicker, mourning dove, California quail, house finch, American and lesser goldfinches, Bewick's and house wrens, northern mockingbird, yellow-billed magpie, red-winged and Brewer's blackbirds, oak titmouse, and Anna's hummingbird. Common raptors include red-tailed hawk, Cooper's hawk, red-shouldered hawk, American kestrel, and great horned owl. Reptile and amphibian species found within the project area include western fence lizard, gopher snake, western rattlesnake, common kingsnake, Pacific treefrog, and western toad.

The river and small backwater areas provide habitat for many water associated species such as raccoon, beaver, Canada goose, wood duck, common merganser, mallard, black phoebe, great blue heron, belted kingfisher, and common yellowthroat. The levee slopes, which are dominated by annual grassland, provide foraging habitat and cover for California ground squirrel, pocket gopher, and western meadowlark.

The lower American River supports a diverse and abundant fish community; altogether, at least 41 species of fish are known to inhabit the river (USFWS 1986). In recognition of its "outstanding and

remarkable" fishery resources, the entire lower American River was included in the Wild and Scenic Rivers System in 1981, which provides some protection for these resources (USFWS 1991). Four anadromous species are important from a commercial and recreational perspective. The lower river supports a large run of fall-run Chinook salmon, a species with both commercial and recreational values. The salmon run is sustained by natural reproduction in the river, and by hatchery production at the Nimbus Salmon and Steelhead Hatchery, operated by the California Department of Fish and Wildlife (CDFW). The average annual production of fall-run Chinook salmon in the American River from 1992-2009 is 109,574 (USFWS 2013).

Steelhead, a popular sport fish, are largely sustained in the river by production from the Nimbus Hatchery, because summer water temperatures often exceed the tolerances of juvenile steelhead, which typically spend about 1 year in the river. American shad and striped bass enter the river to spawn; these two species, introduced into the Sacramento River system in the late 1800s, now support popular sport fisheries. In addition to species of economic interest, the lower American River supports many nongame species, including Sacramento pikeminnow, Sacramento sucker, tule perch, and hardhead (USFWS 1994).

NEMDC

This canal is a narrow channel with many trees in the lower portion. As the canal heads north the channel widens and has less woody vegetation. The levee slopes on the east side of the canal are clear of vegetation due to maintenance practices. The west side of this canal is not part of this project as it is part of the NLIP Phase 4b Project.

Arcade Creek

The levees along Arcade Creek are maintained vegetation free; however, the channel does have some trees and understory. Between Norwood Avenue and Rio Linda Boulevard the channel contains a thick riparian area but vegetation becomes sparse once it passes Rio Linda Boulevard. Due to the urban conditions in this area, wildlife is limited to those similar to the Parkway but in smaller numbers.

Dry and Robla Creeks

The Dry and Robla Creeks area is a wide open space floodplain, with both creeks being contained between the two levees. The creeks maintain sufficient water throughout the year for trees to survive along the channel. There are scattered wetlands located in the floodplain with a higher concentration at the confluence with the NEMDC. The actual levee slopes in this floodplain contain very little vegetation due to maintenance practices. Wildlife in the floodplain is similar to that in the Parkway.

Magpie Creek Diversion Channel

The project area of Magpie Creek Diversion Channel begins in an industrial area where the channel contains primary grasses. Upstream, the area becomes open space before it intersects with Raley Boulevard and additional industrial development. Seasonal wetlands in the area include natural vernal pools and other areas with standing water that provide a similar biological function as natural vernal pools. Wildlife in this area includes jack rabbits, skunks, beavers, and coyotes that also use

the surrounding undeveloped area. Avian species that utilize this habitat include herons and waterfowl. Amphibian and reptile species include treefrog and common garter snake.

Sacramento River

Vegetation along the Sacramento River is mostly SRA cover consisting of oaks and cottonwoods with shrub understory. There are intermittent locations along the waterline with no trees due to revetment. The Sacramento River Bank Protection Project has repaired some erosion sites along this section of the river using rock revetment on the slope and creating small vegetated benches. These sites have been planted with riparian vegetation and woody material has been placed in the rock to provide in water habitat for fish species.

Due to the urban development adjacent to the levees in this area, wildlife is limited to small mammals and various avian species. Domestic animals from residents are also often seen along the levees in this basin of the project. Though a narrow riparian corridor, this area does function as a migratory corridor for wildlife as the area to the east is completely developed with housing. It is important to maintain a corridor to provide connectivity along the Sacramento River.

The Sacramento River contains a variety of habitat characteristics that are important to many fish species. Streamside vegetation provides SRA cover and aids in temperature control, streambank stability, and habitat complexity. Cover is used by all life stages of anadromous fish for shelter and provides habitat for salmonids, Sacramento splittail, delta smelt, black bass and sunfish.

Root structures of riparian vegetation can provide bank stability and shelter for juvenile fish. Woody debris can provide shelter from predation and refugia from stream flow. Riparian vegetation also influences the food chain of a stream, providing organic detritus and terrestrial insects. Terrestrial organisms falling from overhanging branches contribute to the food base of the aquatic community. Salmonids in particular are primarily insectivores and feed mainly on drifting food organisms.

In general, the Sacramento River channel provides a migratory pathway to many anadromous fish and provides seasonal rearing habitat to many other native fish species. Native anadromous fish species include Chinook salmon, green and white sturgeon, Pacific and river lamprey, and steelhead. Native resident fish species include delta smelt, hardhead, hitch, prickly sculpin, Sacramento blackfish, Sacramento pikeminnow, Sacramento splittail, Sacramento sucker, threespine stickleback and tule perch. Non-native anadromous species, such as American shad and striped bass, provide recreational sport fishing opportunities. Non-native resident fish species include several species of catfish, black bass, sunfish and minnows. Some non-native species may provide recreational fishing opportunities, such as largemouth, smallmouth, and striped bass, yet these species also prey upon native juvenile species that use nearshore habitats.

Sacramento Bypass and Weir

The Sacramento Bypass is a 360 acre area that is an important cover and feeding area for wildlife during the late fall, winter and early spring. Vegetation varies from scattered trees, such as mature cottonwoods, willows and valley oaks, to a sparsely covered sand soil area on the eastern end. There are also wetlands within the bypass. Game birds, raptors, songbirds, and native mammals are all present in this area.

The footprint of the expanded weir contains 8 acres of scattered trees along the road, railroad tracks, and levee slope. Primary wildlife use this area is avian species, beavers, skunks, and rabbits. The trees along the river provide shade for many native and non-native species. These trees are also used by various avian species for nesting.

Threatened and Endangered Species

Potentially affected federally-listed species within the project area include the valley elderberry longhorn beetle, giant garter snake, delta smelt, Central Valley steelhead, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and green sturgeon. The valley elderberry longhorn beetle, giant garter snake, delta smelt, yellow-billed cuckoo, and least Bell's vireo fall under the jurisdiction of the Service. The National Marine Fisheries Service (NMFS) is responsible for the listed salmonids and green sturgeon.

The riverbank and associated nearshore aquatic area that would be affected by the proposed action constitute portions of the designated critical habitat of the delta smelt. Indirect effects of the proposed action may also extend to other portions of this critical habitat. The Corps completed section 7 consultation with the Service. The consultation is included as Appendix 1.

In addition, the bank protection action area constitutes elements of essential fish habitat (EFH). EFH is the aquatic habitat (water and substrate) necessary to fish for spawning, breeding, feeding and or growth to maturity that will allow a level of production needed to support a long-term, sustainable commercial fishery and contribute to a health ecosystem. Consultation with NMFS regarding EFH is required for all commercially-harvested runs of salmon, including all runs of salmon in the project's action area.

Future Conditions Without the Project (No Action Alternative)

American River

Under the No Action Alternative, the Corps would not participate in construction of the proposed project. There would be no construction related effects to the vegetation and wildlife. However, looking over the past several decades the largest and most frequent flows come down the American River system, some of the floodplain in the Parkway has eroded away. During the 50 year life span of the project it is expected that larger flows would be released from Folsom Dam and sustained for longer periods, leading to potential loss of floodplain and the vegetation on it within the Parkway. While erosion and accretion within the riverine system is a normal and healthy process, Folsom Dam has cutoff sediment supply to the lower American River which creates a sediment starved section of the river. Sediment starvation means that accretion would not occur and the loss of floodplain and its ability to support habitat would be lost. This loss would also cause any wildlife in the area to relocate to other areas where the habitat they need is present. Because we cannot predict when and how large events would occur, it is not possible to determine when the floodplain would erode. The loss of the Parkway vegetation and wildlife habitat would be considered a significant impact.

East Side Tributaries

Under the No Action Alternative, the Corps would not participate in construction of the proposed project. There would be no construction related effects to the vegetation and wildlife. The riparian habitat on Arcade Creek between Norwood Avenue and Rio Linda Boulevard would remain. The other creeks do not contain much vegetation; however, the little vegetation that does exist would not be removed. Wildlife in these creek areas would not be disturbed due to construction activities.

Sacramento River

Under the No Action Alternative, the Corps would not participate in construction of the proposed project. There would be no construction related effects to the vegetation and wildlife. The banks along the Sacramento River are very erosive and without some kind of erosion control measures, the banks would continue to erode during high flows. As the banks of the river erode, vegetation would be lost and the levees could fail. It is likely that in order to save the levee structures, flood fighting activities would occur during a high flow emergency response. Flood fighting is usually performed by placing large rock along the levee slope to stop erosion and prevent levee failure and loss of lives. The placement of the rock could prevent and/or impede future growth of trees and vegetation on the levee slopes.

In the event that flood fighting activities are not successful and a levee failure occurs, all vegetation could be lost and wildlife could be swept away in the flood waters. The loss of vegetation that could occur in a large flood event and the placement of rock along the banks could have significant impacts to vegetation and wildlife, particularly to the functioning of a migratory corridor.

While this area of the project does not provide large patches of habitat, it does serve as a migratory corridor for wildlife from further south in the Sacramento-San Joaquin Delta to areas further north along the Sacramento River, such as the Parkway. Riparian corridors can be especially important for reptiles, amphibians, and small mammals.

Future Conditions With the Project

Impacts to vegetation and wildlife within the project area are evaluated based on data collected from tree surveys conducted in 2011, site visits, Google Earth, and the American River Parkway Plan (Parkway Plan). The goals and objectives of the Parkway Plan and how construction of the project would impact those goals and objectives were considered in the impact analysis. Table 3 summarizes the impacts to vegetation by basin and reach.

Alternative 1: Fix Levees in Place

American River

The construction of rock trenches along the American River would result in the removal of about 65 acres of riparian habitat within the Parkway. This acreage was determined by overlaying the largest possible footprint onto an aerial photograph and calculating the riparian habitat within the footprint. Much of this riparian habitat contains trees that have been in the Parkway for 50 to 100 years or more. The Parkway is the largest remaining riparian corridor in the city of Sacramento. In addition, construction would also impact 135 acres of grassland, which include the levees, patrol

roads, and open lands. Project construction along the American River would be intermittent and would occur over a 7 year period. Trees would not be removed all at one time, they would be removed at each trench site as the trench is constructed.

Table 3. Potential Impacts by Flood Basin and Reach

Waterway	Impacts
American River	65 acres of riparian habitat
	135 acres of grassland habitat
East Side Tributaries	2 acres oak woodland
	4 acres of grassland
	10.5 acres riparian
Sacramento River	70 acres of riparian
Sacramento Bypass	300 acres of agricultural fields and drainage canals
	8 acres of riparian vegetation

Most of the 65 acres of riparian habitat is located on land designated by the Parkway Plan as Protected Areas or Nature Study Area. However, the Parkway Plan also allows for flood control activities to be conducted in order to pass 160,000 cfs through the system. Section 4.10 of the Parkway Plan states:

> *Flood control project, including levee protection projects and vegetation removal for flood control purposes, shall be designed to avoid or minimize adverse impacts on the Parkway, including impacts to wildlife and wildlife corridors. To the extent that adverse impacts are unavoidable, appropriate feasible compensatory mitigation shall be part of the project. Such mitigation should be close to the site of the adverse impact, unless such mitigation creates other undesirable impacts.*

Any trees planted would take many years to mature to the level where they provide the same value as those removed. Because there would be many years between when the trees are planted and when they mature to a value of those removed, this impact is considered significant. Construction would likely occur from May through October when birds are nesting. Once the project is authorized and funded, surveys of the project areas would occur to determine if migratory birds are nesting in areas which may be impacted during construction.

East Side Tributaries

Riparain and oak woodland along Arcade Creek and the NEMDC would need to be removed to construct the project. These trees are suitable nesting habitat for many avian species in the area. Surveys would be conducted to determine if any nesting birds are present prior to construction. If nesting birds are located adjacent to the project area, coordination with the resource agencies would occur. Any trees where nesting birds are located would not be removed while they are actively nesting. However, once the young have fledged, the trees may be removed to construct the project. The loss of trees in this area would be considered significant because new plantings would take many years to grow to the value of those removed.

This alternative would result in temporary impacts to about 4 acres of grasses along the creek channels and levee slopes. Once construction is complete, the areas would be planted with a native

grass seed mix to prevent erosion and replace the grasses removed for construction. The grasslands are likely to grow back in a single season.

Sacramento River

Under this alternative the existing levee structure would be degraded by one half to create a working platform for slurry wall installation. As the levee is degraded, all vegetation on the top one half would be removed. Levee degradation will result in the loss of 70 acres of riparian habitat. These trees are located on the top half of the levee, so they provide a small amount of SRA cover and habitat for many avian species. They also contribute to the width of the riparian corridor. On average the current width of the riparian corridor along the Sacramento River is 100 feet. Riparian loss will remove about 60 feet of those 100 feet. The construction and planting of the berm as part of the erosion repair will create an additional 25 feet to the width of the riparian corridor. There will still be a net loss of 35 feet from the riparian corridor. The loss of this 35 feet from the width of the riparian habitat can cause increased predation because the narrower corridor will increase edge effects. Additionally, smaller widths of habitat make it more likely that stochastic events will affect the habitat and loss of the vegetation could result in complete removal of the riparian corridor diminishing connectivity. It will be important for the Corps and the non-federal and local sponsors to ensure that the remaining riparian habitat remains, regeneration occurs (it may need to be helped through active planting), and non-native vegetation does not become established within the corridor.

On the waterside of the levee, 930 large trees would be left in place on the lower one-third and rock would be placed around the base of the trees. The trees that would remain in place are scattered over 31,130 linear feet (50 acres). The rock protection around the trees would reduce the potential for erosion and anchor the trees in place to lower the risk of uprooting in high water events. The understory vegetation would be removed to provide a clean surface to place the rock. Excluding the large trees, vegetation in this area is primarily small shrubs, low growing plants of various species, and grasses. Once the rock protection is in place and a planting berm is constructed, the area would be planted with small shrubs. Appropriate plants would be selected to maximize wildlife habitat.

On the landside of the levee all trees would be removed on the levee slope and within 15 feet of the levee toe to comply with the Corps vegetation policy. Within this 15 feet compliance area, a 10-foot wide landside operations, maintenance, and emergency access corridor would be established. There are 670 trees of various species and size within this landside area that would be removed and not be replaced on-site. The removal of these trees is considered significant because it would take many years for the replacement trees to establish to the value of those removed.

The landside slopes are primarily covered with ornamental groundcovers installed by adjacent private property owners. In some places landscaping has been extended beyond the fence or property lines and up the levee slopes. Degrading of the levee would include removal of all vegetation on the upper half of the landside slope. All disturbed areas, including the levee slopes, would be planted with native grasses to prevent erosion. The 15 foot landside vegetation free zone would be maintained vegetation free, except for the native grasses.

The loss of woody vegetation would affect avian species. Surveys would be conducted to determine if any nesting birds are present prior to construction. If nesting birds are located adjacent to the project area, coordination with the resource agencies would occur. Trees where nesting birds are located would not be removed while they are actively nesting.

Alternative 2 – Fix Levees and Widen the Sacramento Weir and Bypass

The footprints of all features in this alternative are the same as Alternative 1 with the added feature of widening the Sacramento Weir and Bypass. Areas that no longer require a raise would still maintain the same footprint since the purpose of the raise would instead be accomplished via the installation of a retaining wall at the toe of the levee. Therefore, the effects to vegetation and wildlife are the same as those for Alternative 1, with the addition of those associated with the Sacramento Weir and Bypass.

Sacramento Weir and Bypass

Habitat within the existing Bypass would remain the same as the existing conditions. The Bypass would be expanded by about 300 acres, which would become open space and would likely become similar habitat for wildlife as the existing Bypass. Operations of the new weir and bypass would be determined after construction is complete. No grading or altering of the lands within the existing bypass would occur as part of this alternative. Since the southern side of the bypass is lowest in elevation, water would naturally flow to the existing area and continue to support existing vegetation and wildlife. Due to the natural flow of water in the Bypass, existing wetlands are not expected to be impacted by construction of the project. There is a potential for additional wetlands to actually develop in the added 300 acres of bypass since the land would no longer be farmed. Conversion of this land back to its natural state would have benefits to other wildlife and could become an expansion of the Sacramento Bypass Wildlife Area.

There are 8 acres of riparian vegetation that would be removed to construct the weir structure. The 8 acre area contains both the Old River Road and Union Pacific Railroad train tracks. Avian species are the primary wildlife in this area with some small animals like fox and coyotes, which pass through the area to access the river. Included within the 8 acres are 1,500 linear feet of vegetation along the Sacramento River which may be removed to allow the river to flow freely into the weir. Both native and non-native fish species use this area of the river. During construction there would be direct effects to wildlife as the human activities associated with the construction would likely cause any wildlife to relocate to other open space lands to avoid the disturbance; however, the expansion of the Sacramento Weir and Bypass would have a positive effect on vegetation and wildlife once construction is complete and lands are converted from farming activities to open space.

DISCUSSION

Service Mitigation Policy

The recommendations provided herein for the protection of fish and wildlife resources are in accordance with the Service's Mitigation Policy as published in the Federal Register 46:15; January 23, 1981).

The Mitigation Policy provides Service personnel with guidance in making recommendations to protect or conserve fish and wildlife resources. The policy helps ensure consistent and effective Service recommendations, while allowing agencies and developers to anticipate Service recommendations and plan early for mitigation needs. The intent of the policy is to ensure

protection and conservation of the most important and valuable fish and wildlife resources, while allowing reasonable and balanced use of the Nation's natural resources.

Under the Mitigation Policy, resources are assigned to one of four distinct Resource Categories, each having a mitigation planning goal which is consistent with the fish and wildlife values involved. The Resource Categories cover a range of habitat values from those considered to be unique and irreplaceable to those believed to be much more common and of relatively lesser value to fish and wildlife. However, the Mitigation Policy does not apply to threatened and endangered species, Service recommendations for completed Federal projects or projects permitted or licensed prior to enactment of Service authorities, or Service recommendations related to the enhancement of fish and wildlife resources.

In applying the Mitigation Policy during an impact assessment, the Service first identifies each specific habitat or cover-type that may be impacted by the project. Evaluation species which utilize each habitat or cover-type are then selected for Resource Category analysis. Selection of evaluation species can be based on several criteria, as follows: (1) species known to be sensitive to specific land- and water-use actions; (2) species that play a key role in nutrient cycling or energy flow; (3) species that utilize a common environmental resource; or (4) species that are associated with Important Resource Problems, such as anadromous fish and migratory birds, as designated by the Director or Regional Directors of the Service. Based on the relative importance of each specific habitat to its selected evaluation species, and the habitat's relative abundance, the appropriate Resource Category and associated mitigation planning goal are determined.

Mitigation planning goals range from "no loss of existing habitat value" (i.e., Resource Category 1) to "minimize loss of habitat value" (i.e., Resource Category 4). The planning goal of Resource Category 2 is "no net loss of in-kind habitat value." To achieve this goal, any unavoidable losses would need to be replaced in-kind. "In-kind replacement" means providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate those lost. The planning goal of Resource Category 3 is "no net loss of habitat while minimizing loss of in-kind value." To achieve this goal any unavoidable losses will be replaced in-kind or if it is not desirable or possible out-of-kind mitigation would be allowed. The planning goal of Resource Category 4 is "minimize loss of habitat value." To achieve this goal the Service will recommend ways to rectify, reduce, or minimize loss of habitat value.

In addition to mitigation planning goals based on habitat values, Region 8 of the Service, which includes California, has a mitigation planning goal of no net loss of acreage and value for wetland habitat. This goal is applied in all impact analyses.

In recommending mitigation for adverse impacts to fish and wildlife habitat, the Service uses the same sequential mitigation steps recommended in the Council on Environmental Quality's regulations. These mitigation steps (in order of preference) are: avoidance, minimization, rectifying, reducing or eliminating impacts over time, and compensation.

Ten fish and/or wildlife habitats were identified in the project area which had potential for impacts from the project: oak woodland, riparian forest, riparian scrub-shrub, SRA cover, shallow open water, emergent wetland, annual grassland, agriculture (non-rice cultivation), ornamental landscape,

and other. The resource categories, evaluation species, and mitigation planning goal for the habitats impacted by the project are summarized in Table 4.

The evaluation species selected for the oak woodland that would be impacted are acorn woodpecker, turkey, and mule deer. Acorn woodpeckers utilize oak woodlands for nearly all their life requisites; 50-60 percent of the acorn woodpecker's annual diet consists of acorns. Acorn woodpeckers can also represent impacts to other canopy-dwelling species. Turkeys forage and breed in oak woodlands and are abundant in the project area. Mule deer also heavily depend on acorns as a dietary item in the fall and spring; the abundance of acorns and other browse influence the seasonal pattern of habitat use by deer. These latter species represent species which utilize the ground component of the habitat and both have important non-consumptive human uses (i.e., wildlife viewing and bird watching). Based on the high value of oak woodlands to the evaluation species, and their declining abundance, the Service has determined oak woodlands which would be affected by the project should be placed in Resource Category 2, with an associated mitigation planning goal of "no net loss of in-kind habitat value or acreage."

The evaluation species selected for the riparian forest that would be impacted by the project are Swainson's hawks, wood ducks, and Bullock's orioles. Riparian forest vegetation provides important cover, and roosting, foraging, and nesting habitat for these species. Large diameter trees also provide nesting sites for species such as wood ducks and Swainson's hawks. Riparian woodland cover-types are of generally high value to the evaluation species, and are overall, extremely scare (less than 2% remaining from pre-development conditions). Therefore, the Service finds that any riparian forest cover-type that would be impacted by the project should be placed in Resource Category 2, with an associated mitigation planning goal of "no net loss of in-kind habitat value or acreage." In addition, the Service's regional goal of no net loss of wetland acreage or habitat values, whichever is greater, would apply to this habitat type.
The evaluation species selected for the riparian scrub-shrub vegetation that would be impacted by the project is the yellow warbler. Riparian scrub-shrub vegetation provides important cover, and roosting, foraging, and nesting habitat for this species. Riparian cover-types are generally of high value to the evaluation species, and are overall extremely scarce (less than 2% remaining from pre-development conditions). Therefore, the Service finds that any riparian scrub-shrub cover-type that would be impacted by the project should be placed in Resource Category 2, with an associated mitigation planning goal of "no net loss of in-kind habitat value or acreage." In addition, the Service's regional goal of no net loss of wetland acreage or habitat values, whichever is greater, would apply to this habitat type.

The evaluation species selected for SRA cover that would be affected by the project are juvenile salmonids (salmon and steelhead) and the heron and egret family (family Ardeidae). Salmonids were selected because large declines in their numbers are among the most important resource issues in the region, and because of their very high commercial and sport fishing values. Herons and egrets were selected because of the Service's responsibilities for their management under the Migratory Bird Treaty Act, their relatively high value for non-consumptive human uses, such as bird watching, and their value as indicator species for the many birds which use SRA cover.

Table 4. Resource categories, evaluation species, and mitigation planning goal for the habitats possibly impacted by the proposed American River Common Features General Re-evaluation Report, Sacramento County, California.

COVER-TYPE	EVALUATION SPECIES	RESOURCE CATEGORY	MITIGATION GOAL
Oak Woodland	Acorn woodpecker Turkey Deer	2	No net loss of in-kind habitat value or acreage.
Riparian Forest	Swainson's hawk Wood duck Bullock's oriole	2	No net loss of in-kind habitat value or acreage.
Riparian Scrub-Shrub	Yellow warbler	2	No net loss of in-kind habitat value or acreage.
SRA Cover	Juvenile salmonids Herons and Egrets	1	No loss of existing habitat value.
Emergent Wetland	Marsh Wren	2	No net loss of in-kind habitat value or acreage.
Shallow Open Water	Egret Sunfish	2	No net loss of in-kind habitat value or acreage.
Annual Grassland	Red-tailed hawk	3	No net loss of habitat value while minimizing loss of in-kind habitat value.
Agriculture (non-rice cultivation)	White-tailed kite California vole	4	Minimize loss of habitat value.
Ornamental Landscape	None	4	Minimize loss of habitat value.
Other	None	4	Minimize loss of habitat value.

In 1992, the Service designated SRA cover that is impacted by bank protection activities within the Sacramento Bank Protection Project action area as Resource Category 1 (USFWS 1992). Under Resource Category 1, habitat to be impacted is high value, unique, and irreplaceable on a national basis or in the eco-region, and the Service's mitigation planning goal is for no loss of existing habitat value.

The evaluation species selected for the emergent wetland cover-type is the marsh wren. Drainage wetland habitat provides important cover, foraging, nesting, and roosting habitat for such water associated birds as well as some amphibians and aquatic mammals. Insects and spiders are taken from vegetation, the wetland floor, and while in flight (Gutzwiller and Anderson 1987). For protection from predators, the marsh wren usually constructs nests in reedy vegetation about 15

inches above water that is 2 to 3 feet deep (Gutzwiller and Anderson 1987). Because of the medium to high value of this habitat to the evaluation species, and its relative scarcity, the Service designates any emergent wetland habitat within the project area as Resource Category 2, with its associated mitigation planning goal of "no net loss of in-kind habitat value or acreage."

The evaluation species selected for the shallow open water cover-type is the egret and sunfish. Shallow, open water is important to a number of regionally important fish and wildlife. For example, wading birds (e.g., herons and egrets) use it for feeding, as do a number of gamefish, including sunfish, catfish and striped bass. It is also part of the critical habitat designated for federally listed delta smelt and Sacramento River winter-run Chinook salmon. Such shallow water is generally removed when typical bank protection is done, especially when the bank is reshaped. The result is likely to be higher velocities and deeper water along the new shoreline. Compounding the problem is the large amount of riprap that has already been placed in the vicinity of the proposed action, thus effectively removing many miles of shallow, open water. In concert with past Sacramento River Bank Protection Project planning, the Service is designating such habitat that would be impacted as Resource Category 2, with an associated planning goal of "no net loss of in-kind habitat value or acreage."

The evaluation species selected for the annual grassland cover-type is the red-tailed hawk, which utilizes these areas for foraging. This species was selected because of the Service's responsibility for their protection and management under the Migratory Bird Treaty Act, and their overall high non-consumptive values to humans. Annual grassland areas potentially impacted by the project vary in their relative values to the evaluation species, depending on the degree of human disturbance, plant species composition, and juxtaposition to other foraging and nesting areas. Therefore, the Service designates the annual grassland cover-type in the project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

The evaluation species selected for the agriculture, non-rice cultivation, cover-type is the white-tailed kite (formerly black-shouldered kite) and the California vole. The white-tailed kite in California is a common species of open and cultivated bottomland and is an obligate predator on diurnal small mammals (Faanes and Howard 1987). Movements and nesting of the white-tailed kite is largely governed by concentrations of mice and voles (Faanes and Howard 1987). The California vole is a widespread and common herbivore in California (Brylski 1990), and its abundance and distribution, along with daytime activity, make it an important prey species. Because this habitat is not native, and is managed for crop production unless fallowed, the Service designates the agriculture cover-type in the project area as Resource Category 4. Our associated mitigation planning goal for these areas is "minimize loss of habitat value."

No evaluation species were identified for the ornamental landscape or "other" cover-types. The ornamental landscape is typically vegetation which occurs along the fence line of adjacent private properties and is maintained by individual landowners. The "other" cover-type encompasses those areas which do not fall within the other cover-types such as gravel and paved roads, parking areas, buildings, bare ground, riprap, etc. Generally these cover-types would not provide any significant habitat value for wildlife species. Therefore, the Service designates the ornamental landscape and "other" cover-types in the project area as Resource Category 4. Our associated mitigation planning goal for these areas is "minimize loss of habitat value."

The recommendations below are based on preliminary construction designs provided by the Corps for the Common Features GRR. Once the specific project designs are developed, the Service's recommendations will be refined.

RECOMMENDATIONS

The Service recommends:

1. Avoid the loss of SRA cover by planting native woody vegetation within the bank protection areas. Work with the Service, NMFS, and California Department of Fish and Wildlife (CDFW) to develop planting and monitoring plans, and with DWR and SAFCA to develop a variance to allow vegetation within the Corps' vegetation free zone to remain in place, especially in areas designed for rock slope protection.

2. Woody vegetation that needs to be removed within the construction footprint should be removed during the non-nesting season to avoid affecting active bird nests.

3. Avoid impacts to migratory birds nesting in trees along the access routes and adjacent to the proposed repair sites by conducting pre-construction surveys for active nests along proposed haul roads, staging areas, and construction sites. This would especially apply if construction begins in spring or early summer. Work activity around active nests should be avoided until the young have fledged. The following protocol from the CDFW for Swainson's hawk would suffice for the pre-construction survey for raptors.

   A focused survey for Swainson's hawk nests will be conducted by a qualified biologist during the nesting season (February 1 to August 31) to identify active nests within 0.25 mile of the project area. The survey will be conducted no less than 14 days and no more than 30 days prior to the beginning of construction. If nesting Swainson's hawks are found within 0.25 mile of the project area, no construction will occur during the active nesting season of February 1 to August 31, or until the young have fledged (as determined by a qualified biologist), unless otherwise negotiated with the California Department of Fish and Wildlife. If work is begun and completed between September 1 and February 28, a survey is not required.

4. Avoid future impacts to the site by ensuring all fill material is free of contaminants.

5. Minimize project impacts by reseeding all disturbed areas, including staging areas, at the completion of construction with native forbs and grasses. Reseeding should be conducted just prior to the rainy season to enhance germination and plant establishment. The reseeding mix should include species used by and beneficial for native pollinators. The Service can work with you in developing this seed mix.

6. Minimize the impact of removal and trimming of all trees and shrubs by having these activities supervised and/or completed by a certified arborist.

7. Compensate the loss of oak woodland, riparian forest, riparian scrub-scrub, and emergent wetland at a ratio of at least 2:1. The Corps should work with the Service and other resource agencies on the development of a riparian plan that will evaluate locations for riparian vegetation planting based on land use in the lower American River Parkway, effects from known future projects, such as the reoperation of Folsom Dam, where existing riparian and

valley elderberry longhorn beetle habitat exists, creating and maintaining connectivity between large riparian patches, and coordination with Sacramento County Parks. For the loss of other cover-types, the Corps should work with the Service and other resource agencies on the development of compensation success benchmarks to ensure that goals are achieved.

8. All bank protection areas should be planted with a diverse mix of woody and herbaceous riparian vegetation. Sites should be diverse (a mix of riparian forest and scrub-shrub) and fit into the surrounding landscape. The planting plan should take into account what is missing from the surrounding vegetation and attempt to create heterogeneous habitats. The Corps should develop a baseline map of existing vegetation communities. Given the amount of rock already placed and the amount proposed for placement, this can serve to create diverse and heterogeneous habitats.

9. Include within the planting contract a provision for the contractor to plant understory species after some of the woody canopy has established. Studies have shown that planting late successional understory species after woody species canopy cover has been established provides better success for establishing these understory plants. Incorporating these species within the planting mix provides more diverse habitat for wildlife species (Johnston 2009).

10. Contact the California Department of Fish and Wildlife regarding possible effects of the project on State listed species.

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APPENDIX 1

U.S. FISH AND WILDLIFE ENDANGERED SPECIES CONSULTATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825-1846

In Reply Refer to:
08ESMF00-
2014-F-0518

SEP 11 2015

Ms. Alicia E Kirchner
Chief, Planning Division
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814

Subject: Formal Consultation on the American River Common Features (AFRC) Project, Sacramento County, California

Dear Ms. Kirchner:

This letter is in response to the U.S. Army Corps of Engineers (Corps) April 3, 2015, request for consultation with the U.S. Fish and Wildlife Service (Service) on the proposed American River Common Features General Reevaluation Report (ARCF GRR) project in Sacramento County, California. You request was received by the Service on April 7, 2015. The Corps originally initiated consultation on June 30, 2014; however, the Service responded on July 23, 2014, with a request for additional information regarding the project description and the effects analysis the Corps had completed. The April 3, 2015, letter and biological assessment began the formal consultation period. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The Federal action on which we are consulting is the ARCF GRR, which includes levee improvements and bank protection along the Sacramento River, levee improvements along Arcade, Magpie, and Dry/Robla Creeks, widening the Sacramento Bypass and Weir, and bank protection along the lower American River. Pursuant to 50 CFR 402.12(j), you submitted a biological assessment for our review and requested concurrence with the findings presented therein. These findings conclude that the proposed project may affect and is not likely to adversely affect the vernal pool fairy shrimp (*Branchinecta lynchi*) and vernal pool tadpole shrimp (*Lepidurus packardi*); may affect likely to adversely affect the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), delta smelt (*Hypomesus transpacificus)* (smelt) and its critical habitat; the giant garter snake (*Thamnophis gigas*); and the yellow-billed cuckoo (*Coccyzus americanus occidentalis*). The project is outside of critical habitat designated for the valley elderberry longhorn beetle and critical habitat proposed for the yellow-billed cuckoo.

The Corps previously consulted with the Service on the Magpie Creek Flood Control Project and on September 15, 2004 a biological opinion regarding effects to the vernal pool fairy shrimp, vernal pool tadpole shrimp, and giant garter snake (File # 1-1-04-F-0132) was provided. The project described in the 2004 biological opinion is exactly the same as the Magpie Creek portion of the

project description in the Common Features biological assessment. Because the environmental baseline for vernal pool fairy shrimp and vernal pool tadpole shrimp has not changed from the baseline that was analyzed in the 2004 biological opinion and the project description remains the same, effects to and take of vernal pool fairy shrimp and vernal pool tadpole shrimp are addressed i the September 15, 2004, biological opinion. More recent information regarding the status of the habitat along Magpie Creek for giant garter snake has changed from the 2004 biological opinion. This opinion addresses those changes and any potential effects to the giant garter snake.

Seasonal wetlands, which may provide suitable habitat for vernal pool fairy shrimp and vernal pool tadpole shrimp, occur in the vicinity of the Robla Creek woodland mitigation site A, however any vernal pools in this area would be avoided by these activities. The Corps will implement a 250-foot buffer between vernal pools and vegetation planting. Planting activities will be done in the fall when the wetlands are dry and will use best management practices to ensure that sediment does not enter the seasonal wetlands. The Service concurs that with your determination of may affect, not likely to adversely affect vernal pool fairy shrimp and vernal pool tadpole shrimp at the Robla Creek woodland mitigation site A.

This biological opinion is based on information provided in the Corps' letter requesting consultation and the biological assessment. A complete administrative record is on file at the Service's Sacramento Fish and Wildlife Office.

CONSULTATION HISTORY

September 4, 2013: The Service commented on the April 2013 draft biological assessment.

April 8, 2014: The Service commented on the October 2013 draft biological assessment.

June 30, 2014: The Corps initiated section 7 consultation with the Service.

July 23, 2014: The Service sent a letter in response to the Corps initiation requesting additional information.

April 3, 2015: The Corps provided an updated biological assessment with responses to the Service's July 23, 2014, request for additional information.

August 31, 2015: The Corps provided a revised biological assessment that addressed questions the Service had regarding the project description.

BIOLOGICAL OPINION

Description of the Action

Congress directed the Corps to investigate the feasibility of reducing flood risk of the city of Sacramento. The Corps completed feasibility studies in 1991 and 1996, recommending a concrete gravity flood detention dam on the north fork of the American River at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features." Thus, the ARCF Project was authorized in the Water Resources Development Act (WRDA) of 1996 and a decision on Auburn Dam was deferred

to a later date. Major construction components of ARCF in the WRDA 1996 authorization included construction of seepage remediation along about 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas.

Following the 1986 flood, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5. In addition, both the north and south bank of the American River from RM 0 to about RM 11.4 experienced seepage. Seepage on the Sacramento River was so extensive that Congress, soon after the 1986 flood event, funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport.

Shortly thereafter, the Sacramento Valley experienced a flood event in 1997. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was expected because remediation measures had yet to be constructed, but the occurrence of significant seepage on the Sacramento River in the reach remediated as part of the Sac Urban Project was alarming and confirmed that deep underseepage was also of significant concern. As a result, seepage remediation on the American River (then in the late 1990s in the design phase) would need to be designed to remediate both through- and deep underseepage.

In 1999, Congress decided not to authorize Auburn Dam, but instead authorized improvements for Folsom Dam. By doing this, improvements to levees downstream of Folsom Dam could be fine-tuned to work closely with the Folsom improvements being discussed by Congress. Therefore, the ARCF project was modified by WRDA 1999 to include additional necessary features for the American River so that it could safely convey the proposed emergency release of 160,000 cubic feet per second (cfs) from Folsom Dam. Major construction components for the ARCF project in the WRDA 1999 authorization include construction of seepage remediation and levee raise along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of Natomas Cross Canal levee in Natomas. All American River features authorized in WRDA 1996 and 1999 have been constructed or are in design analysis for construction within a year or two.

The purpose of the ARCF project is to reduce the flood risk for the city of Sacramento. The following problems were identified within the Sacramento levee system:

- Seepage and underseepage;
- Levee erosion;
- Levee stability;
- Levee overtopping;
- Access for maintenance and flood fighting;
- Vegetation and encroachments;
- Releases from Folsom Dam;
- Floodplain management; and
- Additional upstream storage from existing reservoirs.

In order to evaluate the effects to listed species, the Corps looked at the largest foreseeable footprint. As the Corps moves into the design phase of the project, footprint changes will likely reduce the effects to listed species.

The project is designed to allow for the release of 160,000 cubic feet per second (cfs) from Folsom Dam. The levees along the American River are unable to withstand these maximum flows for extended periods of time without increased risk of erosion and potential failure. The exact location where erosion will occur and to what extent erosion will occur during any given event is unknown. Erosion within the American River Parkway will be addressed as part of the Folsom Dam Water Control Manual Update currently under evaluation and a biological assessment is being prepared to initiate section 7 consultation with both the Service and National Marine Fisheries Service (NMFS). Therefore, the effects of erosion along the lower American River and effects of increased Yolo Bypass flooding frequency due to changes in operations from Folsom Dam are not analyzed in this project description. This is because construction of the American River and Sacramento Bypass measures, which are dependent on releases from Folsom Dam, will not occur until after a biological opinion is received for the Water Control Manual Update. Sacramento River and East Side Tributaries measures are necessary to improve the flood risk management system in the Sacramento area regardless of the change in operation at Folsom Dam and are not dependent on Folsom Dam operations for their implementation. As a result, construction in these areas could occur regardless of the Folsom Dam Water Control Manual Update schedule.

The Corps' project involves the construction of fix-in-place levee remediation measures to address seepage, stability, erosion, and height concerns identified for the Sacramento River and American River levees, Natomas East Main Drainage Canal (NEMDC), Arcade, Dry/Robla, and Magpie Creeks (Figure 1). Most height concerns along the Sacramento River will be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass. Due to the urban nature and proximity of existing development within the American River North and South basins the Corps is planning fix in place remediation. This would improve the flood damage reduction system to safely convey flows to a level that maximizes net benefits. Table 1 summarizes the levee problems discussed above and the proposed measure for each waterway.

Sacramento Area Flood Control Agency (SAFCA), the project's local sponsor, will complete some portions of the Federal project. SAFCA is seeking permission from the Corps pursuant to 33 USC §408 (Section 408) for alteration of the Federal levees along the NEMDC and Arcade Creek.

In addition to the proposed levee improvements measures shown in Table 1, the following measures and policies would be addressed during construction:

- The non-Federal (Department of Water Resources (DWR)) will bring the levees into compliance with the Corps' standard levee footprint using a System Wide Implementation Framework (SWIF) process. A SWIF is a plan developed by the levee sponsor(s) and accepted by the Corps to implement system-wide improvements to a levee system (or multiple levee systems within a watershed) to address system-wide issues, including correction of unacceptable inspection items, in a prioritized way to optimize flood risk reduction. The standard levee footprint consists of a 20 foot crown width, 3:1 waterside

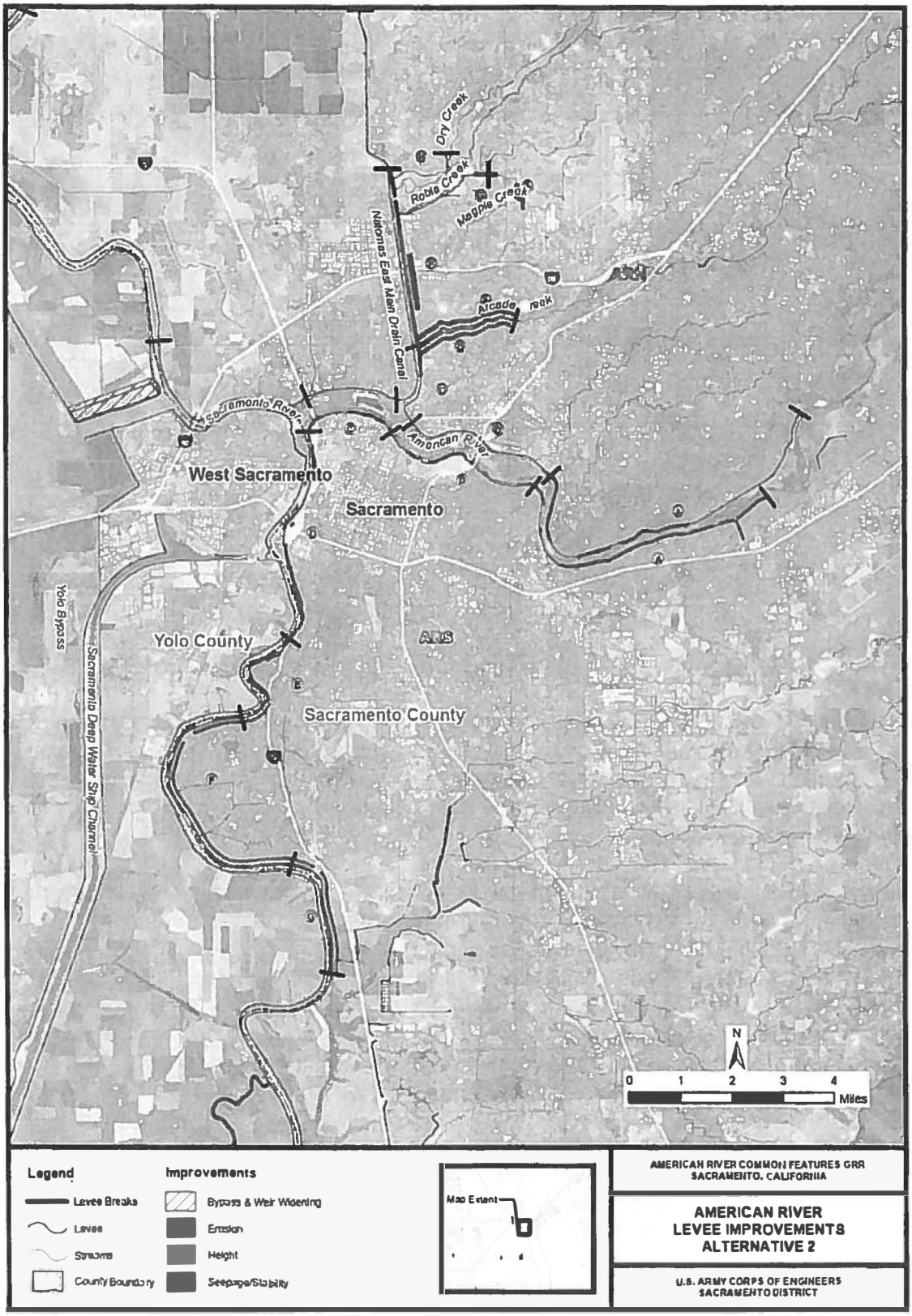

Figure 1. American River Common Features Project Area

Table 1. Remediation by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench (31,000 linear feet)	---
Sacramento River	Cutoff Wall (50,300 linear feet)	Cutoff Wall (50,300 linear feet)	Bank Protection (50,300 linear feet)	Sacramento Bypass and Weir Widening, Levee Raise (1,500 feet)
NEMDC	Cutoff Wall (6,000 linear feet)	Cutoff Wall	---	Floodwall (15,600 linear feet)
Arcade Creek	Cutoff Wall (22,000 linear feet)	Cutoff Wall	---	Floodwall (22,000 linear feet)
Dry/Robla Creeks	---	---	---	Floodwall (2,500 linear feet)
Magpie Creek[2]	---	---	---	Floodwall, Levee Raise

[1]American River seepage, stability, and overtopping measures were addressed in a previous construction project.

[2]In addition to the floodwall, Magpie Creek will include construction of a new levee (3,100 linear feet) along Raley Boulevard south of the creek, and construction of a detention basin on both sides of Raley Boulevard (79 acres). In addition, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek Bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

slope and 2:1 landside slope, when possible. If the 3:1 waterside slope is not possible, then a minimum 2:1 waterside slope would be established instead.

- Engineering Technical Letter 1110-2-583 (ETL) vegetation compliance would occur under a SWIF by the local maintaining agency (LMA). The intent of the SWIF is to collaboratively work with the resource agencies and levee sponsors to transition existing levees to Corps standards while maintaining Public Law (PL) 84-99 rehabilitation assistance and adhering to the Act and other environmental laws. The SWIF is a two-step process completed by the applicant that is composed of a letter of intent, which is followed by submission of a SWIF plan. The SWIF process allows eligible local sponsors to implement levee improvements in a prioritized "worst first" way to optimize the achievement of risk reduction. The Corps acknowledges that implementing system-wide improvements will need to be done within a collaborative intergovernmental framework and that it will take time to develop and implement improvements in complex situations. Challenges including ensuring that both environmental and levee safety considerations are adequately served.
- The vegetation requirements for the SWIF include a 15-foot waterside, landside, and vertical vegetation-free zone. Trees that pose an unacceptable risk to levee integrity will be removed and the root balls and roots will be remediated. Trees that do not pose a threat will not be removed. Vegetation on the landside slope would only be removed within the construction

footprint (up to ½ levee degrade) and the remaining vegetation would be dealt with under the SWIF process.

- Utility encroachments will be brought into compliance with Corps policy. Utilities that penetrate the levee would be removed and replaced with one of two fixes: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.
- Private encroachments shall be removed by the non-Federal sponsor prior to construction.
- The Sacramento District of the Corps will pursue a vegetation variance which will allow vegetation on the lower ½ of the levee slope to 15 feet waterward of the waterside levee toe to remain in place. The Sacramento District has conducted an evaluation which examined the safety, structural integrity, and functionality of the levees that will be retained and not compromised if a tree were to fall and result in scouring of the root ball area. The results show that the tree fall and scour did not significantly affect levee performance, and the levee meets Corps seepage and slope stability criteria assuming the entire project is constructed.

American River

Levees along the American River require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion to the river bank and levee, which could potentially undermine the levee foundation. There are two measures proposed for the American River levees: (1) a maximum of 31,000 linear feet (LF) of bank protection, and (2) a maximum of 65 acres/45,000 LF of launchable rock trench. Both of these measures are described in detail in the subsections below. These numbers are maximized because there is some overlap identified to account for the uncertainty of site-specific conditions. For example, for some reaches both bank protection and launchable rock trench impacts were estimated even though both measures will not be constructed in the same reach.

Bank Protection

This measure consists of placing rock revetment on the river's bank to prevent erosion. It entails installing revetment along the stream bank based on site-specific analysis (Figure 2). When necessary, the eroded portion of the bank will be filled and compacted prior to the rock placement. The sites will be prepared by clearing and stripping of loose material and understory growth prior to construction. In most cases, large vegetation will be permitted to remain at these sites. Temporary access ramps will be constructed, if needed, using imported borrow material that would be trucked on site.

The placement of rock onto the bank will occur from a land based staging area using long reach excavators and loader. The loader brings rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the waterside of the levee.

The revetment will be placed on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a planting berm will be constructed in the rock to allow for revegetation of the site. The planting berm varies in width from 5 to 15 feet. In all cases the planting will occur outside the vegetation free zone as required by the ETL.

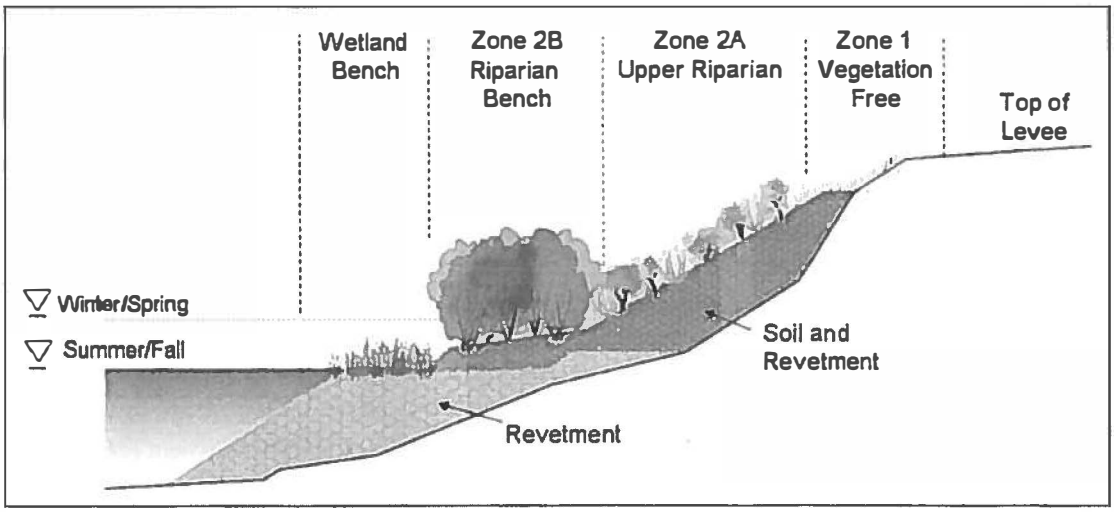

Figure 2. Bank Protection with Planting Bench.

Launchable Rock Trench

For the purposes of this project description, it is assumed that 65 acres of the lower American River will have a launchable rock trench fix. The remainder will be the bank protection described above. This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it (Figure 3). All launchable rock trenches will be constructed outside of the natural river channel. The vegetation will be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration will include a 2:1 landside slope and 1:1 waterside slope and will be excavated at the toe of the existing levee. All soil removed during trench excavation will be stockpiled for potential reuse. The bottom of the trench will be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench will be filled with revetment that will be imported from an offsite commercial location. After rock placement the trench will be covered with a minimum of 3 feet of the stockpiled soil for a planting berm. Rock placed on the levee slope will be covered with 2 feet of stockpiled soil. All disturbed areas will be reseeded with native grasses and small shrubs where appropriate. Trees and shrubs could be permitted on the trench if planted outside the specified vegetation free zone as required by the ETL.

Sacramento River

Levees along the Sacramento River require improvements to address seepage, stability, and erosion. About 50,300 LF of bank protection and cutoff wall or slope stability work is proposed for the Sacramento River. In addition, these levees require a total of one mile of intermittent height improvements in order to convey additional flows that exceed current design levels.

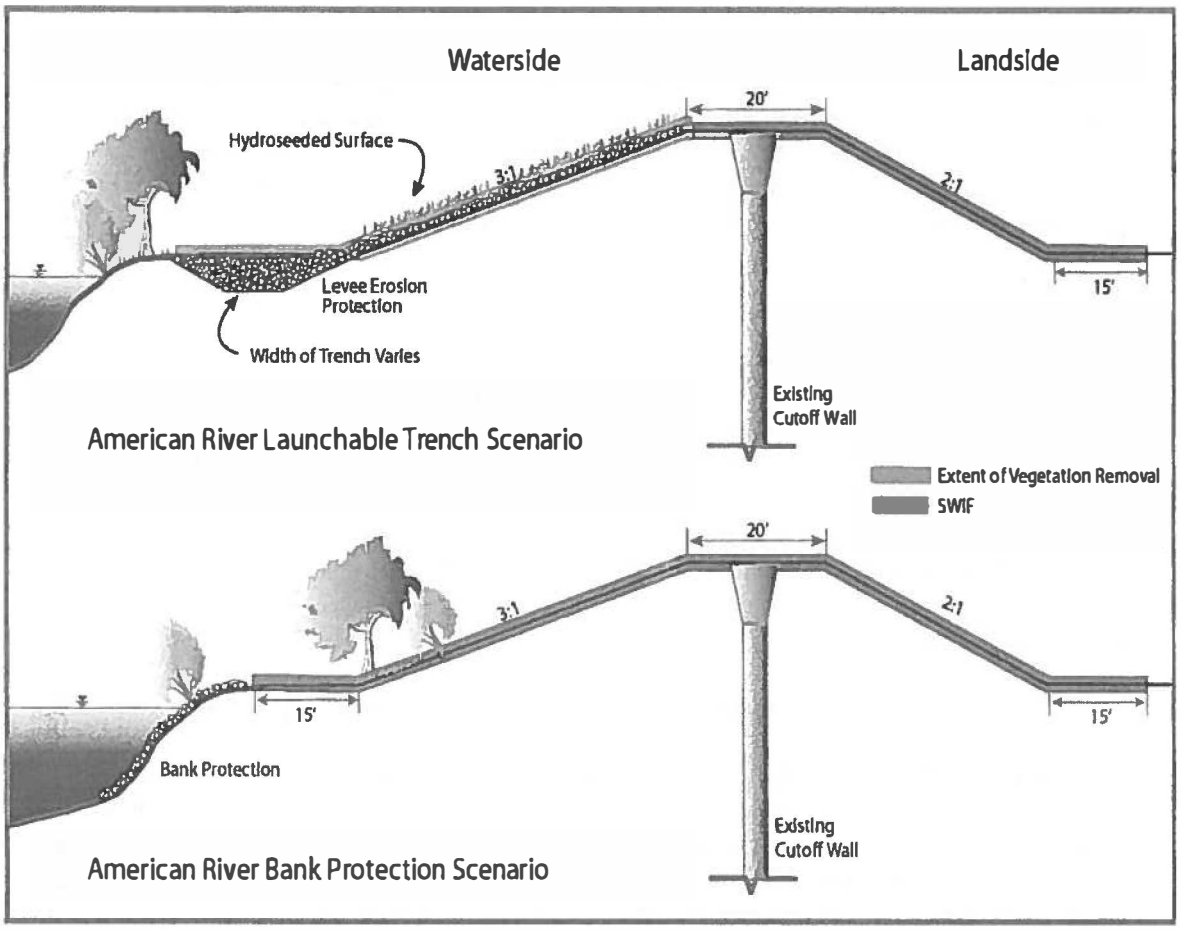

Figure 3. Launchable Rock Trench and Bank Protection.

Where the existing levee does not meet the levee design requirements, as discussed above, slope flattening, crown widening, and/or a minimal amount of levee raise is required. This improvement measure addresses problems with slope stability, geometry, height and levee crest access and maintenance. To begin levee embankment grading, loose material and vegetation understory will be cleared, grubbed, stripped, and where necessary, portions of the existing embankment will be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) will be stockpiled at staging areas. Haul trucks and front end loaders will bring borrow materials to the site, which will then be spread evenly and compacted according to levee design plans.

The levee will be raised about 1 to 2 feet resulting in the levee footprint extending out a maximum of 5 feet on the landside from the existing levee. The levee crown patrol road will be re-established at the completion of construction.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown. The cutoff wall will be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach will depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of about 85 feet. For cutoff walls of greater depth the DSM method will be utilized.

Prior to any cutoff wall construction method, the construction site and any staging areas will be cleared, grubbed, and stripped. The levee crown will be degraded up to half the levee height to create a large enough working platform (about 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. This method of slurry wall installation will also reduce the risk of slurry mixture following seepage paths and leaking into the river or into landside properties.

Open Trench Cutoff Wall

Under the open trench method, a trench about 3 feet wide will be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it is filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry was hardened, it will be capped and the levee embankment will be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of about 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout will be injected through the augers and mixed with the native soils. An overlapping series of mixed columns will be drilled to create a continuous seepage cutoff barrier. A degrade of up to one half the levee height will be required for construction of the DSM wall. For both methods, once the slurry has hardened it will be capped and the levee embankment will be reconstructed with impervious or semi-impervious soil.

Bank Protection

Proposed bank protection along the Sacramento River will address erosion concerns. Studies have shown that the Sacramento River levees have a medium to high risk of breach due to erosion. Bank protection will be addressed by standard bank protection with planting berm. The standard bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, where necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. Large trees on the lower half of the waterside slope will be protected in place to retain shaded riverine aquatic (SRA) habitat. The sites will be prepared by removing vegetation along the levee slopes at either end of the site for construction of a temporary access ramp, if needed. The ramp will then be constructed using imported commercial borrow material that will be trucked on site.

The placement of rock onto the levee slope will occur from atop the levee and/or from the waterside by means of barges. Rock required within the channel, both below and slightly above the water line at the time of placement, will be placed by an excavator located on a barge. Construction will require two barges: one barge would carry the excavator, while the other barge will hold the stockpile of rock to be placed on the channel slopes. Rock required on the upper portions of the slopes will be placed by an excavator located on top of the levee. Rock placement from atop the levee will require one excavator and one loader for

each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the waterside of the levee.

The revetment will be placed via the methods discussed above on existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a small planting berm will be constructed in the rock to allow for some revegetation of the site.

Natomas East Main Drain Canal

The east levee of the NEMDC requires 6,000 LF of improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A cutoff wall will be constructed at this location to address the seepage and stability problems. The cutoff wall will be constructed by one of the methods described in the Sacramento River section above. SAFCA is proposing to construct 1,700 LF of cutoff wall beginning just south of the confluence of Arcade Creek and extending south along the NEMDC. The Corps will construct the remaining 4,300 LF of cutoff wall.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A centerline cutoff wall will be constructed to address seepage along 22,000 LF of the Arcade Creek levees. Levees from Rio Linda Boulevard to Marysville Boulevard will have a cutoff wall constructed at the waterside toe of the levee. Construction of the waterside toe cutoff wall will require constructing a work bench along the toe of the levee. Excavation for the bench will extend deep enough below existing grade to remove organic material and soft, unsuitable foundation soils. Bench excavation will also extend into the existing waterside slope of the levee as needed. Riprap will be placed on the waterside benches after construction of the waterside toe cutoff wall. Some portions of the Arcade Creek north levee will require more substantial excavation and reconstruction of the waterside slope to provide a low permeable seepage levee slope barrier. Bench fill material will be integrated with the slope reconstruction fill to provide an integral seepage barrier with the cutoff wall over the full height of the levee slope. A small section of levee will have a sheet pile cutoff wall at the centerline of the levee, rather than the waterside toe cutoff wall.

There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path, and could affect the stability of the levee. The ditch will be replaced with a conduit or box culvert and then backfilled. This will lengthen the seepage path and improve the stability of the levee. Additionally, pressure relief wells will be installed along the landside toe of the levee along the north levee west of Norwood Avenue.

The majority of the Arcade Creek levees have existing floodwalls, however there remains a height issue in this reach. A 1 to 4-foot floodwall will allow the levees to pass flood events greater than the current design level. The floodwall will be placed on the waterside hinge point of the levee and will be designed to disturb a minimal amount of waterside slope and levee crown for construction. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with aggregate base.

Dry and Robla Creeks

The Dry and Robla Creeks levees require improvements to address overtopping when flood events exceed the design level. Height improvements will be made with a new floodwall constructed to a height of 4 to 6 feet along 2,500 LF of the south levee. The floodwall will be placed at the waterside hinge point of the levee and will be designed to disturb a minimal amount of waterside slope and levee crown for construction. Construction of the floodwall will be consistent with the description for Arcade Creek above. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with aggregate base.

Magpie Creek Diversion Canal

The Magpie Creek Diversion Canal project description is the same as was described in the September 15, 2004 biological opinion.

Sacramento Weir and Bypass

The Sacramento Weir was completed in 1916. It is the only weir in the Sacramento River Flood Control Project that is manually operated; all others overflow by gravity on their own. It is located along the right bank of the Sacramento River about 4 miles upstream of the Tower Bridge, and about 2 miles upstream from the confluence with the American River. Its primary purpose is to protect the city of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The weir limits flood stages (water surface elevations) in the Sacramento River to project design levels through the Sacramento/West Sacramento area. Downstream of the Sacramento Weir, the design flood capacity of the American River is 5,000 cfs higher than that of the Sacramento River. Flows from the American River channel during a major flood event often exceed the capacity of the Sacramento River downstream of the confluence. When this occurs, floodwaters flow upstream from the mouth of the American River to the Sacramento Weir.

The project design capacity of the weir is 112,000 cfs. It is currently 1,920 feet long and consists of 48 gates to divert floodwaters to the west through the mile-long Sacramento Bypass to the Yolo Bypass. Each gate has 38 vertical wooden plank "needles" (4 inches thick by 1 foot wide by 6 feet long).

Though the weir crest elevation is 24.75 feet, the weir gates are not opened until the river reaches 27.5 feet at the I Street gage with a forecast to continue rising. This gage is about 1,000 feet upstream from the I Street Bridge and about 3,500 feet upstream from the mouth of the American River. The number of gates to be opened is determined by the National Weather Service/DWR river forecasting team to meet either of two criteria: (1) to prevent the stage at the I Street gage from exceeding 29 feet, or (2) to hold the stage at the downstream end of the weir to 27.5 feet (DWR 2010). The weir gates are then closed as rapidly as practicable once the stage at the weir drops below 25 feet. This provides "flushing" flows to re-suspend sediment deposited in the Sacramento River between the Sacramento Weir and the American River during the low flow periods when the weir is open during the peak of the flood event (DWR 2010).

The Sacramento Weir and Bypass will be expanded to roughly twice their current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass will be degraded and a new levee would be constructed 1,500 feet to the north. The existing Sacramento Weir will be expanded to match the wider bypass. At this time, it is not known whether the new segment of weir will be constructed consistent with the 1916 design described above, or whether it

will be designed to be a gravity-type weir. The new north levee of the bypass will be designed to be consistent with the existing Sacramento Bypass north levee; however, it will also include a 300-foot-wide seepage berm on the landside with a system of relief wells. A hazardous, toxic, and radiological waste site near the existing north levee will be remediated by the non-Federal sponsor prior to construction.

Operation of the new segment of the Sacramento Weir will occur during high water situations only, when the American River flows exceed 115,000 cfs. The existing Sacramento Weir will be operating at the pre-existing conditions described above. There are not expected to be any water quality impacts, though this has not been specifically modeled. The approximate change in water diversions, which are shown in Table 2, will vary based on the size of the flood event. The frequency of water diversion is expected to be the same, dependent on the stream gage at the I Street Bridge reaching 27.5 feet.

The widened portion of the Sacramento Weir will only be operated when the release from Folsom Dam is above 115,000 cfs. With the Folsom Dam improvements in place, releases from Folsom Dam will be above 115,000 cfs for flood events greater than the 100-year event. Therefore, for events up to and including the 100-year event, only the existing weir will be operated per the criteria previously established. For events greater than the 100-year event, when the release from Folsom Dam will go above 115,000 cfs, the new weir will be opened. Therefore, for events up to the 100-year event there will be no change in flow conditions in the Sacramento and Yolo Bypasses.

Table 2. Comparison of 10-, 100-, and 200-year Frequency Flows under Various Conditions

10-Year Event	Existing Condition	Future Without Project Condition	Future With Project Condition
American River	43,000 cfs	72,000 cfs	72,000 cfs
Sacramento Bypass	50,000 cfs	66,000 cfs	66,000 cfs
Yolo Bypass below Sacramento Bypass	270,000 cfs	296,000 cfs	296,000 cfs
100-Year Event	Existing Condition	Future Without Project Condition	Future With Project Condition
American River	145,000 cfs	115,000 cfs	115,000 cfs
Sacramento Bypass	131,000 cfs	115,000 cfs	115,000 cfs
Yolo Bypass below Sacramento Bypass	555,000 cfs	535,000 cfs	535,000 cfs
200-Year Event	Existing Condition	Future Without Project Condition	Future With Project Condition
American River	320,000 cfs	160,000 cfs	160,000 cfs
Sacramento Bypass	183,000 cfs	149,000 cfs	164,000 cfs
Yolo Bypass below Sacramento Bypass	656,000 cfs	631,000 cfs	643,000 cfs

For the 200-year event, there will be an increase in flows in the Sacramento Bypass of about 15,000 cfs. In the Yolo Bypass, this equates to an increase of about 0.10-foot of water surface elevation. During the 200-year event, the Yolo Bypass is already flooded from levee to levee. The addition of these flows will equate to about 0.5-foot of additional width on the Yolo Bypass levee slopes.

High Hazard Levee Encroachment and Vegetation Removal

The National Flood Insurance Program (NFIP) standards for levee accreditation and the State's ULDC both require removal or modification of encroachments that pose an unacceptably high risk to the performance and safety of a levee either by undermining its structural integrity or by interfering with necessary inspection, operation, and maintenance activities. To address this requirement, SAFCA has identified and evaluated all of the encroachments in the NEMDC, Robla Creek, and Arcade Creek area. Each of these encroachments has been evaluated and based on this evaluation the encroachments have been classified as either:

- High-risk – poses a threat to levee integrity, removable prior to the levee being accredited;
- High-risk – impedes operation, maintenance, and inspection, removable within 3 years after the levee is accredited; or
- Low-risk – not identified as high hazard.

High-risk encroachments to be removed are limited to residential landscaping located at 10 locations along the landside of the south and north levees of Arcade Creek and along the Robla Creek south levee.

Vegetation on levees must be modified or removed if it presents an unacceptable risk to the structural integrity or impedes operation and maintenance of the levee. Eight high-risk trees along Arcade Creek have been identified for removal. All of the trees are either nonnative (7) or snags (1). Five are located on the waterside of the levees. These trees are in addition to any trees that will be removed as a result of implementation of levee improvements in the Arcade Creek area.

Utility Relocation

Existing encroachments and penetrations within the NEMDC and Arcade Creek have been inventoried by SAFCA. Many utilities will be avoided, however some utilities may need to be temporarily removed or relocated prior to construction. Temporary bypass pumping may be required for sanitary sewers. SAFCA and the construction contractors will coordinate with utility owners to manage the utilities in advance of construction. Disturbed utilities will be restored after construction consistent with Central Valley Flood Protection Board requirements.

Stormwater Pollution Prevention

Temporary erosion/runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. These temporary control measures may include implementing construction staging in a manner that minimizes the amount of area disturbed at any one time; secondary containment for storage of fuel and oil; and the management of stockpiles and disturbed areas by means of earth berms, diversion ditches, straw wattles, straw bales, silt fences, gravel filters, mulching, revegetation, and temporary covers as appropriate. Erosion and stormwater pollution control measures will be consistent with National Pollutant Discharge Elimination System (NPDES) permit requirements and included in a Stormwater Pollution Prevention Plan (SWPPP).

After completion of construction activities, the temporary facilities (construction trailers and batch plants) will be removed and the site would be restored to pre-project conditions. Site restoration activities for areas disturbed by construction activities, including borrow areas and staging areas, will

include a combination of regrading, reseeding, constructing permanent diversion ditches, using straw wattles and bales, and applying straw mulch and other measures deemed appropriate.

Borrow Sites, Haul Routes, and Staging Areas

Borrow Sites - It is estimated that a maximum of 1 million cubic yards (cy) of borrow material will be needed to construct the project. Detailed studies of the borrow needs have not been completed. Actual volumes exported from any single borrow site will be adjusted to match demands for fill. Borrow sites will be selected that avoid effects to endangered species or their habitat.

To identify potential locations for borrow material soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. Except as discussed below for Arcade Creek and NEMDC, eventual borrow site selection will include the following criteria: avoid threatened and endangered species effects and habitat, current land use patterns, and soil types.

Excavation limits on the borrow sites will provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation will be no steeper than 3:1. Excavation depths from the borrow sites will be determined based on available suitable material. The borrow sites will be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites will be returned to their existing use whenever possible, or these lands could be used to mitigate for project effects, if appropriate.

Because SAFCA has completed more detailed design and studies for work along NEMDC and Arcade Creek the borrow site has been selected. Borrow site 2 is located along the east side of the NEMDC north of where the levee repairs will occur. About 27,000 cubic yards of material will be excavated from the 5.5-acre borrow site in order to construct levee improvements along the NEMDC and Arcade Creek. Following borrow activities the site will be contoured to create about 0.5 acre of tule bench, set an elevation the will provide aquatic habitat all year, 1.0 acre of higher bench with seasonal wetlands, that will flood in the winter and spring, and 3.5 acres of native grassland.

Clean rock will be commercially acquired in order to construct the American and Sacramento River bank protection sites. For the Sacramento River, rock will be acquired from a commercial source in the Bay Area and barged up the Sacramento River to the construction sites. Rock for the American river sites will be acquired from a commercial source within a 50-mile radius and will be hauled in trucks to the construction sites.

Haul Routes – Haul routes will be determined during the design phase and will depend on what borrow sites and staging areas are selected. Haul routes will be selected based on existing commercial routes and levee roads. Haul routes will be selected that avoid effects to federally listed species.

For Arcade Creek and NEMDC, haul trucks will leave borrow site 2 and use East Levee Road from the borrow site down to a point just north of the existing Del Paso/Main Avenue Bridge over NEMDC. Temporary bridges crossing the NEMDC and Arcade Creek will be used to allow haul trucks to reach repair sites. Railroad car undercarriages on temporary abutment supports will be one option for temporary bridge crossings.

Staging Areas – Staging areas will be selected that do not require the removal of vegetation or habitat that is used by threatened or endangered species or effect threatened or endangered species. Four potential staging areas have been identified for improvements along Arcade Creek. All four

areas will require little preparation other than surface striping and temporary connection roads and ramps to the levee crown. The primary use of staging areas will be for temporary trailers, parking, and material staging. Additionally, there will need to be space to process material and an area where excavated soils and imported soils will be spread out and processed material. Importing, processing, and exporting material for levee reconstruction will be continuous activities once the work flow is established during the start of the construction season. Staging areas will be returned to pre-project conditions following construction activities unless the owner agrees to some grade raising to help dispose of excess construction soils.

Operation and Maintenance

Operation and maintenance (O&M) of the levees in the Sacramento area are the responsibility of the local maintaining agencies, including the American River Flood Control District, the DWR, and the City of Sacramento. The applicable O&M Manual for the Sacramento area levees is the Standard Operation and Maintenance Manual for the Sacramento Flood Control Project. Typical levee O&M in the Sacramento in the Sacramento area currently includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.
- Post-construction, groundwater levels will be monitored using the piezometers.

The Corps will work with local maintaining agencies to develop the maintenance activities necessary for long-term operations and maintenance. This will occur during the preconstruction engineering and design phase of the project. The Corps will evaluate if these maintenance activities will affect any Federally-listed species and reinitiate section 7 consultation if there will be adverse effects to listed species. Currently, the Corps only has a project description for activities that will affect valley elderberry longhorn beetle habitat. This is included below.

Following construction, the O&M manual for these reaches will be adjusted to reflect the vegetation variance and the SWIF plan. Under the adjusted O&M manual, large trees that are protected in place under the variance will be allowed to remain on the waterside slopes and additional vegetation will be planted on the planting benches.

Vegetation maintenance includes keeping maintenance roads clear of overhanging branches. Some of the vegetation along the levees includes elderberry shrubs. As part of long-term O&M, elderberry shrubs will be trimmed by the three levee maintenance districts. Table 3 describes the maximum amount of elderberry acreage that will be trimmed each year as a result of O&M. Trimming consists of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. Up to a third of a shrub will be trimmed in a single season. Trimming will occur between November 1 and March 15. Loss of habitat will be offset through the development of a conservation area as described in the conservation measures below. Each year the local maintaining agency will document the amount of valley elderberry longhorn beetle habitat that they have trimmed and report that number to the Corps to ensure compliance with this biological opinion. If the local maintaining agency has a need to exceed the amount of valley elderberry longhorn beetle

habitat which needs to be trimmed or affected due to routine maintenance, then they will request the Corps reinitiate consultation on this biological opinion for those actions.

Table 3. O&M by Maintaining Agency

Local Maintaining Agency	Levee Systems Covered	Annual Acreage of Trimmed Elderberry Shrubs*	Total Acreage of Elderberry Shrubs Trimmed over the 50 Year Life of the Project
American River Flood Control District	Lower American River, Dry/Robla Creek, Arcade Creek, NEMDC	0.5	25
Maintenance Area 9	Sacramento River east levee between Sutterville Road and the Beach Lake Levee	0.2	10
City of Sacramento	Sacramento River East Levee between the confluence of the American River and Sutterville Road	0.1	5

*acreage based on an estimated average shrub of 0.027 acre and no more than 1/3 of a shrub trimmed any given year.

Valley Elderberry Longhorn Beetle Habitat

Valley elderberry longhorn beetles are closely associated with elderberry shrubs. In 2011, the Corps conducted surveys and mapped all of the elderberry shrubs on the levees and 15 feet on either side of the levee. Elderberry shrubs were located along the American River and Sacramento River. The Corps counted shrub clusters and used elderberry stem counts from previous projects in the area to estimate a standard number and size of elderberry stems per shrub cluster. Tables 4 and 5 list the stem counts for shrubs along the American River and Sacramento River respectively. While shrubs exist along Arcade Creek or Magpie Creek, the Corps and SAFCA will avoid effects to the beetle by following the conservation measures below.

Table 4. American River Elderberry Shrub Effects and Compensation

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios	Elderberry Plantings	Associated Native Planting	Associated Native Ratios
riparian	> or = 1" & < or = 3"	no	1,998	2	3,996	3,996	1
		yes	0	4	0	0	2
riparian	> 3" & < 5"	no	790	3	2,370	2,370	1
		yes	16	6	96	192	2
Riparian	> or = 5"	no	312	4	1,248	1,248	1
		yes	23	8	184	368	2
TOTAL			**3,139**		**7,894**	**8,174**	
				total basins or credits=	1,606.8		
				total acres for compensation	66.40		

Table 5. Sacramento River Elderberry Shrub Effects and Compensation

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios	Elderberry Plantings	Associated Native Plantings	Associated Native Ratios
riparian	> or = 1" & < or = 3"	no	104	2	208	208	1
		yes	0	4	0	0	2
riparian	> 3" & < 5"	no	40	3	120	120	1
		yes	1	6	6	12	2
riparian	> or = 5"	no	16	4	64	64	1
		yes	2	8	16	32	2
TOTAL			**163**		**414**	**436**	
				total basins or credits=	85		
				total acres need for compensation	3.51		

Delta Smelt Habitat

The American River lacks suitable turbidity making it unsuitable for delta smelt. Due to the higher temperatures within Arcade Creek, Magpie Creek, and NEMDC it is also unlikely that delta smelt will use these tributaries. Therefore, suitable delta smelt habitat occurs within the Sacramento River in the reach where erosion protection will occur. The Corps has calculated that there will be a complete loss of 14 acres of shallow water habitat due to the placement of riprap and a change of substrate from natural soil to riprap on 32 acres.

Giant Garter Snake Habitat

Giant garter snakes are not known to use large rivers such as the American and Sacramento Rivers. Given the close proximity to urban development, high level of human disturbance, presence of riparian vegetation along the banks of most channel reaches, and lack of extensive marsh or rice to the east, giant garter snakes are unlikely to occur in Arcade Creek, Dry Creek, Robla Creek, Magpie Creek, or the southern section of the NEMDC (south of where Dry Creek enters). North of Dry Creek, the NEMDC has less woody vegetation, less urban development, and large areas of open grassland along the landside of the levee with rice farming occurring to the west of the grasslands. Therefore, there is potential for the snake to occur either in the upland or within the NEMDC north of where Dry Creek enters. Work in this location will involve removal of borrow material at borrow site 2 (5.5 acres of upland habitat).

Habitat for the giant garter snake also exists north of the existing Sacramento Bypass north levee. The land north of the Sacramento Bypass is currently agricultural fields producing row crops and nut orchards. Existing giant garter snake aquatic habitat occurs in drainage ditches and farm canals and the surrounding upland habitat. About 15 acres of aquatic habitat will be filled making it and the associated 30 acres of upland habitat unavailable to the giant garter snake. The Sacramento Bypass also has a toe drain along the levee with 25 acres of aquatic and 50 acres of upland habitat that will be relocated to the toe of the new Sacramento Bypass levee.

Yellow-billed Cuckoo Habitat

Yellow-billed cuckoos use riparian habitat for foraging and nesting. Suitable habitat occurs within the lower American River. The project will affect 65 acres of riparian habitat that could be used by the yellow-billed cuckoo. While riparian habitat occurs along Arcade Creek, Magpie Creek, and NEMDC it is very narrow and cuckoos are not likely to use these areas. Riparian habitat occurs along the Sacramento River and in some areas may be of such a width that a cuckoo could stop and use it during migration, but it is not wide enough to support a nesting pair of cuckoos. The Corps will remove 110 acres of riparian habitat along the Sacramento River and disturb an additional 50 acres of riparian habitat by removing the understory and placing rock around the large trees. The Sacramento Bypass does not have suitable habitat for the yellow-billed cuckoo. But riparian habitat does exist north of the existing Sacramento Weir along the Sacramento River (8 acres). Cuckoos have been observed in the Yolo Bypass in recent years (Ebird 2015).

Conservation Measures

Valley Elderberry Longhorn Beetle

- The Corps assumes complete avoidance of the valley elderberry longhorn beetle when a 100-foot (or wider) buffer is established and maintained around elderberry shrubs.
- When work will occur within the 100-foot buffer, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.
- During construction activities, all areas to be avoided will be fenced and flagged.
- Contractors will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs will be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area will be restored.
- Buffer areas will continue to be protected after construction.
- No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Elderberry shrubs that cannot be avoided would be transplanted to an appropriate riparian area at least 100 feet from construction activities.
- Elderberry shrubs will be surveyed prior to construction to ensure that the actual effects match the estimated effects of this biological opinion. If the Corps will effect more valley elderberry longhorn beetle habitat than estimated than they will reinitiate consultation with the Service.
- If possible, elderberry shrubs would be transplanted during their dormant season (November through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation will apply.
- Elderberry compensation will be planted in the American River Parkway. The Corps has six existing sites which are offsetting previous Corps flood control projects along the lower American River and near Folsom Dam. The Corps will find areas within the lower American River parkway which will either expand existing compensation areas or provide for connectivity between conserved valley elderberry longhorn beetle habitat. Sites within the lower American River parkway will be coordinated with Sacramento County Parks and the Service during the design phase of the project. Sites will be designed and developed prior to any effects to valley elderberry

longhorn beetle habitat. The Corps will create 69.91 acres of riparian habitat which supports valley elderberry longhorn beetle within the lower American River parkway for the transplantation of elderberry shrubs. In addition, the local sponsors will create an additional 40 acres of land to benefit the valley elderberry longhorn beetle or purchase 40 acres of credits at a Service approved conservation bank to offset the loss of habitat due to trimming of elderberry shrubs along the lower American River, Sacramento River, Dry/Robla Creeks, Arcade Creek, Magpie Creek, and NEMDC.

- Management of these lands will include all measures specified in the Service's conservation guidelines (1999a) related to weed and litter control, fencing, and the placement of signs.
- Monitoring will occur for 10 consecutive years or for 7 non-consecutive years over a 15-year period. Annual monitoring reports will be submitted to the Service.
- Compensation areas will be protected in perpetuity and have a funding source for maintenance (endowment).

Giant Garter Snake

- Unless approved otherwise by the Service, construction will be initiated only during the giant garter snakes' active period (May 1–October 1, when they are able to move away from disturbance).
- Construction personnel will be given a Service-approved worker environmental awareness program.
- A survey for giant garter snakes will be conducted within 24 hours prior to construction beginning in potential giant garter snake habitat. Should there be any interruption in work for greater than 2 weeks, a biologist will resurvey the area within 24 hours prior to the restart of construction.
- Giant garter snakes encountered during construction will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from giant garter snake aquatic habitat.
- Giant garter snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.
- Habitat temporarily affected for one season (the 5.5 acre borrow site along the NEMDC and the 75 acres along the toe drain of the Sacramento Bypass levee) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants. If for any reason construction extends into another active season the Corps will replace the habitat on-site and purchase credits at a ratio of 1:1 at a Service approved conservation bank.
- Habitat temporarily affected for more than three or more seasons will be restored and twice as much habitat will be created.
- Habitat permanently affected in the Sacramento Bypass in the form of drainage ditches and irrigation canals will be compensated for through the purchase of 135 acres of credits at a Service approved conservation bank.
- One year of monitoring will be conducted for the 80.5 acres that are temporarily affected.

- The Corps will purchase credits at a conservation bank prior to any permanent disturbance of giant garter snake habitat.
- A biological monitor will be on-site during all ground disturbing activities at borrow site 2.
- Exclusionary fencing will be placed, at least 10 days prior to the beginning of ground disturbing activities after May 1, to exclude giant garter snakes from entering areas where upland disturbance (borrow site 2 and Sacramento Bypass) will occur during the active season (May 1 to October 1). Prior to fencing installation, the fence line will be mowed (with a minimum height of 6 inches) in order to conduct a surface survey of potential burrows. Fencing will be installed with a minimum of 6 inches buried in the ground and a minimum of 24 inches above ground. Fence staking will be installed on the inside of the exclusion area. One-way escape funnels will be installed every 50 to 100 feet and sealed along the fence line to provide an escape for any giant garter snake that may be within the exclusion area. The fencing will enclose the entirety of the site, or additional exclusionary fencing can be extended 200 to 400 feet beyond the proposed entrance area. The fencing will be inspected before the start of each work day and maintained by the contractor until completion of the project. The fencing will be removed only when project activities are completed.

Yellow-Billed Cuckoo

- Prior to construction, surveys will be conducted to determine the presence of yellow-billed cuckoos within the project area in accordance with any required Service survey protocols and permits at the time of construction.
- If surveys find cuckoos in the area, vegetation removal will be done outside of the cuckoo nesting season.
- Riparian habitat that is removed due to project construction along the American River will be replanted within the American River parkway. The Corps intends to expand existing conserved riparian lands within the parkway that could support the yellow-billed cuckoo. The design of replacement riparian areas will be coordinated with the Service to ensure that the habitat benefits both valley elderberry longhorn beetles and yellow-billed cuckoos.

Fisheries Conservation Measures

- In-water construction activities (e.g., placement of rock revetment) will be limited to the work window of August 1 through November 30. If the Corps wants to work outside of this window they will consult with National Marine Fisheries Service (NMFS) and/or the Service.
- The Corps will purchase 42 acres of delta smelt credits from a Service-approved conservation bank to off-set the loss of 14 acres of shallow water habitat.
- The Corps will purchase an additional 32 acres of delta smelt credits from a Service-approved conservation bank to off-set the loss of spawning habitat due to the placement of riprap on the river bed.
- Erosion control measures (BMPs), including Storm Water Pollution Prevention Program and Water Pollution Control Program, that minimize soil or sediment from entering the river shall be installed, monitored for effectiveness, and maintained

throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.

- Screen any water pump intakes, as specified by NMFS and the Service screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.
- The Corps shall include as part of the project, a Riparian Corridor Improvement Plan with the overall goal of maximizing the ecological function and value of the existing levee system within the Sacramento Metropolitan area.

Additional Minimization and Conservation Measures

- Obtain an ETL approved vegetation variance exempting sites from vegetation removal prior to final design and construction phase for the Sacramento River.
- Construction will be scheduled when listed terrestrial and aquatic species will be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present, then coordination/reinitiation with the Service will occur.
- Compensation for impacts to native riparian habitat will occur on a 2:1 basis on-site or in close proximity to the impact area. Riparian vegetation impacted under the SAFCA 408/404 actions will be replaced on a 3:1 canopy cover acreage basis.
- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110% containment system.
- Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetland areas.
- Implement BMPs to prevent slurry from seeping out to the river and require piping systems on the landside of the levee.
- Project related vehicles will observe a 20-mile-per-hour speed limit within construction areas, except on County roads and on State and federal highways.
- Site access will be limited to the smallest area possible in order to minimize disturbance. Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
- Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
- Designating a Service approved biologist as a point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of the effects assessment, the action area encompasses the Sacramento River from the Sacramento Bypass downstream to River Mile 45, the Yolo Bypass south the confluence of the Sacramento Bypass, the lower American River from Arden Way to the confluence of the Sacramento River, Arcade Creek from Marysville Boulevard to the confluence of the NEMDC, the NEMDC from the south Dry

Creek levee to just south of the NEMDC Arcade Creek confluence, the southern Dry Creek levee between Dry Creek Road and Rose Street, the borrow site along the NEMDC, and any borrow sites. Additionally, we are including a buffer of 300 feet from construction to account for effects to listed species due to dust and noise.

Analytical Framework for the Jeopardy Analysis

The following analysis relies on four components to support the jeopardy determination for the giant garter snake, valley elderberry longhorn beetle, yellow-billed cuckoo, and delta smelt: (1) the *Status of the Species*, which evaluates the species' range-wide condition, the factors responsible for that condition, and their survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the role of the action area in the species' survival and recovery; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on these species; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on these species.

In accordance with the implementing regulations for section 7 and Service policy, the jeopardy determination is made in the following manner: the effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the current status of the delta smelt, valley elderberry longhorn beetle, giant garter snake, and yellow-billed cuckoo. Additionally, for non-Federal activities in the action area, we will evaluate those actions likely to affect the species in the future, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both its survival and recovery in the wild.

The following analysis places an emphasis on using the rang-wide survival and recovery needs of the delta smelt, valley elderberry longhorn beetle, giant garter snake, and yellow-billed cuckoo, and the role of the action area in providing for those needs as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Analytical Framework Adverse Modification

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.2. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the *Status of the Critical Habitat*, which evaluates the range-wide condition of critical habitat for the delta smelt in terms of primary constituent elements (PCE)s, the factors responsible for that condition, and the intended recovery function of the critical habitat at the provincial and range-wide scale; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units and; (4) *Cummulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on the delta smelt critical habitat are evaluated in the context of the range-wide condition of the critical habitat at the provincial and range-wide scales, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the delta smelt.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of delta smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species and Environmental Baseline

Valley Elderberry Longhorn Beetle Status of the Species

Please refer to the *Withdrawl of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife* (Service 2014) for the current status of the species. Ongoing threats to the valley elderberry longhorn beetle include habitat loss due to flood control projects, development projects, and invasive species. While these threats continue to affect the valley elderberry longhorn beetle throughout its range, to date no project has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the valley elderberry longhorn beetle.

Valley Elderberry Longhorn Beetle Environmental Baseline

The project footprint along both the Sacramento River and the American River contain riparian vegetation. The beetle is known in numerous locations along the American River parkway (CNDD 2015). Suitable habitat for the beetle in the form of elderberry shrubs occurs within the action area along the Sacramento River, the American River, and Arcade Creek.

Sacramento River - Riparian habitat along the Sacramento River, south of the city of Sacramento, occurs in narrow bands along the riverbank and levee. Generally an overstory layer is present composed of cottonwood, sycamore, and oak trees. Shrubs occur as a mid-story layer including buttonbush, blue elderberry, white alder, and Oregon ash. Elderberry shrubs occur randomly along the reach of river proposed for improvements. The Corps has documented at least 73 elderberry shrubs along the Sacramento River reach where construction is proposed. Natural river processes of erosion and accretion effect elderberry shrubs which is the host plant of the valley elderberry longhorn beetle by eroding away bank and potentially elderberry shrubs. Levee maintenance can adversely affect elderberries within this stretch of the Sacramento River either by pruning or drift of herbicides used along the levee slope.

American River – The valley elderberry longhorn beetles have been identfied along the lower American River Parkway in the CNDDB (2015). Additionally, the Corps has designed and built six sites along the lower American River as habitat for the valley elderberry longhorn beetle. These sites extend from RM 0.9 up to RM 21. Levee maintenance can adversely affect elderberry shrubs, though the largest threat to valley elderberry longhorn beetle is fires that have been started in the parkway and burned habitat that supports valley elderberry longhorn beetles.

Delta Smelt Status of Species

Listing Status: The Service proposed to list the delta smelt as threatened with proposed critical habitat on October 3, 1991 (56 FR 50075). The Service listed the delta smelt as threatened on March 5, 1993 (58 FR 12854), and designated critical habitat for this species on December 19, 1994 (59 FR 65256). The delta smelt was one of eight fish species addressed in the *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (Service 1996). This recovery plan is currently under revision. A 5-year status review of the delta smelt was completed on March 31, 2004 (Service 2004). The 2004 review affirmed the need to retain the delta smelt as a threatened species. A 12-month finding on a petition to reclassify the delta smelt was completed on April 7, 2010 (75 FR 17667). After reviewing all available scientific and commercial information, the Service determined that re-classifying the delta smelt from a threatened to an endangered species was warranted, but precluded by other higher priority listing actions (Service 2010).

Distribution: The delta smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The delta smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary.

Description: Live delta smelt are nearly translucent with a steely-blue sheen to their sides and have been characterized to have a pronounced odor reminiscent of cucumber (Moyle 2002). Although delta smelt have been recorded to reach lengths of up to 120 millimeters (mm) (4.7 in) (Moyle 2002), mean fork length of the delta smelt from 1974 to 1991 was measured to be 64.1 ± 0.1 mm. Since then, catch data from 1992 - 2004 showed mean fork length decreased to 54.1 ± .01 mm (Bennett 2005; Sweetnam 1999). Delta smelt are also identifiable by their relatively large eye to head size (Moyle 2002). Delta smelt have a small, translucent adipose fin located between the dorsal and caudal fins.

The delta smelt is one of six species currently recognized in the *Hypomesus* genus (Bennet 2005). Genetic analyses have confirmed that *H. transpacificus* presently exists as a single intermixing population (Stanley *et al.* 1995; Trenham *et al.* 1998; Fisch *et al.* 2011). Within the genus, delta smelt is most closely related to surf smelt (*H. pretiosis*), a species common along the western coast of North America. Despite morphological similarities, the delta smelt is less-closely related to the wakasagi (*H. nipponensis*), an andadromous western Pacific species introduced to Central Valley reservoirs in 1959, and may be seasonally sympatric with delta smelt in the estuary (Trenham *et al.* 1998). Allozyme studies have demonstrated that wakasagi and delta smelt are genetically distinct and presumably derived from different marine ancestors (Stanley *et al.* 1995).

Life History and Biology

Adult-Spawning: Adult delta smelt spawn during the late winter and spring months, with most spawning occurring during April through mid-May (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta. Delta smelt spawning has also been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most spawning occurs at temperatures between 12-18°C. Although spawning may occur at temperatures up to 22°C, hatching success of the larvae is very low (Bennett 2005).

Fecundity of females ranges from about 1,200 to 2,600 eggs, and is correlated with female size (Moyle 2002). Moyle *et al.* (1992) considered delta smelt fecundity to be "relatively low." However,

based on Winemiller and Rose (1992), delta smelt fecundity is fairly haigh for a fish its size. Captive delta smelt can spawn up to 4-5 times. While most adults do not survive to spawn a second season, a few (<5 percent) do (Moyle 2002; Bennett 2005). Those that do survive are typically larger (90-110 mm Standard Length[sdl]) females that may contribute disproportionately to the population's egg supply (Moyle 2002 and references therein). Two-year-old females may have 3-6 times as many ova as first year spawners.

Most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the California Department of Fish and Wildlife Spring Kodiak Trawl (SKT) and 20-mm Survey, respectively. In the laboratory, delta smelt spawned at night (Baskerville-Bridges *et al.* 2000; Mager *et al.* 2004). Other smelts, including marine beach spawning species and estuarine populations and the landlocked Lake Washington longfin smelt, are secretive spawners, entering spawning areas during the night and leaving before dawn. If this behavior is exhibited by delta smelt, then delta smelt distribution based on the SKT, which is conducted during daylight hours in offshore habitats, may reflect general regions of spawning activity, but not actual spawning sites.

Delta smelt spawning has only been directly observed in the laboratory and eggs have not been found in the wild. Consequently, what is known about the mechanics of delta smelt spawning is derived from laboratory observations and observations of related smelt species. Delta smelt eggs are 1 mm diameter and are adhesive and negatively buoyant (Moyle 1976, 2002; Mager *et al.* 2004; Wang 1986, 2007). Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the bottom over substrates of sand and/or pebble in current (DWR and Reclamation 1994; Brown and Kimmerer 2002; Lindberg *et al.* 2003; Wang 2007). Spawning over gravel or sand can also aid in the oxygenation of delta smelt eggs. Eggs that may have been laid in silt or muddy substrates might get buried or smothered, preventing their oxygenation from water flow (Lindberg pers. comm. 2011). The eggs of surf smelts and other beach spawning smelts adhere to sand particles, which keeps them negatively buoyant but not immobile, as the sand may move ("tumble") with water currents and turbulence (Hay 2007). It is not known whether delta smelt eggs "tumble incubate" in the wild, but tumbling of eggs may moderately disperse them, which might induce predation risk within a localized area.

The locations in the Delta where newly hatched larvae are present, most likely indicates spawning occurrence. The 20-mm trawl has captured small (~5 mm sdl) larvae in Cache Slough, the lower Sacramento River, San Joaquin River, and at the confluence of these two rivers (e.g., 20-mm trawl survey 1 in 2005). Larger larvae and juveniles (size > 23 mm sdl), which are more efficintly sampled by the 20-mm trawl gear, have been captured in Cache Slough and the Sacramento Deep Water Ship Channel in July (e.g. 20-mm trawl survey 9 in 2008). Because they are small fish inhabiting pelagic habitats with strong tidal and river currents, delta smelt larval distribution depends on both the spawning area from which they originate and the effect of transport processes caused by flows. Larval distribution is further affected by water salinity and temperature. Hydrodynamic simulations reveal that tidal action and other factors may cause substantial mixing of water with variable salinity and temperature among regions of the Delta (Monson *et al.* 2007). This could result in rapid dispersion of larvae away from spawning sites.

The timing of spawning may affect delta smelt population dynamics. Lindberg (2011) has suggested that smelt larvae that hatch early, around late February, have an advantage over larvae hatched during late spawning in May. Early season larvae have a longer growing season and may be able to grow larger faster during more favorable habitat conditions in the late winter and early spring. An early growing season may result in higher survivorship and a stronger spawning capability for that

generation. Larvae hatched later in the season have a shorter growing season which effectively reduces survivorship and spawning success for the following spawning season.

Larval Development: Mager *et al.* (2004) reported that embryonic development to hatching takes 11-13 days at 14-16° C for delta smelt, and Baskerville-Bridges *et al.* (2000) reported hatching of delta smelt eggs after 8-10 days at temperatures between 15-17° C. Lindberg *et al.* (2003) reported high hatching rates of delta smelt eggs in the laboratory at 15° C, and Wang (2007) reported high hatching rates at temperatures between 14-17° C. Hatching success peaks near 15°C (Bennett 2005) and swim bladder inflation occurring at 60-70 days post hatch at 16-17°C (Mager *et al.* 2004). At hatching and during the succeeding three days, larvae are buoyant, swim actively near the water surface, and do not react to bright direct light (Mager *et al.* 2004). As development continues, newly hatched delta smelt become semi-buoyant and sink in stagnant water. However, larvae are unlikely to encounter stagnant water in the wild.

Growth rates of wild-caught delta smelt larvae are faster than laboratory-cultured individuals. Mager *et al.* (2004) reported growth rates of captive-raised delta smelt reared at near-optimum temperatrues (16-17°C). Their fish were about 12 mm long after 40 days and about 20 mm long after 70 days. In contrast, analyses of otoliths indicated that wild delta smelt larvae were 15-25 mm, or nearly twice as long at 40 days of age (Bennett 2005). By 70 days, most wild fish were 30-40 mm long and beyond the larval stage. This suggests there is a strong selective pressure for rapid larval growth in nature, a situation that is typical for fish in general (Houde 1987). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges *et al.* 2000; Mager *et al.* 2004; Baskerville-Bridges *et al.* 2004). The food available to larval fishes is constrained by mouth gape and status of fin development. Larval delta smelt cannot capture as many kinds of prey as larger individuals, but all life stages have small gapes that limit their range of potential prey. Prey availability is also constrained by habitat use, which affects what types of prey are encountered. Larval delta smelt are visual feeders. They find and select individual prey organisms and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges *et al.* 2004). Thus, delta smelt diets are largely comprised of small crustacea that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval delta smelt have particularly restricted diets (Nobriga 2002). They do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods, *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding delta smelt larvae are largely restricted to the larval stages of these copepods; older, larger life stages of the copepods are increasingly targeted as the delta smelt larvae grow, their gape increases, and they become stronger swimmers.

The triggers for and duration of delta smelt larval movement from spawning areas to rearing areas are not known. Hay (2007) noted that eulachon larvae are probably flushed into estuaries from upstream spawning areas within the first day after hatching, but downstream movement of delta smelt larvae occurs much later. Most larvae gradually move downstream toward the two parts per thousand (ppt) isohaline (X2). X2 is scaled as the distance in kilometers from the Golden Gate Bridge (Jassby *et al.* 1995).

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow (above normal to wet water years), delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish versus the degree to which they originate upstream and are transported by tidal currents to the bay and marsh is uncertain.

Juveniles: Young-of-the-year delta smelt rear in the low-salinity zone (LSZ) from late spring through fall and early winter. Once in the rearing area growth is rapid, and juvenile fish are 40-50 mm sdl long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). They reach adult size (55-70 mm sdl) by early fall (Moyle 2002). Delta smelt growth during the fall months slows considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al.* 1950; Radtke 1966).

Delta Smelt Population Dynamics and Abundance Trends

As a consequence of channelization, water operations, and agriculture in the Delta there has been a change to the physical appearance, water salinity, water clarity, and hydrology in the Delta such that most life stages of the delta smelt are now distributed across a smaller area than historically (Arthur *et al.* 1996; Feyrer *et al.* 2007). Wang (1991) noted in a 1989 and 1990 study of delta smelt larval distribution that, in general, the San Joaquin River was used more intensively for spawning than the Sacramento River. Nobriga *et al.* (2008) found that delta smelt capture probabilities in the Summer Townet Survey (TNS) are highest at specific conductance levels of 1,000 to 5,000 $\mu S\ cm^{-1}$ (approximately 0.6 to 3.0 practical salinity unit [psu]). Similarly, Feyrer *et al.* (2007) found a decreasing relationship between abundance of delta smelt in the Fall Midwater Trawl (FMWT) and specific conductance during September through December. The location of the low salinity zone (LSZ) and changes in delta smelt habitat quality in the San Francisco Estuary can be indexed by changes in X2. The LSZ historically had the highest primary productivity and is where zooplankton populations (on which delta smelt feed) were historically most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). However, this has not always been true since the invasion of the overbite clam (Kimmerer and Orsi 1996). The abundance of many local aquatic species has tended to increase in years when winter-spring outflow has high and Z2 was pushed seaward (Jassby *et al.* 1995), implying that the quantity and quality (overall suitability) of estuarine habitat increases in years when outflows are high. However, delta smelt is not one of the species whose abundance has statistically covaried with winter-spring freshwater flows (Stevens and Miller 1983; Moyle *et al.* 1992; Kimmerer 2002a; Bennett 2005).

The distribution of juvenile delta smelt has also changed over the last several decades. During the years 1970 through 1978, delta smelt catches in the TNS survey declined rapidly to zero in the Central and South Delta and have remained near zero since. A similar shift in FMWT catches occurred after 1981 (Arthur *et al.* 1996). This portion of the Delta has also had a long-term trend increase in water clarity during July through December (Arthur *et al.* 1996; Feyrer *et al.* 2007; Nobriga *et al.* 2008).

The CDFW has conducted several long-term monitoring surveys that have been used to index the relative abundance of delta smelt. The 20-mm Survey has been conducted every year since 1995. This survey targets late-stage delta smelt larvae. Most sampling has occurred April-June. The TNS has been conducted nearly every year since 1959. This survey targets 38-mm striped bass, but collects similar-sized juvenile delta smelt. Most sampling has occurred June-August. The Fall Midwater Trawl Survey has been conducted nearly every year since 1967. This survey also targets age-0 striped bass, but collects delta smelt > 40 mm in length. The FMWT samples monthly, September-December. The relative abundance index data and maps of the sampling stations used in these surveys are available at http://www.CDFW.ca.gov/delta/. The methods that underlie the surveys have been described previously (Stevens and Miller 1983; Moyle *et al.* 1992; Dege and Brown 2004). The delta smelt catch data and relative abundance indices derived from these sampling programs have been used in numerous publications (e.g., Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995; Kimmerer 2002b; Dege and Brown 2004; Bennett 2005; Feyrer *et al.* 2007; Sommer *et al.* 2007; Kimmerer 2008; Newman 2008; Nobriga *et al.* 2008; Kimmerer *et al.* 2009; Mac

Nally *et al.* 2010; Thomson *et al.* 2010; Feyrer *et al.* 2011; Maunder and Deriso 2011). These abundance index time series document the long-term decline of the delta smelt.

Early statistical assessments of delta smelt population dynamics concluded that at best, the relative abundance of the adult delta smelt population had only a very weak influence on subsequent juvenile abundance (Sweetnam and Stevens 1993). Thus, early attempts to describe abundance variation in delta smelt ignored stock-recruit effects and researchers looked for environmental variables that were directly correlated with interannual abundance variation (e.g., Stevens and Miller 1983; Moyle *et al.* 1992; Sweetnam and Stevens 1993; Herbold 1994; Jassby *et al.* 1995). Because delta smelt live in a habitat that varies in size and quality with Delta outflow, the authors cited above searched for a linkage between Delta outflow (or X2) and the TNS and FMWT indices. Generally, these analyses did not find strong support for an outflow-abundance linkage. These analyses led to a prevailing conceptual model that multiple interacting factors had caused the delta smelt decline (Moyle *et al.* 1992; Bennett and Moyle 1996; Bennett 2005). It has also recently been noted that delta smelt's FMWT index is partly influenced by explanation for why few analyses could consistently link springtime environmental conditions to delta smelt's fall index.

One published exception to the multi-factor hypothesis was proposed by Gilbert (2010), who posited that nutrient pollution was the root cause of all the food web and fish assemblage changes that caused the decline of delta smelt and other pelagic fishes. However, the statistical approach she used to support her hypothesis was not appropriate and the untransformed data sets do not support this hypothesized chain of consequences stemming solely from wastewater inputs to the Delta (Jassby *et al.* in press). It is now recognized that delta smelt abundance plays an important role in subsequent abundance (Bennett 2005; Maunder and Deriso 2011). Bennett (2005) assessed (1) the influence of adult stock as indexed by the FMWT versus the next generation of juveniles indexed by the following calendar year's TNS; (2) the influence of the juvenile stock indexed by the TNS versus the subsequent adult stock indexed a few months later in the FMWT; (3) the influence of the FMWT on the following year's FMWT and on the FMWT two years later, and (4) he did the same for the TNS data. He concluded that (1) two-year-old delta smelt might play an important role in delta smelt population dynamics, (2) it was not clear wheter juvenile production was a density-independent or density-dependent function of adult abundance, and (3) adult production was a density-dependent function of juvenile abundance and the carrying capacity of the estuary to support this life-stage transition had declined over time. These conclusions are also supported by Maunder and Deriso (2011).

The concept of density-dependence and how it has affected the delta smelt is important because it may be used as a reason not to protect particular life stages from sources of mortality. Bennet (2005) concluded it was (statistically) unclear whether density-dependence occurs between generations. He also noted that the delta smelt indices strongly suggest that density-dependence has occurred, at least over the long-term, during the juvenile stage. The uncertainty about density-dependence between generations results because statistical assessments of the relationship between the adult stock and the next generation of recruits (juveniles_ result in similar fits for linear (density-independent) and nonlinear (density-dependent) relationships (Bennett 2005; Maunder and Deriso 2011).

One reason for this is that delta smelt population dynamics may have changed over time. Previous papers have reported a delta smelt step-decline during 1981-1982 (Kimmerer 2002a; Thomson *et al.* 2010). Prior to this decline, the stock-recruit data are consistent with "Ricker" type density-dependence where increasing adult abundance resulted in decreased juvenile abundance. Since the decline, recruitment has been positively and essentially linearly related to prior adult abundance, suggesting that reproduction has been basically density-independent for about the past 30 years.

This means that since the early 1980s, more adults translates into more juveniles and fewer adults translates into fewer juveniles without being 'compensated for' by density-dependence. In contrast to the transition among generations, the weight of scientific evidence strongly supports the hypothesis that, at least over the history of Interagency Ecological Program (IEP) fish monitoring, delta smelt has experienced density-dependence during the juvenile stage of its life cycle, i.e., between the summer and fall (Bennett 2005; Maunder and Deriso 2011). This has been inferred because, statistically, the FMWT index does not increase linearly with increases in the summer townet index. Rather, the best-fitting relationships between the summer townet index and the FMWT index show that the FMWT indices approach an asymptote as the summer townet increases or possibly even declines at the highest summer townet indices.

From a species conservation perspective, the most relevant aspect of this juvenile density dependence is that the carrying capacity of the estuary for delta smelt has declined (Bennett 2005). Thus, the delta smelt population decline has occurred for two basic reasons. First, the compensatory density-dependence that historically enabled juvenile abundance to rebound from low adult numbers stopped happening. This change had occurred by the early 1980s as described above. The reason is still not known, but the consequence of the change is that for the past several decades, adult abundance drives juvenile production in a largely density-independent manner. Thus, if numbers of adults or adult fecundity decline, juvenile production will also decline (Kimmerer 2011). Second, because juvenile carrying capacity has declined, juvenile production hits a 'ceiling' at a lower abundance than it once did. This limits adult abundance and possibly per capita fecundity, which cycles around and limits the abundance of the next generation of juveniles. The mechanism causing carrying capacity to decline is likely due to the long-term accumulation of deleterious habitat changes, both physical and biological, during the summer-fall (Bennett *et al.* 2008; Feyrer *et al.* 2007; 2011; Maunder and Deriso 2011).

Habitat

The existing physical appearance and hydrodynamics of the Delta have changed substantially from the environment in which native fish species like delta smelt evolved. The Delta once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Delta from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002a). For instance, in the early 1900s, the location of maximum salinity intrusion into the Delta during dry periods varied from Chipps Island in the lower Delta to Stockton along the San Joaquin River and Merritt Island in the Sacramento River. Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows (Knowles 2002), though Delta outflows have been tightly constrained during late summer-fall for several decades. The following is a brief description of the changes that have occurred to delta smelt's habitat that are relevant to the environmental baseline for this consultation.

Changes to the LSZ: There have been documented changes to the delta smelt's LSZ habitat that have led to present-day, baseline habitat conditions. The close association of delta smelt with the San Francisco estuary LSZ has been known for many years (Stevens and Miller 1983; Moyle *et al.* 1992). Peterson (2003) developed a conceptual model that hypothesized how, "stationary and dynamic components of estuarine habitats" interacted to influence fisheries production in tidal river estuaries.

Peterson's model suggests that when the dynamic and static aspects of estuarine habitat sufficiently overlap, foraging, growth, density, and survival are all high, and that enables fish production to outpace losses to predators. The result is high levels of successful recruitment of new individuals. The model also hypothesizes that when the dynamic and static aspects of an estuarine habitat do not sufficiently overlap, foraging, growth, density, and survival are impaired such that losses to predators increase and recruitment of new individuals decreases. This model was developed specifically for species spawned in marine environments that were subsequently transported into estuaries. However, the concept of X2, which was developed in the San Francisco estuary to describe how freshwater flow affected estuarine habitat (Jassby *et al.* 1995), played a role in the intellectual development of Peterson's model. The Peterson model also provides a useful framework to conceptualize delta smelt's LSZ habitat.

Currently available information indicates that delta smelt habitat is most suitable for the fish when low-salinity water is near 20°C, highly turbid, oxygen saturated, low in contaminants, supports high densities of calanoid copepods and mysid shrimp (Moyle *et al.* 1992; Lott 1998; Nobriga 2002), and occurs over comparatively static 'landscapes' that support sandy beaches and bathymetric variation that enables the fish and their prey to aggregate (Kimmerer *et al.* 2002a; Bennett *et al.* 2002; Hobbs *et al.* 2006). Almost every component listed above has been degraded over time (see below). The Service has determined that this accumulation of habitat change is the fundamental reason or mechanism that has caused delta smelt to decline.

Alterations to estuarine bathymetry and salinity distribution (~ 1850-present): The position of the LSZ, where delta smelt rear, has changed over the years. The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Moyle *et al.* 2010). The ancestral Delta was a large tidal marsh-floodplain habitat totaling approximately 700,000 acres. Most of the historic wetlands within the system were diked and reclaimed for agriculture or other human uses by 1920 (Atwater *et al.* 1979). Channels were dredged deep (~12 meters[m]) to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the confluence of the Sacramento-San Joaquin Rivers as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995). However, the deepened channels created to support shipping and flood control, requires more freshwater outflow to maintain the LSZ in the large Suisun Bay and River confluence than was once required (Gartrell 2010). The construction of the CVP and SWP not only provided water supply for urban, agricultural and industrial users, but also provided water needed to combat salinity intrusion into the Delta, which was observed by the early 20th century. California's demand for freshwater (keeps) continues to increase, thus seasonal salinity intrusion perpetually reduces the temporal overlap of the LSZ (indexed by X2) within the Suisun Bay (region), especially in the fall (Feyrer *et al.* 2007; 2011). Consequently, the second major habitat change in the Delta has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation. There was a step-decline in the LSZ in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer *et al.* 2011).

Summer and fall environmental quality has decreased overall in the Delta because outflows are lower and water transparency is higher. These changes may be due to increased upstream water diversions for flooding rice fields (Kawakami *et al.* 2008). The confluence of the Sacramento and San Joaquin Rivers has, as a result, become increasingly important as a rearing location for delta smelt, with physical environmental conditions constricting the species range to a relatively narrow area (Feyrer *et al.* 2007; Nobriga *et al.* 2008). This has increased the likelihood that most of the

juvenile population is exposed to chronic and cyclic environmental stressors, or catastrophic events. For instance, all seven delta smelt collected during the September 2007 FMWT survey were captured at statistically significantly higher salinities than what would be expected based upon historical distribution data generated by Feyrer *et al.* (2007). During the same year, the annual bloom of toxic cyanobacteria (Microcystis aeruginosa) spread far downstream to the west Delta and beyond during the summer (Peggy Lehman, pers comm). This has been suggested as an explanation for the anomaly in the distribution of delta smelt relative to water salinity levels (US Bureau of Reclamation 2008).

Bank Protection (Levees): The placement of riprap bank protection has led to the loss of riparian habitat, large woody debris, shallow water habitat, and natural channel migration. Bank stabilization and riprapping has been shown to change natural river processes such as erosion and accretion which reduces habitat complexity; creates a smooth, hydraulically enhanced surface that is not conducive to the habitat requirements of fish including delta smelt; stops woody vegetation from entering the river and reduces the long-term recruitment of large woody debris; inhibits plant growth through a change is substrate; lowers the amount of outside food sources because of the lack of riparian and wetland vegetation for aquatic invertebrates; and increases stream edge velocities which decreases available refuge areas for fish (Service 2000). More than half of the Sacramento River's lower 194 miles have been riprapped, mostly under the Corps Sacramento River bank Protection Project. Today most of the riparian forests and wetlands have been removed and the Sacramento River has been constrained to not allow natural erosion and accretion to occur.

Turbidity: From 1999 to present, the Delta experienced a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). For decades, the turbidity of the modified estuary had been sustained by very large sediment deposits resulting mainly from gold mining in the latter 19th century. Sediments continued to accumulate into the mid-20th century, keeping the water relatively turbid even as sediment loads from the Sacramento River basin declined due to dam and levee construction (Wright and Schoellhamer 2005). The flushing of the sediment deposits may also have made the estuary deeper overall and thus a less suitable nursery from the 'static' bathymetric perspective (Schroeter 2008).

Delta smelt are associated with highly turbid waters; there is a negative correlation between the frequency of delta smelt occurrence in survey trawls during the summer, fall and early winter and water clarity. For example, the likelihood of delta smelt occurrence in trawls at a given sampling station decreases with increasing Secchi depth at the stations (Feyrer *et al.* 2007, Nobriga *et al.* 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). Few daylight trawls catch delta smelt at Secchi depths over 0.5 m and capture probabilities for delta smelt are highest at 0.40 m depth or less. First-feeding delta smelt larvae require relatively turbid (muddy) waters to capture prey, but older fish do not require turbidity to capture prey and very high turbidity may even have some inhibitory effect on prey consumption (Hasenbein *et al.* 2013). Delta smelt may also use turbidity as cover from predators; this was hypothesized based on long-term monitoring of the distribution of fish in the wild (e.g., Feyrer *et al.* 2007) and recently supported by a laboratory experiment (Ferrari *et al.* 2014).

Temperature: Temperature also affects delta smelt distribution. Swanson and Cech (1995) and Swanson *et al.* (2000) indicate delta smelt tolerate temperatures (<8° C to >25° C), however warmer water temperatures >25° C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the water is well oxygenated and temperatures are usually less than 25° C in summer (Nobriga *et al.* 2008). Currently, delta smelt are subjected to thermally stressful temperatures every summer, and all available regional climate change projections

predict central California will be warmer still in the coming decades (Dettinger 2005). We expect warmer estuary temperatures to be yet another significant conservation challenge based on climate change models. Warmer water temperatures would increase delta smelt mortality and constrict suitable habitat throughout the Delta during the summer months. Higher temperatures would shrink delta smelt distribution into the fall, limiting their presence to Suisun Bay and in waters with less than optimal salinities (Brown *et al.* 2013). Water temperatures are presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding the nominal lethal limit of 25°C for short periods. Coldwater fishes begin to have behavioral impairments (Marine and Cech 2004) and lose competitive abilities (Taniguchi *et al.* 1998) prior to reaching their thermal tolerance limits. Thus, the estuary can already be considered thermally stressful to delta smelt and can only become more so if temperatures warm in the coming decades.

Foraging Ecology: Delta smelt feed primarily on small planktonic crustaceans, and occasionally on insect larvae (Moyle 2002). Juvenile-stage delta smelt prey upon copepods, cladocerans, amphipods, and insect larvae (Moyle 2002). Historically, the main prey of delta smelt was the euryhaline copepod *Eurytemora affinis* and the euryhaline mysid *Neomysis mercedis*. The slightly larger *Pseudodiaptomus forbesi* has replaced *E. affinis* as a major prey source of delta smelt since its introduction into the Bay-Delta, especially in summer, when it replaces *E. affinis* in the plankton community (Baxter *et al.* 2008; Moyle 2002). The most common copepod in the estuary now is a small nonnative species, *Limnoithona tetraspina*. It has been suggested that *L. tetraspina* may be an inferior food for pelagic fishes including delta smelt because of its small size and generally sedentary behavior (Bouley and Kimmerer 2006). Experimental studies addressing this issue have suggested that smelt larvae will attack *L. tetraspina* until they grow large enough to successfully capture larger copepods; also, growth rate of delta smelt fed *L. tetraspina* was lower than that of smelt fed the larger copepods (Sullivan *et al.*, unpublished). *L. tetraspina* is sometimes consumed in large numbers by juvenile delta smelt during late summer when this copepod is abundant in the LSZ (Slater and Baxter 2014). *Acartiella sinensis*, a calanoid copepod species that invaded the Delta at the same time as *L. tetraspina*, also occurs at high densities in Suisun Bay and in the western Delta over the last decade. Delta smelt eat these newer copepods, but *Pseudodiaptomus* remains their dominant prey (Baxter *et al.* 2008).

River flows influence estuarine salinity gradients and water residence times and thereby affect both habitat suitability for benthos and the transport of pelagic plankton upon which delta smelt feed. High tributary flow leads to lower residence time of water in the Delta, which generally results in lower plankton biomass (Kimmerer 2004). In contrast, higher residence times, which result from low tributary flows, can result in higher plankton biomass but water diversions, overbite clam grazing (Jassby *et al.* 2002) and possibly contaminants (Baxter *et al.* 2008) remove a lot of plankton biomass when residence times are high. These factors all affect food availability for planktivorous fishes that utilize the zooplankton in Delta channels. Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga *et al.* 2008). Thus, there is the potential for mismatches between regions of high zooplankton abundance in the Delta and delta smelt distribution now that the overbite clam has decimated LSZ zooplankton densities.

The delta smelt compete with and are prey for several native and introduced fish species in the Delta. The introduced Mississippi silverside may prey on delta smelt eggs and/or larvae and compete for copepod prey (Bennett and Moyle 1996; Bennett 2005). Young striped bass also use the LSZ for rearing and may compete for copepod prey and eat delta smelt. Centrarchid fishes and coded wire tagged Chinook salmon smolts released in the Delta for survival experiments since the early 1980s may potentially also prey on larval delta smelt (Brandes and McLain 2001; Nobriga and Chotkowski 2000). Studies during the early 1960s found delta smelt were only an occasional prey fish for striped bass, black crappie and white catfish (Turner and Kelley 1966). However, delta smelt

were a comparatively rare fish even then, so it is not surprising they were a rare prey. Striped bass appear to have switched to piscivorous feeding habits at smaller sizes than they historically did, following severe declines in the abundance of mysid shrimp (Feyrer *et al.* 2003). Nobriga and Feyrer (2008) showed that Mississippi silverside, which is similar in size to delta smelt, was only eaten by subadult striped bass less than 400-mm fork length. While largemouth bass are not pelagic, they have been shown to consume some pelagic fishes (Nobriga and Feyrer 2007).

Other Stressors

Aquatic Macrophytes: For many decades, the Delta's waterways were turbid and growth of submerged plants was apparently unremarkable. That began to change in the mid-1980s, when the Delta was invaded by the non-native plant, *Egeria densa*, a fast-growing aquatic macrophyte that has now taken hold in many shallow habitats throughout the Delta (Brown and Michnuik 2007; Hestir 2010). *Egeria densa* and other non-native species of submerged aquatic vegetation (SAV) grow most rapidly in the summer and late fall when water temperatures are warm (> 20°C) and outflow is relatively low (Hestir 2010). The large canopies formed by these plants have physical and biological consequences for the ecosystem (Kimmerer *et al.* 2008). First, the dense nature of SAV promotes sedimentation of particulate matter from the water column, which increases water transparency that then limits the amount of habitat available for delta smelt (Feyrer *et al.* 2007; Nobriga *et al.* 2008). Second, dense SAV canopies provide habitat for a suite of non-native fishes that occupy the littoral and shallow habitats of the Delta, displacing native fishes (Nobriga *et al.* 2005; Brown and Michniuk 2007). Finally, the rise in SAV colonization over the last three decades has led to a shift in the dominant trophic pathways that fuel fish production in the Delta. Until the latter 1980s, the food web of most fishes was often dominated by mysid shrimp (Feyrer *et al.* 2003) that were subsidized by phytoplankton food sources (Rast and Sutton 1989). Now, most littoral and demeral fishes of the Delta have diets dominated by the epibenthic amphipods that eat SAV detritus or the epiphytic algae attached to SAV (Grimaldo *et al.* 2009).

E. densa and other non-native submerged aquatic vegetation (e.g., *Myriophyllum spicatum*) can affect delta smelt in direct and indirect ways. Directly, submerged aquatic vegetation can over whelm littoral habitats (inter-tidal shoals and beaches) where delta smelt may spawn making them unsuitable for spawning. Indirectly, submerged aquatic vegetation decreases turbidity (by trapping suspended sediment) which has contributed to a decrease in both juvenile and adult smelt habitat (Feyrer *et al.* 2007; Nobriga *et al.* 2008). Increased water transparency may delay feeding and may also make delta smelt more susceptible to predation pressure.

Predators: Delta smelt is a rare fish and has been a rare fish (compared to other species) for at least the past several decades (Nobriga and Herbold 2008). Therefore, it has also been rare in examinations of predator stomach contents. Delta smelt were occasional prey fish for striped bass, black crappie, and white catfish in the early 1960s (Turner and Kelly 1966) but went undetected in a recent study of predator stomach contents (Nobriga and Feyrer 2007). The predator with the highest historical documentation of predation on delta smelt is striped bass (*Morone saxatilis*, Stevens 1963; 1966; Thomas 1967). In these studies, striped bass were confirmed to prey on both juvenile and adult delta smelt. Striped bass are widely distributed in pelagic areas of the San Francisco Bay-Delta and parts of its watershed, and thus striped bass distribution fully encompasses the distribution of delta smelt juveniles and adults (Nobriga *et al.* 2013). Striped bass also tend to aggregate in the vicinity of water diversion structures, where delta smelt are frequently entrained (Nobriga and Feyrer 2007). No inverse correlations between the abundance of striped bass and the relative abundance of delta smelt have been found to date using a variety of statistical approaches (Mac Nally et al 2010; Thomson *et al.* 2010; Maunder and Deriso 2011; Miller *et al.* 2012; Nobriga et al 2013). Although the relative rarity of delta smelt in the estuary food web would presumably make

them a n incidental prey item for striped bass, it is possible that striped bass abundance and demand for prey are always high enough to limit delta smelt population growth rate (Nobriga *et al.* 2013).

Fish eggs and larvae can be opportunistically preyed upon by many invertebrate and vertebrate animals. There has always been a very long list of potential predators of delta smelt's eggs and larvae. One of these is the nonnative Mississippi silverside (*Menidia audens*), which like delta smelt is and annual fish with a maximum length near 100 mm (4 inches). Mississippi silversides may be both predators and competitors of delta smelt (Bennett 2005). Mississippi silversides were first introduced to the San Francisco Bay-Delta in the mid-1970s, and have increased dramatically in numbers since the mid-1980s. They forage in schools around the shoreline habitats and tidal marsh channels of the San Francisco Bay-Delta, where they are exceptionally common (Matern *et al.* 2002); Nobriga *et al.* 2005; Gewant and Bollens 2012). They readily consume delta smelt larvae in aquarium tests Bennett (20025_ concluded that "delta smelt are at high risk of eggs or larvae co-occur with schools of foraging silversides."

Another known predator is the largemouth bass are freshwater fish that prefer clear waters along shorelines (littoral habitat) with relatively dense water plants (Nobriga and Feyrer 2007; Brown and Michniuk 2007; Baxter *et al.* 2008). This is a suite of habitat characteristics that is distinctly different from those described above for delta smelt. Thus, unlike delta smelt and striped bass, delta smelt and largemouth bass have different habitat requirements (e.g., Nobriga *et al.* 2005) and their distributions do not strongly overlap. However, there has been a major increase in the Delta's largemouth bass population since the early 1990's that is believed to have been facilitated by the spread of the introduced plant *Egeria densa*, which provides rearing habitat for the bass (Baxter *et al.* 2008). Despite increases in largemouth bass populations and habitat, Nobriga and Feyrer (2007) did not find delta smelt as largemouth bass prey. Nor have more recent and extensive surveys of largemouth bass stomach contents. In captivity however, even young juvenile largemouth bass will attempt to consume delta smelt (Ferrari *et al.* 2014) so they presumably represent a predation threat when the species closely co-occur in the wild. In contrast to the situation for striped bass, several researchers have found inverse correlations between the relative abundance of largemouth bass or multi-species indices that included largemouth bass and the relative abundance of delta smelt (MacNally *et al.* 2010; Thomson *et al.* 2010; Maunder and Deriso 2011). At this time however, there is no way to determine whether these correlations are causative (predation by largemouth bass caused delta smelt to decline) or not (delta smelt simply use different habitats than largemouth bass and delta smelt habitat has decreased whil largemouth bass habitat has increased).

Other potential predators of eggs and larvae of smelt in littoral habitats are yelllowfin goby, entrarchids, and Chinook salmon. Potential native predators of juvenile and adult delta smelt would also have included numerous bird and fish species and this may be reflected in delta smelt's annual life-history. Annual fish species, also known as "opportunistic strategists", are adapted to high mortality rates in the adult stage (Winemiller and Rose 1992). This high mortality is usually due to predation or highly unpredictable environmental conditions, both of which could have characterized the ancestral niche of delta smelt.

Predation is a common source of density-dependent mortality in fish populations (Rose *et al.* 2001). Thus, it is possible that predation was a mechanism that historically generated the density-dependence observable in delta smelt population dynamics that has been noted by Bennett (2005) and Maunder and Deriso (2011). As is the case with other fishes, the vulnerability of delta smelt to predators may be influence primarily by habitat suitability. It is widely documented that pelagic fishes, including many smelt species, experience lower predation risks under turbid water conditions (Thetmeyer and Kils 1995; Utne-Palm 2002; Horpilla *et al.* 2004). Growth rates, a result of feeding

success plus water temperature, are also well known to affect fishes' cumulative vulnerability to predation (Sogard 1997).

Competition: It has been hypothesized that delta smelt are adversely affected by competition from other introduced fish species that use overlapping habitats, including Mississippi silversides, (Bennett and Moyle 1995) striped bass, and wakasagi (Sweetnam 1999). Laboratory studies show that delta smelt growth is inhibited when reared with Mississippi silversides (Bennett 2005) but there is no empirical evidence to support the conclusion that competition between these species is a factor that influences the abundance of delta smelt in the wild. There is some speculation that the overbite clam competes with delta smelt for copepod nauplii (Nobriga and Herbold 2008). It is unknown how intensively overbite clam grazing and delta smelt directly compete for food, but overbite clam consumption of shared prey resources does have other ecosystem consequences that appear to have affected delta smelt indirectly.

Microcystis. Large blooms of toxic blue-green algae, *Microcystis aeruginosa*, were first detected in the Delta during the summer of 1999 (Lehman *et al.* 2005). Since then *M. aeruginosa* has bloomed each year, forming large colonies throughout most of the Delta and increasingly down into eastern Suisun Bay. Blooms typically occur between late spring and early fall (peak in the summer) when temperatures are above 20°C. *M. aeruginosa* can produce natural toxins that pose animal and human health risks if contacted or ingested directly. It is unclear whether microcystins and other toxins produced by local blooms are acutely toxic to fishes at current concentrations; however, the toxins accumulate in fish and their prey. During the summer of 2005, Age-0 striped bass and Mississippi silversides that were co-occurring with the *Microcystis* bloom showed various forms of liver damage (Lehman *et al.* 2010). When ingested with food, microcystins have been experimentally shown to cause substantial impairment of health in threadfin shad (Acuna *et al.* 2012). In addition, the copepods that delta smelt eat are particularly susceptible to these toxins (Ger 2008; Ger *et al.* 2010). An investigation of food web effects and fish toxicity concluded that even at low abundances, *M. aeruginosa* may impact estuarine fish productivity through both toxicity and food web impacts (Lehman *et al.* 2010). *M. aeruginosa* is most likely to affect juvenile delta smelt during summer blooms. Microcystis blooms may also decrease dissolved oxygen to lethal levels for fish (Saiki *et al.* 1998), although delta smelt do not strongly overlap the densest *Microcystis* concentrations, so dissolved oxygen is not likely a problem. *Microcystis* blooms are a symptom of eutrophication and high ammonia to nitrate ratios in the water.

Contaminants: Contaminants can change ecosystem functions and productivity through numerous pathways. However, contaminant loading and its ecosystem effects within the Delta are not well understood. Although a number of contaminant issues were first investigated during the Pelagic Organism Decline (POD) years, concern over contaminants in the Delta is not new. There are long-standing concerns related to mercury and selenium levels in the watershed, Delta, and San Francisco Bay (Linville *et al.* 2002; Davis *et al.* 2003). Phytoplankton growth rate may, at times, be inhibited by high concentrations of herbicides (Edmunds *et al.* 1999). New evidence indicates that phytoplankton growth rate is chronically inhibited by ammonium concentrations in and upstream of Suisun Bay (Wilkerson *et al.* 2006, Dugdale *et al.* 2007). Contaminant-related toxicity to invertebrates has been noted in water and sediments from the Delta and associated watersheds (e.g., Kuivila and Foe 1995, Giddings 2000, Werner *et al.* 2000, Weston *et al.* 2004). Undiluted drain water from agricultural drains in the San Joaquin River watershed can be acutely toxic (quickly lethal) to fish and have chronic effects on growth (Saiki *et al.* 1992).

Evidence for mortality of young striped bass due to discharge of agricultural drainage water containing rice herbicides into the Sacramento River (Bailey *et al.* 1994) led to new regulations for

water discharges. Bio assays using caged Sacramento sucker (Catostomus occidentalis) have revealed deoxyribonucleic acid strand breakage associated with runoff events in the watershed and Delta (Whitehead *et al.* 2004). Kuivila and Moon (2004) found that peak desities of larval and juvenile delta smelt sometimes coincided in time and space with elevated concentrations of dissolved pesticides in the spring. These periods of co-occurrence lasted for up to 2-3 weeks, but concentrations of individual pesticides were low and much less than would be expected to cause acute mortality. However, the effects of exposure to the complex mixtures of pesticides actually present are unknown.

Current science suggests the possible link between contaminants and the POD may be the effects of contaminant exposure on prey items, resulting in an indirect effect on the survival of POD species (Johnson *et al.* 2010). The POD investigators initiated several studies beginning in 2005 to address the possible role of contaminants and disease in the declines of Delta fish and other aquatic species. Their primary study consists of twice-monthly monitoring of ambient water toxicity at fifteen sites in the Delta and Suisun Bay. In 2005 and 2006, standard bioassays using the amphipod *Hyalella azteca* had low (<5 percent) frequency of occurrence of toxicity (Werner *et al.* 2008). The results indicated that 2007, a dry year, showed a higher incidence of toxic events than in the previous (wetter) year, 2006 (Werner *et al.* 2010). Parallel testing with the addition of piperonyl butoxide, an enzyme inhibitor, indicated that both organophosphate and pyrethroid pesticides may have contributed to the pulses of toxicity. Most of the tests that were positive for *H. azteca* toxicity have come from water samples from the lower Sacramento River.

Pyrethroids are of particular concern because of their widespread use, and their tendency to be genotoxic (DNA damaging) to fishes at low doses (in the range of micrograms per liter) (Campana *et al.* 1999). The pyrethroid esfenvalerate is associated with delayed spawning and reduced larval survival of bluegill sunfish (*Lepomis macrochirus*) (Tanner and Knuth 1996) and increased susceptibility of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) to disease (Clifford *et al.* 2005). In addition, synthetic pyrethroids may interfere with nerve cell function, which could eventually result in paralysis (Bradbury and Coats 1989; Shafer and Meyer 2004). Weston and Lydy (2010) found the largest source of pyrethroids flowing into the Delta to be coming from the Sacramento Regional Waste water Treatment Plant, where only secondary treatment occurs. Their data not only indicate the presence of these contaminants, but the concentrations found exceeded acute toxicity thresholds for the amphipod *Hyalella azteca*. This is of substantial concern because the use of insecticides flowing into the Delta. Furthermore, this was not the case for the Stockton Wastewater Treatment facility, where tertiary treatment occurs, suggesting that different treatment methods may remove or etain pyretroids differently (Baxter *et al.* 2010).

In conjunction with the POD investigation, larval delta smelt bioassays were conducted simultaneously with a subset of the invertebrate bioassays. The water samples for these tests were collected from six sites within the Delta during May-August of 2006 and 2007. Results from 2006 indicated that delta smelt are highly sensitive to high levels of ammonia, low turbidity, and low salinity. There is some preliminary indication that reduced survival may be due to disease organisms (Werner *et al.* 2008). No significant mortality of larval delta smelt was found in the 2006 bioassays, but there were two instances of significant mortality in June and July of 2007. In both cases, the water samples were collected from sites along the Sacramento River and had relatively low turbidity and salinity levels and moderate levels of ammonia. It is also important to note that no significant *H. azteca* mortality was detected in these water samples. While H. Azteca tests are very useful for detecting biologically relevant levels of water column toxicity for zooplankton, interpretation of the *H. azteca* test results with respect to fish should proceed with great caution. The relevance of the bioassay results to field conditions remains to be determined. Werner *et al.* (2010b) conducted *in situ* testing in the laboratory and compared contaminant sensitivity of delta smelt to common bioassay organisms, including *H. azteca*. The investigations included contaminants commonly observed in the

Delta, such as organophosphate and pyrethroid insecticides, copper, and total ammonia. In the laboratory, delta smelt were 1.8 to >11 times more sensitive than fathead minnow to ammonia, copper and all insecticides tested (except permethrin). The invertebrates tested were more sensitive to contaminants than delta smelt or fathead minnows. *Eurytemora affinis* and *Ceriodaphnia dubia* were the most sensitive to total ammonia. *C. dubia* was the most sensitive to copper and organophosphates pesticides. *H. azteca* was the most sensitive test organism to pyrethroids. Toxicity was not detected for the Sacramento River at Hood or the San Joaquin River at Rough and Ready Island during the 2009 in situ testing period. Delta smelt survival was low in treatment and control waters. Werner *et al.* (2010b) concluded that larval smelt may be too sensitive to salinity, temperature and transport stress for *in situ* exposures and recommended using surrogate species in future tests.

Persistent confinement of the spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawners will be affected by a catastrophic event or localized chronic threat. For instance, large volumes of highly concentrated ammonia released into the Sacramento River from the Sacramento Regional County Sanitation District may affect embryo survival or inhibit prey production. Further, agricultural field in the Yolo Bypass and surrounding areas are regularly sprayed by pesticides, and water samples taken from Cache Slough sometimes exhibited toxicity to *H. azteca* (Werner *et al.* 2008; 2010). The thresholds of toxicity for delta smelt for most of the known contaminants have not been determined, but the exposure to a combination of different compounds increases the likelihood of adverse effects. The extent to which delta smelt larvae are exposed to contaminants varies with flow entering the Delta. Flow pulses during spawning increase exposure to many pesticides (Kuivila and Moon 2004) but decrease ammonia concentrations from wastewater treatment plants.

The POD investigations into potential contaminant effects also include the use of biomarkers that have been used previously to evaluate toxic effects on POD fishes (Bennett and Moyle 1996, Bennett 2005). The results to date have been mixed. A pathogen survey of 105 adult delta smelt, sampled from January through May, at several sites in the Delta, found that disease did not appear to overtly influence the health of the surveyed population for that year (Foott and Bigelow 2010). Histopathological and viral evaluation of young longfin smelt collected in 2006 indicated no histological abnormalities associated with exposure to toxics or disease (Foott *et al.* 2006). There was also no evidence of viral infection or high parasite loads. Similarly, young threadfin shad showed no histological evidence of contaminant effects or of viral infections (Foott *et al.* 2006). Parasites were noted in threadfin shad gills at a high frequency but the infections were not considered severe. Both longfin smelt and threadfin shad were considered healthy in 2006. Adult delta smelt collected from the Delta during the winter of 2005 also were considered healthy, showing little histopathological evidence for starvation or disease (Teh 2007). However, there was some evidence of low frequency endocrine disruption. In 2005, nine of 144 (six percent) of adult delta smelt males sampled were intersex, having immature oocytes in their testes (Teh 2007). Bennett (2005) reported that about 10 percent of the delta smelt analyzed for histopathological anomalies in 1999-2000 showed evidence of deleterious contaminant exposure. In contrast, 30-60 percent of these fish had liver glycogen depletion consistent with food limitation.

In contrast, preliminary histopathological analyses have found evidence of significant disease in other species and for POD species collected from other areas of the estuary. Massive intestinal infections with an unidentified myxosporean were found in yellowfin goby (*Acanthogobius flavimanus*) collected from Suisun Marsh. Severe viral infection was also found in Mississippi silverside and juvenile delta smelt collected from Suisun Bay during summer 2005. Lastly, preliminary evidence suggests that contaminants and disease may impair survival of age-0 striped bass. Baxter *et al.* 2008 found high occurrence and severity of parasitic infections, inflammatory conditions, and muscle

degeneration in young striped bass collected in 2005; levels were lower in 2006. Several biomarkers of contaminant exposure including P450 activity (i.e., detoxification enzymes in liver), acetylcholinesterase activity (i.e., enzyme activity in brain), and vitellogenin induction (i.e., presence of egg yolk protein in blood of males) were also reported from striped bass collected in 2006 (Ostrach 2008).

Delta smelt can also be exposed to other toxic substances. Recent toxicological research has provided dose-response curves for several contaminants (Connon *et al.* 2009; 2011). This research has also shown that gene expression changes and impairment of delta smelt swimming performance occur at contaminant concentrations lower than levels that cause mortality.

Climate Change: Climate change is likely already impacting the delta smelt. Climate change may affect the delta smelt directly by creating physiological stress, the primary impacts of climate change on the species are expected to be through changes in the availability and distribution of delta smelt habitat.

The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years of being a typical period for such measurements (IPCC 2013a). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (for example, temperature or precipitation) that persists for an extended period, whether the change is due to natural variability or human activity (IPCC 2013a). Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has increased since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions.

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has increased since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions (for these and other examples, see Solomon *et al.* 2007;; IPCC 2013b;; IPCC 2014). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (Solomon *et al.* 2007; IPCC 2013b). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011), whom concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (Meehl *et al.* 2007, entire; Ganguly *et al.* 2009; Prinn *et al.* 2011). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increasing global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be

influenced substantially by the extent of GHG emissions (Meehl *et al.* 2007; Ganguly *et al.* 2009; Prinn *et al.* 2011; IPCC 2013b). See IPCC 2013b (entire), for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation.

Current Drought Conditions and Relative Abundance: California is experiencing its fourth consecutive dry water-year due to low rainfall and low snowpack. On January 17, 2014, the Governor of California declared a State of Emergency due to the drought and directed state officials to take all necessary actions to make water immediately available (Office of the Governor 2014). As of June 2015, the Governor's drought declaration remains in place and the current drought conditions are comparable to the driest years on record in California. The severity of California's drought has been exacerbated by record warm temperatures and below-normal precipitation in 2015, resulting in a severely reduced snowpack. During the last two years, Federal and state governments (Bureau of Reclamation and California Department of Water Resources) have taken actions to ensure the reduced water quality and supply does not reach a level of concern for human health and safety, while complying with biological opinions. The actions taken include the 2015 placement of a salinity rock barrier on West False River and numerous Temporary Urgency Change Orders to modify requirements under Decision 1641 to meet certain water quality objectives, reduction of river flows caused by low reservoir storage, and river temperature requirements.

Drought conditions and some drought management actions have decreased suitable and available aquatic habitat in the Delta for delta smelt breeding and survival, thereby reducing the overall population in the Delta. Fish surveys indicate that the relative abundance of delta smelt is very low. In the last five years, the FMWT, TNS, and 20mm survey results have produced some of the lowest adult and larval delta smelt abundance indexes on record (CDFW 2013, 2014, 2015). The 2014 FMWT abundance index which determines the relative population status for the delta smelt was set at 9, which is the lowest index on record. The low index numbers and relatively few occurrences represent the additive impact of drought to the delta smelt and its habitat.

Status of the Delta Smelt Critical Habitat

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code) (Service 1994).

Conservation Role of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful spawning, larval and juvenile transport, rearing, and adult migration. Delta smelt are endemic to the Bay-Delta and the vast majority only live one year. Thus, regardless of annual hydrology, the Delta must provide suitable habitat all year, every year. Different regions of the Delta provide different habitat conditions for different life stages, but those habitat conditions must be present when needed, and have sufficient connectivity to provide migratory pathways and the flow of energy, materials and organisms among the habitat components. The entire Delta and Suisun Bay are designated as critical habitat; over the course of a year, the entire habitat is occupied.

Description of the Primary Constituent Elements

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements (PCEs) essential to the conservation of the species:

Primary Constituent Element 1: "Physical habitat" is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary's low-salinity zone (LSZ) (Bennett *et al.* 2002, Hobbs *et al.* 2006).

Primary Constituent Element 2: "Water" is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.

Primary Constituent Element 3: "River flow" is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and Old and Middle Rivers flow influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones. River flow interacts with the fourth primary constituent element, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.

Primary Constituent Element 4: "Salinity" is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5-6.0 psu (parts per thousand salinity) (Kimmerer 2004). The 2 psu isohaline is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby *et al.* 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu isohaline to the Golden Gate Bridge (X2); X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby *et al.* 1995, Kimmerer 2002a). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from San Pablo Bay (45 kilometers) to as far upstream as Rio Vista on the Sacramento River (95 kilometers). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete their life cycle. In general, delta smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish the more frequently and further the LSZ moves upstream, toward the confluence.

Overview of Delta Smelt Habitat Requirements and the Primary Constituent Elements

Delta smelt live their entire lives in the tidally-influenced fresh- and brackish waters of the San Francisco Estuary (Moyle 2002). Delta smelt are an open-water, or pelagic, species. They do not associate strongly with structure. They may use nearshore habitats for spawning (PCE #1), but free-swimming life stages mainly occupy offshore waters (PCE #2). Thus, the distribution of the population is strongly influenced by river flows through the estuary (PCE #3) because the quantity of fresh water flowing through the estuary changes the amount and location of suitable low-salinity,

open-water habitat (PCE #4). This is true for all life stages. During periods of high river flow into the estuary, delta smelt distribution can transiently extend as far west as the Napa River and San Pablo Bay. Delta smelt distribution is highly constricted near the Sacramento-San Joaquin river confluence during periods of low river flow into the estuary (Feyrer *et al.* 2007). In the 1994 designation of critical habitat, the best available science held that the delta smelt population was responding to variation in spring X2.

Alterations to Estuarine Bathymetry (PCE # 1) (~ 1850-present)

The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Nichols *et al.* 1986). The ancestral Delta was a large tidal marsh-floodplain habitat totaling approximately 300,000 acres. Most of the wetlands were diked and reclaimed for agriculture or other human use by the 1920s. The physical habitat modifications of the Delta and Suisun Bay were mostly due to land reclamation and urbanization. Water conveyance projects and river channelization have had some influence on the regional physical habitat by armoring levees with riprap, building conveyance channels like the Delta Cross Channel, storage reservoirs like Clifton Court Forebay, and by building and operating temporary barriers in the south Delta and permanent gates and water distribution systems in Suisun Marsh.

In the 1930s to 1960s, the shipping channels were dredged deeper (~12 m) to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the Sacramento-San Joaquin river confluence region as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995). However, the deeper landscape created to support shipping and flood control requires more freshwater outflow to maintain the LSZ in the large Suisun Bay/river confluence region than was once required (Gartrell 2010).

Seasonal salinity intrusion reduces the temporal overlap of the LSZ (indexed by X2) with the Suisun Bay region, especially in the fall (Feyrer *et al.* 2007, 2010). Thus, the second major change has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation. This metric showed a step-decline in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer *et al.* 2011). As such this alteration of PCE # 1 also affects the other PCEs, particularly PCE # 4. The major landscape factor affecting this interaction was the dredging of shipping channels.

Spawning delta smelt require all four PCEs, but spawners and embryos are the life stage that is believed to most require a specific structural component of habitat. Spawning delta smelt require sandy or small gravel substrates for egg deposition (Bennett 2005). The major invasive species effect on physical habitat is the dense growth of submerged aquatic vegetation in the Delta. These plants carpet large areas in parts of the Delta such as Frank's Tract. The vegetation beds act as mechanical filters removing turbidity and possibly other water quality components as the tides and river flows move water over them (Hestir 2010). Thus, the proliferation of submerged aquatic plants has likely also reduced the area of nearshore habitat suitable for delta smelt spawning.

Alterations to Water (PCE # 2)

PCE # 2 is primarily referring to a few key water quality components (other than salinity) that influence spawning and rearing habitat suitability for delta smelt. Research to date indicates that water quality conditions are more important than physical habitat conditions for predicting where

delta smelt occur (Feyrer *et al.* 2007; Nobriga *et al.* 2008) probably because delta smelt is a pelagic fish except during its egg/embryo stage. However, the interaction of water quality and bathymetry is thought to generally affect estuarine habitat suitability (Peterson 2003) and there is evidence that delta smelt habitat is optimized when appropriate water quality conditions overlap the Suisun Bay region (Moyle *et al.* 1992; Hobbs *et al.* 2006; Feyrer *et al.* 2011). This is discussed further in the section about PCE # 4 (salinity).

Changing predation pressure (1879 to present): Noting is known about the historical predators of delta smelt or their possible influence on delta smelt. Fish eggs and larvae can be opportunistically preyed upon by many invertebrate and vertebrate animals so there has always been a very long list of potential predators of delta smelt's eggs and larvae. Potential native predators of juvenile and adult delta smelt would also have included numerous bird and fish species and this may be reflected in delta smelt's annual life-history. Annual fish species, also known as "opportunistic strategists", are adapted to high mortality rates in the adult stage (Winemiller and Rose 1992). This high mortality is usually due to predation or highly unpredictable environmental conditions, both of which could have characterized the ancestral niche of delta smelt.

The introduction of striped bass into the San Francisco Estuary in 1879 added a permanently resident, large piscivorous fish to the low-salinity zone: a habitat that is not known to have had an equivalent predator prior to the establishment of striped bass (Moyle 2002). This likely changed predation rates on delta smelt, but there are no data available to confirm this hypothesis. For many decades the estuary supported higher striped bass and delta smelt numbers than it does currently. This is evidence that delta smelt is able to successfully coexist with striped bass.

The current influence of striped bass and other predators on delta smelt population dynamics is also not known mainly because quantitative descriptions of predator impacts on rare prey are extremely difficult to generate. Delta smelt were observed in the stomach contents of striped bass and other fishes in the 1960s (Stevens 1963; Turner and Kelley 1966), but have not been observed in more recent studies (Feyrer *et al.* 2003; Nobriga and Feyrer 2007). Predation is a common source of density-dependent mortality in fish populations (Rose *et al.* 2001). Thus, it is possible that predation was a mechanism that historically generated the density-dependence observed in delta smelt population dynamics (Bennett 2005; Maunder and Deriso 2011). Because it is generally true for fishes, the vulnerability of delta smelt to predators is influenced primarily by habitat conditions. Turbidity may be a key mediatory of delta smelt's vulnerability to predators (Nobriga *et al.* 2005; 2008). Growth rates, an interactive outcome of feeding success and water temperature, are also well known to affect fishes' cumulative vulnerability to predation (Sogard 1997). Thus, predation rate is best characterized as an aspect food web function linked to PCE # 2.

Food web alterations attributable to the overbite clam (1987-present): The next major change to PCE #2 occurred following the invasion of the estuary by overbite clam (*Corbula amurensis*). The overbite clam was first detected in 1986 and from 1987-1990 its influence on the ecosystem became evident. Since 1987, there has been a step-decline in phytoplankton biomass (Alpine and Cloern 1992; Jassby *et al.* 2002). Phytoplankton in the LSZ is an important component of the pelagic food web that delta smelt are a part of because a key part of the diet of delta smelt's prey is phytoplankton. Not only does the overbite clam reduce food for delta smelt's prey, it can also graze directly on the larval stages of the copepods eaten by delta smelt (e.g., Kimmerer *et al.* 1994). The grazing pressure applied by the overbite clam rippled through the historical zooplankton community that fueled fishery production in the LSZ (Kimmerer and Orsi 1996; Orsi and Mecum 1996; Kimmerer 2002b; Feyrer *et al.* 2003). This major change in the way energy moved through the ecosystem has likely facilitated the numerous invasions of the estuary by suppressing the production of historically

dominant zooplankton, which increases the opportunity for invasion by other species that are less dependent on high densities of LSZ phytoplankton.

The distribution and abundance of several LSZ fishes have changed since 1987 (Kimmerer 2002b; Kimmereer 2006; Rosenfield and Baxter 2007; Mac Nally *et al.* 2010). Surprisingly, the changes in phytoplankton and zooplankton production have not been as evident for delta smelt as for other organisms (Kimmer 2002b; Kimmerer 2006; Sommer *et al.* 2007; Mac Nally *et al.* 2010). Nonetheless, delta smelt collected in the FMWT have been persistently smaller since the overbite clam invasion (Sweetnam 1999; Bennett 2005). This is evidence for reduced growth rates that could have been caused by food web changes stemming from overbite clam grazing. The Service considers the prey density aspect of the estuarine food web to be a component of PCE #3 ("Water"). The Central Valley Project and State Water Project entrain some food web production (about 4.5 percent on a daily average basis was attributed to all water diversions in the Delta; Jassby *et al.* 2002). However, prey densities have been most strongly affected by clam grazing (Kimmerer *et al.* 1994; Jassby *et al.* 2002). Urban wastewater input, *Microcystis* blooms, and pesticide loads may also impair the production of zooplankton eaten by delta smelt or eaten by delta smelt's prey (Wilkerson *et al.* 2006; Dugdale *et al.* 2007; Jassby 2008; Ger *et al.* 2009; Werner *et al.* 2010).

Proliferation of submerged aquatic vegetation (1980s to present): For many decades, the Delta's waterways were turbid and the growth of submerged plants was apparently unremarkable. That began to change in the mid-1980s, when the Delta was invaded by non-native plant *Egeria densa*, a fast-growing aquarium plant that has taken hold in many shallow habitats (Brown and Michnuik 2007; Hestir 2010). *Egeria densa* and other non-native species of submerged aquatic vegetation (SAV) grow most rapidly in the summer and late fall when water temperatures are warm (>20°C) and outflow is relatively low (Hestir 2010). The large canopies formed by these plants have physical and biological consequences for the ecosystem (Kimmerer *et al.* 2008). First, dense SAV promotes water transparency. Increased water transparency leads to a loss of habitat for delta smelt (Feyrer *et al.* 2007; Nobriga *et al.* 2008). Second, dense SAV canopies provide habitat for a suite of non-native fishes, including largemouth bass, which now dominate many shallow habitats of the Delta and displace native fishes (Nobriga *et al.* 2005; Brown and Michniuk 2007). Finally, SAV colonization over the last three decades has led to a shift in the dominant freshwater food web pathways and that fuel fish production (Grimaldo *et al.* 2009b). It is noteworthy that SAV-dominated habitats are comparatively productive (Nobriga *et al.* 2005; Grimaldo *et al.* 2009b), but most of the productivity they generate remains in the nearshore environment and therefore does not contribute much to pelagic fish production (Grimaldo *et al.* 2009b).

Reduced turbidity (1999-present): The next major change was a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). For decades, the turbidity of the modified estuary had been sustained by very large sediment deposits resulting mainly from gold mining in the latter 19th century. The sediments continued to accumulate into the mid-20th century, keeping the water relatively turbid even as sediment loads from the Sacramento River basin declined due to dam and levee construction (Wright and Schoellhamer 2004). The flushing of the sediment deposits may also have made the estuary deeper overall and thus a less suitable nursery from the 'static' bathymetric perspective (Schroeter 2008). Delta smelt larvae require turbidity to initiate feeding (Baskerville-Bridges *et al.* 2004), and as explained above, older fish are thought to use turbidity as cover from predators. Thus, turbidity is an aspect of PCE # 2 which is a necessary water quality aspect of delta smelt's critical habitat.

Dams and armored levees have contributed to the long-term decline in sediment load to the estuary (Wright and Schoellhamer 2004) and to the clearing of estuary water. This is a long-term effect that stemmed from building and maintaining infrastructure. Opportunities to substantively address this

change are limited due to the extreme Central Valley flood and water supply risks that will result from decommissioning dams or removing levees.

Changing water temperature (present through long-term climate forecasts): Delta smelt is already subjected to thermally stressful temperatures every summer in the Delta. Water temperatures are presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding the nominal lethal limit of 25°C for short periods. Coldwater fishes begin to have behavioral impairments (Marine and Cech 2004) and lose competitive abilities (Taniguchi *et al.* 1998) prior to reaching their thermal tolerance limits. Thus, the estuary can already be considered thermally stressful to delta smelt and can only become more so if temperatures warm in the coming decades.

All available regional climate change projections predict central California will be warmer still in the coming decades (Dettinger 2005). It is expected that warmer estuary temperatures will be yet another significant conservation challenge (Brown *et al.* 2013; Cloern *et al.* 2011). This is true because they will limit abiotic habitat suitability further than indicated by flow-based projection (e.g., Feyrer *et al.* 2011). In addition, warmer water temperatures mean that higher prey densities will be required just to maintain present-day growth rates, which are already lower than they once were (Sweetnam 1999; Bennett 2005). Water temperature is mainly affected by climate variation, both as air temperature and as flood and drought scale flow variation (Kimmer 2004; Wagner *et al.* 2011).

Sensitivities to contaminants (ongoing): Delta smelt's spawning migration coincides with early winter rains (Sommer *et al.* 2011). This 'first-flush' of inflow to the Delta brings sediment-bound pesticides with it (Bergamaschi *et al.* 2001), and peak densities of larvae and juveniles can co-occur with numerous pesticides (Kuivila and Moon 2004). Bennett (2005) reported that about 10 percent of the delta smelt analyzed for histopathological anomalies in 1999-2000 showed evidence of deleterious contaminant exposure, but this was low compared to the 30-60 percent of these fish that appeared to be food-limited.

Delta smelt can also be exposed to other toxic substances. Recent toxicological research has provided dose-response curves for several contaminants (Connon *et al.* 2009; 2011). This research has also shown the gene expression changes and impairment of delta smelt swimming performance occur at contaminant concentrations lower than levels that cause mortality. Climate scale flow variation (e.g., flood versus drought scale variation) affects the amount of methyl mercury (Darryl Slotton presentation) entering the ecosystem and may have some influence on the meaningful dilution of ammonium from urban wastewater inputs (Dick Dugdale presentation).

Invasive species may also affect PCE #2 by changing contaminant dynamics. For instance, *Microcystis* blooms generate toxic compounds that can kill delta smelt prey (Ger *et al.* 2009) and accumulate in the estuarine food web (Lehman *et al.* 2010). A second example is the biomagnification of selenium in the food web by *Corbula* (Stewart *et al.* 2004). This has been considered a potential issue for the clam's predators – namely sturgeon, splittail, and diving ducks (Richman and Lovvorn 2004; Stewart *et al.* 2004). However, it is not known whether this change in selenium dynamics negatively affects delta smelt and other fishes that do not directly prey on the clams.

Alterations of River Flows (PCE # 3)

This PCE refers to the transport flows that help guide young delta smelt from spawning habitats to rearing habitats, and to flows that guide adult delta smelt from rearing habitats to spawning habitats. Delta outflow also has some influence on delta smelt's supporting food web (Jassby *et al.* 2002; Kimmerer 2002a) and it affects abiotic habitat suitability as well (Feyrer *et al.* 2007; 2011). The latter

is expanded upon in the discussion of PCE # 4. The environmental driver with the strongest influence on PCE # 3 is highly dependent on the time-scale being considered. The tide has the largest influence on flow velocities and directions in delta smelt's critical habitat at very short timescales (minutes to days), whereas interannual variation in precipitation and runoff has the largest influence on flows into and through the Delta at very long timescales (years to decades), and sometimes at shorter time scales (days to weeks) during major storm events. Changes to flow regimes can have the largest influence on PCE #3 at timescales of weeks to seasons. This is particularly true during periods of low natural inflow, for instance during the fall and during droughts, and in the south Delta where Old and Middle River flows are often managed using changes in export flow rates.

Entrainment into water export diversions (1951 to present): The amount of water diverted from the estuary has generally increased over time, and most of the increase during the 1950s and 1960s was due to CVP exports and since the latter 1960s, SWP exports. There are two basic potential fishery impacts that result from water diversion from the Delta: ecosystemic impacts and direct entrainment. From the ecosystemic perspective, water diversions are unnatural 'predators' because they 'consume' organisms at every trophic level in the ecosystem from phytoplankton (Jassby *et al.* 2002) to fish (Kimmerer 2008). Unlike natural predators which typically shift their prey use over time in association with changes in prey fish density (Nobriga and Feyrer 2008), fractional entrainment losses of fishes to diversions are functions of water and demand (e.g., Grimaldo *et al.* 2009). Thus, water diversions not only elevate 'predation' mortality in an aquatic system, but they can do so in an atypical, density-independent manner. Diversions and fish collection facilities in the south Delta are very large structures which attract large aggregations of actual predatory fish and prey on smaller species like delta smelt before they reach the fish salvage facilities and within these facilities (Gingras 1997).

Estimated entrainment losses of delta smelt to SWP and CVP diversions can be substantial in some years (Kimmerer 2008). Given the delta smelt's current density-independent population dynamics, even a statistically indiscernible entrainment effect on the population is likely to cause the species to continue to decline (Kimmerer 2011). The entrainment losses of delta smelt are not generally observed until they reach the early juvenile stage (~20-30 mm in length), but combinations of 20-mm Survey distribution data and hydrodynamic modeling provide evidence that their risk of entrainment into the CVP and SWP diversions can be described by any of several indices that integrate Delta inflow and export flow (Kimmerer and Nobriga 2008; Kimmerer 2008; Service 2008; Grimaldo *et al.* 2009).

Delta smelt entrainment losses estimated from survey data and hydrodynamics can also be substantial in some years (Kimmerer 2008), though it is possible that Kimmerer may have overestimated them (Miller 2011). Nonetheless, increasing higher outflow (or lower X2) moves the bulk of the larval population increasingly west, which results in fewer larvae distributed in the south Delta where they are at highest risk of entrainment. At the same time, indices like the export to inflow ratio or Old and Middle river flow are useful metrics for gauging the effect of exports on the south Delta.

The risk of delta smelt entrainment into smaller agricultural irrigation diversions used mainly to irrigate crops within the Delta is also related to flow conditions. These in-Delta irrigation diversions generally have mean flow rates less than 1 cubic meter per second (Nobriga *et al.* 2004). The lower the Delta outflow, the higher the proportion of the young delta smelt population that overlaps the array of irrigation diversions in the Delta (Kimmerer and Nobriga 2008). However, the irrigation diversions are not currently considered to represent a substantial source of mortality because they individually draw small quantities of water relative to channel volumes (Nobriga *et al.* 2004).

In Suisun Marsh, water diversions are largely made to support waterfowl production. Some Suisun Marsh diversions are larger for the size of channels they are in than most of the agricultural irrigation diversions in the Delta. Based on hydrodynamic simulations, proximity to water diversions in the marsh is expected to correlate strongly with entrainment (Culberson *et al.* 2004), and substantial delta smelt losses have been reported when these diversions are not screened (Pickard *et al.* 1982). Entrainment risk for delta smelt in western Suisun Marsh is considered low because the habitat surrounding the diversions is often too saline (Enos *et al.* 2007).
Salinity PCE # 4

The core delta smelt habitat, is the LSZ (Moyle *et al.* 1992; Bennett 2005). The LSZ is where freshwater transitions into brackish water; the LSZ is defined as the area of the estuary where salinity ranges from 0.5-6.0 psu (Kimmerer 2004). This area is always moving due to tidal and river flow variation. The 2 psu isohaline is a specific location within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby *et al.* 1995). By local convention, changes in the location of the LSZ are described in terms of the distance from the Golden Gate Bridge to the 2 psu isohaline (X2); X2 is an indicator of habitat suitability for many of the estuary's organisms and it is associated with variance in abundance of diverse components of the ecosystem (Jassby *et al.* 1995; Kimmerer 2002b; Kimmerer *et al.* 2009). The LSZ expands and moves downstream when river flows into the estuary are high (Kimmerer *et al.* 2009). Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from as far downstream of San Pablo Bay (45 km) to as far upstream as Rio Vista on the Sacramento River (95 km).

Larval delta smelt tend to reside somewhat landward (upstream) of X2 (Dege and Brown 2004), but the center of juvenile distribution tends to be very near X2 until the fish start making spawning migrations in the winter (Feyrer *et al.* 2011; Sommer *et al.* 2011). Because of this association between the distribution of salinity in the estuary and the distribution of the delta smelt population, the tidal and river flows that comprise PCE # 3 affect PCE # 4.

The expansion and contraction of the LSZ affects the areal extent of abiotic habitat for delta smelt, both during spring (Kimmerer *et al.* 2009) and fall (Feyrer *et al.* 2007; 2011). In the spring, most delta smelt are larvae or young juveniles and the LSZ is typically maintained over the expansive Suisun Bay region. Thus, abiotic habitat "limitation" is unlikely and no consistent influence of spring X2 variation on later stage abundance estimates has been reported to date (Jassby *et al.* 1995; Bennett 2005; Kimmerer *et al.* 2009). In fact, historical maxima in juvenile abundance according to CDFW's TNS occurred in low outflow years when abiotic habitat area was comparatively low (Kimmerer 2002a; Kimmerer *et al.* 2009).

In contrast, during fall delta smelt are late stage juveniles and for the past decade or more, the LSZ has been persistently constricted by low Delta outflow. Fall habitat conditions affect delta smelt distribution and the concurrent FMWT abundance index (Feyrer *et al.* 2007; 2011). However, the quantitative life cycle models developed to date have not found evidence for a year over year effect of fall LSZ location on delta smelt population dynamics (Mac Nally *et al.* 2010; Thompson *et al.* 2010; Maunder and Deriso 2011).

It is now recognized that some delta smelt occur year-round in the Cache Slough region including the Sacramento Deep Water Shipping Channel and Liberty Island (Kimmerer 2011; Miller 2011; Sommer *et al.* 2011). The latter has been a consistently available habitat only since 1997. This region is often lower in salinity than 0.6 psu, the lower formal limit of the LSZ as defined by Kimmerer (2004). Delta smelt likely use it because it is one of the most turbid habitats remaining in the Delta (Nobriga *et al.* 2005). A recent population genetic study found no evidence that delta smelt inhabiting this region are unique compared to delta smelt using the LSZ-proper (Fisch *et al.*

2011), therefore it is likely that individual delta smelt migrate between the LSZ and the Cache Slough region. This is consistent with the high summer water temperatures observed there, which might compel individual delta smelt to seek out cooler habitats within and outside the Cache Slough region.

Delta Smelt Environmental Baseline

The portions of the Action Area that fall within the range of delta smelt include the Sacramento River east levee, south of Sacramento and the Sacramento Weir. Delta smelt typically migrate up into this area as early as December and move out in the spring and summer. The proposed project contains habitat components that can be used for feeding, spawning, rearing, and movement. Some amount of erosion protection has already occurred within the action area. Additionally, the Corps has a project which will place rock along 31,000 linear feet of the right bank of the Sacramento River immediately across the river and extending upstream from the proposed project footprint. Compensation for the placement of this rock will be through the development of a setback levee that will provide 118 acres of newly created shallow water habitat.

Giant Garter Snake Status of the Species

For the most recent assessment of the species' range-wide status please refer to the *Giant Garter Snake (Thamnophis gigas) 5-year Review: Summary and Evaluation* (Service 2012) for the current status of the species. Ongoing threats to giant garter snake include habitat loss from water transfers, rice fallowing due to drought conditions, habitat disturbance and loss from irrigation and drainage ditch maintenance, climate change, and invasive species. While these threats continue to effect the giant garter snake throughout its range, to date no project has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the giant garter snake.

Giant Garter Snake Environmental Baseline

The *Draft Recovery Plan for the Giant Garter Snake* (Service 1999b) subdivides the range of the species into four recovery units. Each recovery unit includes populations. The action area for the proposed project is located within the Yolo Basin-Willow Slough unit and the American Basin unit. According to the 2012, 5-year review (Service 2012) the abundance and distribution of giant garter snakes has not changed significantly. Within the Action Area habitat loss and fragmentation is the most significant threat to the giant garter snake. Urbanizing areas within the Action Area include Sacramento and West Sacramento. Habitat loss through water transfers and rice fallowing also negatively affects giant garter snakes. In the Sacramento Valley, rice has served as a substitute for the large amounts of historical wetlands that used to exist in the Central Valley. Loss of this habitat has been shown to reduce or exclude giant garter snakes compared to areas which are actively irrigated in rice (Wylie *et al.* 2002a, b, 2004).

Flood control maintenance and agricultural activities can reduce and prevent the establishment of vegetation and burrows needed by the giant garter snake for cover and shelter on canals, levees, and agricultural ditches. This can also reduce the prey base for giant garter snake, affecting their feeding. Additionally, clearing, scraping and/or re-contouring canals, ditches, and levees, destroys burrows and crevices that are used as over-wintering habitat and during the summer for thermoregulation, shedding, and giving birth. These activities are being conducted by local maintaining agencies throughout the Action Area.

Other factors which effect the giant garter snake population in the Action Area include vehicular mortality particularly where canals or aquatic habitat are bordered by roads such as the crown of the

levees. Non-native predators such as game fish, bull frogs (*Rana catesbiana*), and domestic cats can affect giant garter snake populations (Service 1999b). This can be particularly detrimental to young and juvenile giant garter snakes. All of the Action Area has non-native predators occurring in it.

Snakes have been located within the Yolo Bypass within 2 miles of the Sacramento Bypass. Numerous irrigation and drainage canals exist which provide connectivity from the Sacramento Bypass and areas that are known to support snakes in the Yolo Bypass. A snake observed 0.5 mile to the west of the NEMDC along Elkhorn Boulevard in 1996 (CNDDB 2015). Borrow site 2's northern boundary is Elkhorn Boulevard on the east side of the NEMDC. Giant garter snakes could be using the NEMDC for aquatic habitat and the surrounding grasslands for uplands.

Western Yellow-Billed Cuckoo Status of the Species

For the most recent assessment of the species range-wide status please refer to the October 3, 2014, *Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (Coccyzus americanus occidentalis)* (79 FR 59991). Ongoing threats to the yellow-billed cuckoo include habitat loss from flood control projects and maintenance, alterations to hydrology, climate change, and invasive species. While these threats continue to affect the yellow-billed cuckoo throughout its range, no project, to date, has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the yellow-billed cuckoo.

Western Yellow-Billed Cuckoo Baseline

Yellow-billed cuckoo detections have occurred most frequently in the upper Sacramento River where levees are setback from the river or do not exist. Additionally, the last 20 years has seen a large amount of riparian restoration occur in the upper Sacramento River. Habitat in the action area tends to be more narrow and linear than in the upper Sacramento River. Levees were constructed close to the bank of the Sacramento River leaving narrow bands of small patch sizes. Construction of the setback levee along the right bank of the Sacramento River as part of the West Sacramento Flood Control Project will provide some wider patches of riparian habitat that will benefit the yellow-billed cuckoo. The American River has a wider floodplain due to levees being setback from the channel. There are some patches large enough to support nesting yellow-billed cuckoos, though cuckoos have not been observed nesting along the American River.

Effects of the Proposed Action

Valley Elderberry Longhorn Beetle

Vegetation removal, including elderberries could cause mortality of any beetle larvae within the elderberry shrub. Transplanting the shrubs between November 1 and February 15, when the shrubs are dormant, will minimize the likelihood of killing larvae within the shrub. Transplanting the shrub could still result in mortality to larvae within the shrub, particularly if the shrub does not survive transplantation. Proper care of the transplants through watering in the initial years can minimize this loss and increase the likelihood that the shrub will survive and provide continued habitat for the valley elderberry longhorn beetle.

Construction that occurs near elderberry shrubs that will be protected in place can kill adult beetles if construction equipment is operating between the months of March and June when valley elderberry longhorn beetles have emerged from the elderberry shrubs and are locating mates for reproduction. Fencing the area which contains riparian habitat, specifically elderberry shrubs, and keeping a minimum of a 20 foot buffer from the dripline of the elderberry shrub will keep

construction equipment from driving too close to the shrubs and minimize the number of beetles that might be struck or run over by equipment.

Transplanting elderberry shrubs out of the construction footprint has the potential to affect valley elderberry longhorn beetle dispersal if there is potential to remove large areas of elderberry shrubs. The Corps has provided maps of where existing valley elderberry longhorn beetle habitat exists and where shrubs will be removed due to the project. Along the Sacramento River, 13 elderberry shrubs distributed within 70 acres of riparian habitat will be transplanted as part of the project, however during surveys the Corps has documented an additional 60 elderberry shrubs that will be protected in place along the Sacramento River. The Corps has also proposed to include elderberry shrub plantings along the bank repair footprint where the elevation is suitable so the shrubs are not inundated too frequently. Along the American River, 250 elderberry shrubs distributed within 65 acres of riparian habitat will be transplanted as part of the project. The American River has many conservation sites and the Corps has proposed to offset the removal of elderberry shrubs through development of additional sites and enlargement of existing sites in the lower American River Parkway. The Corps is proposing to create an additional 69.91 acres of habitat for the valley elderberry longhorn beetle in the lower American River Parkway.

Trimming of elderberry shrubs can result in the loss of some habitat for the valley elderberry longhorn beetle. Unlike transplantation however, the shrub remains within the riparian corridor and can provide habitat for the beetle during dispersal. There is potential for one of the pruned stems to contain the larvae of the valley elderberry longhorn beetle. While elderberry shrubs do resprout readily, there is a temporal loss of habitat for the beetle and as part of the maintenance any resprouted stems will be removed in order to provide maintenance equipment access. To offset these effects the local maintaining agencies have proposed to create a 40-acre conservation area for the valley elderberry longhorn beetle. This area will be selected as described in the preceding paragraph. This will ensure habitat connectivity and help with long-term maintenance and monitoring of these lands.

Delta Smelt

Construction along the Sacramento River will place bank protection along a 50,300 linear foot section of the left bank of the Sacramento River. Delta smelt are a pelagic species that is typically found in the center of the channel. However, as described in the status of the species they do spawn on sandy beaches in shallow water habitat (0 to 3 meters) and in this portion of the Sacramento River are found close to the banks. The rock footprint will change the substrate along the 50,300 linear feet of 33 acres of shallow water habitat. Additionally 13 acres are being converted from riverine bank edge to a rock wedge. Construction related effects to individual delta smelt will be avoided because construction is occurring between August 1 and November 30, a time when delta smelt are located further downstream in the Delta and Suisun Bay. Effects due to increasing sediment downstream of the work area will be minimized through the conservation measures involving monitoring water quality during construction to ensure that effects do not extend into the portion of the Delta that delta smelt occupies during the late summer/fall period. Construction to widen the Sacramento Weir will occur on the landside of the existing Sacramento River right bank levee. Upon completion of the weir extension the levee removed between August 1 and November 30 avoiding effects to delta smelt habitat.

The primary negative effect of the project on potential spawning habitat is the change of substrate from sand to riprap. Rock used for bank protection is large enough to retard erosional forces of the river and therefore has interstitial spaces. Should delta smelt spawn over this riprap substrate, it is very likely that any eggs will fall into these interstitial spaces resulting in the loss of eggs and

potentially causing fertilization to not occur if the eggs fall into the interstitial spaces. The Corps has proposed to offset this loss of spawning potential in these areas through the purchase of 33 acres of credits at a Service-approved delta smelt conservation bank. The placement of rock will permanently narrow the channel by 13 acres through the change of riverine edge to rock wedge. Rock slope protection limits the lateral mobility of a river channel, increases flow velocities (Sedell *et al.* 1990), limit sediment transport, and eliminates bankside refugia areas (Gregory *et al.* 1991). Rock placement can also affect primary productivity through the loss of vegetation. The Corps will protect large trees in place and plant riparian benches at the conclusion of the rock placement to replace the loss of vegetation. Planting benches and vegetation planting will also help to offset the increased velocities that the bank protection sites will experience due to the smoother rock surface. To offset the complete loss of riverine edge habitat the Corps has proposed to purchase 39 acres of credits at a Service-approved delta smelt conservation bank for a total of 72 acres of credits.

The Corps has proposed to evaluate effects to listed species including delta smelt when long-term maintenance activities for the Sacramento River can be described. If maintenance activities will affect delta smelt the Corps will reinitiate consultation with the Service. Therefore, this biological opinion does not address effects to the delta smelt from any long-term levee maintenance activities.

Delta Smelt Critical Habitat

This opinion on the critical habitat for the delta smelt does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR § 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in *Gifford Pinchot Task Force v. U. S. Fish and Wildlife Service* (No. 03-35279) to complete the following analysis with respect to the proposed critical habitat.

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. The placement of rock will change the substrate of shallow water habitat for 46 acres. Any loss of shallow water habitat will be compensated through the purchase of credits at a delta smelt conservation bank. It is expected that planting the sites post-construction will replace any loss of primary productivity within the Sacramento River water column.

Giant Garter Snake

Borrow Site 2 – Upland habitat will be disturbed at borrow site 2 (5.5 acres) when heavy equipment is brought in to remove soil for the Arcade Creek levee repair. Removal of soil from the site will result in the crushing of burrows that snakes use for aestivating and thermoregulation. Fencing the borrow site prior to borrow excavation will minimize the likelihood that snakes will be in the borrow site when construction equipment begins to mobilize. Fencing the site will temporarily (one active season) exclude the use of the area for giant garter snake. This could result in snakes having to move further distances to find upland refugia in the summer months and expose them to predation or other sources of mortality such as being run over by a vehicle on the levee road on the opposite side of the NEMDC. Because the aquatic habitat will not be disturbed by the project, there will not be any effects on the snake's ability to forage.

Upon completion of the project, the site will restored and re-graded to create three habitat types. The creation of additional tule marsh along the edge of the canal will benefit giant garter snakes that may be using the NEMDC as it will provide cover, an area for prey production, and refugia from predators. Additionally, the seasonal wetland bench will only provide aquatic habitat in the winter months when the snake is typically in burrows. The wetland bench will provide some upland habitat

for the giant garter snake during the summer when the snake is active in the form of basking habitat and if dried wetland vegetation remains some refugia from predators; however, because the site will be flooded in the winter it will not serve as overwintering habitat for the snake. The remaining 3.5 acres of the borrow site will be restored to native grassland and will function as summer upland refugia and basking and in the winter serve as overwintering habitat for the snake.

Sacramento Bypass – Enlarging the Sacramento Bypass and Weir will result in both permanent and temporary effects to giant garter snake habitat. Construction of the widened bypass will have similar effects to giant garter snake as the work along borrow site 2. Snakes could be crushed by heavy equipment, entombed in refugia when burrows collapse, and exposed to increased predation because they may have to travel further to find habitat that is unavailable to them due to the project. The 25 acres of aquatic habitat and 50 acres of upland habitat that will be temporarily affected because of the relocation of a levee toe drain will be replaced within one year of construction. The Corps has committed to creating a toe drain that closely mimics the existing aquatic and upland habitat along the northern levee of the Sacramento Bypass. The effects of crushing snakes and exposing them to increased predation will be minimized through the use of the conservation measures described in the project description above.

Permanently, 15 acres of aquatic and 30 acres of upland habitat will be lost through the removal of drainage ditches and farm canals in the area that is currently outside of the bypass footprint. The Corps has committed to offsetting the loss of this habitat through the purchase of 135 acres of giant garter snake credits at a Service-approved conservation bank. Conservation banks provide protection, conservation easement, and funding, endowment, in perpetuity for the giant garter snake. These long-term protections and location of the conservation banks all contribute to the long-term recovery of the giant garter snake.

Operation of the expanded Sacramento Weir and Bypass will result in an increase of water surface elevation of approximately 0.5-foot on the levee slopes on either side of the Yolo Bypass. However, when this increase occurs, during a 200-year flood event, the Yolo Bypass levees already contain water up to 21 feet deep. As a result, giant garter snake burrows would likely already be saturated before the additional water associated with the widened Sacramento Bypass is a factor. The additional 0.5-foot resulting from this action would not significantly change the timing or duration of this flooding and would not result in further impacts to giant garter snake habitat.

The Corps has proposed to evaluate effects to listed species including giant garter snake when long-term maintenance activities for the Sacramento Bypass can be described. If maintenance activities will affect giant garter snakes the Corps will reinitiate consultation with the Service. Therefore, this biological opinion does not address effects to the giant garter snake from any long-term levee maintenance activities.

Yellow-Billed Cuckoo

Sacramento River – The Corps is planning on removing 70 acres of riparian habitat along the Sacramento River. The riparian corridor in this section of the Sacramento River is narrow (about 100 feet wide) because the levees were constructed so close to the edge of the channel bank. This is too narrow for the yellow-billed cuckoo to nest, however it is possible for the yellow-billed cuckoo to use this as a stopover when migrating to the Central Valley to breed. Vegetation removal will reduce the width of the riparian corridor from 100 feet to 40 feet on average. The Corps proposal to plant the bank protection sites will create a 25-foot wide planting berm leaving a loss of about 35 feet of riparian corridor. The Corps proposes to offset the loss of the 70 acres of riparian through the creation of 140 acres of riparian habitat along the lower American River.

American River – The construction of launchable rock trench will remove 65 acres of riparian habitat along the lower American River. The lower American River does have habitat patches large enough to support nesting yellow-billed cuckoos. Large patches of habitat will not be removed; rather a strip will be removed adjacent to the levee which could reduce the size of some of the potential nesting areas. To compensate for this the Corps is proposing to plant 130 acres along the lower American River. As described in the conservation measures, the Corps will develop a Riparian Conservation Plan that will determine the best locations to develop additional riparian habitat. The conservation areas will provide both habitat for yellow-billed cuckoo and valley elderberry longhorn. The areas will also ensure that there is a net increase of potential yellow-billed cuckoo nesting habitat along the lower American River Parkway. There will be a temporal loss of habitat because riparian habitat can take up to 20 years to develop.

In addition to the habitat loss for both the Sacramento and American Rivers, construction itself has the potential to adversely affect yellow-billed cuckoos. Construction that occurs when the cuckoo is in the Sacramento Valley has the potential to harass the bird due to noise. To minimize effects to the cuckoo due to construction noise the Corps conservation measure to do protocol level surveys prior to beginning construction will enable the Corps to determine if yellow-billed cuckoos are nesting near the construction footprint. The Corps has committed to avoid construction near an active yellow-billed cuckoo nest. However, cuckoos that could be foraging in the area could be harassed due to construction activities and noise and move to other locations in the lower American River parkway which could expose individual cuckoos to increased predation.

The Corps has proposed to evaluate effects to listed species including yellow-billed cuckoo when long-term maintenance activities for the Sacramento River and American River can be described. If maintenance activities will affect yellow-billed cuckoos the Corps will reinitiate consultation with the Service. Therefore, this biological opinion does not address effects to the yellow-billed cuckoo from any long-term levee maintenance activities.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Valley Elderberry Longhorn Beetle

Non-Federal adverse effects to the valley elderberry longhorn beetle include effects from nearby pesticide spraying drifting into valley elderberry longhorn beetle habitat and levee and channel maintenance. In the areas of the urbanized areas of the American and Sacramento Rivers human started fires is by far the largest effect to valley elderberry longhorn beetles. Over the last several years numerous fires have burned portions of the American River Parkway.

Delta Smelt

Adverse effects to delta smelt may result from point and non-point source chemical contaminant discharges within the action area. These contaminants include but are not limited to ammonia and free ammonium ion, numerous pesticides and herbicides from agricultural activities, and oil and gasoline product discharges. Oil and gasoline product discharges may be introduced into the Sacramento River from shipping and boating activities and from urban activities and runoff. Other future, non-Federal actions within the action area that are likely to occur and may adversely

affect delta smelt include: the dumping of domestic and industrial garbage that decreases water quality; oil and gas development and production that may affect aquatic habitat and may introduce pollutants into the water; agricultural activities, including burning or removal of vegetation on levees that reduce riparian and wetland habitats that contribute to the quality of habitat used by delta smelt; and livestock grazing activities that may degrade or reduce riparian and wetland habitats that contribute to the quantity and quality of habitat used by delta smelt.

San Francisco Bay-Delta Climate Change

The effects of climate change do not act in isolation; they are anticipated to exacerbate existing threats to delta smelt. We considered the potential effects of climate change on the delta smelt based on projections derived from various modeling scenarios. A series of publications (Feyrer *et al.* 2011; Cloern *et al.* 2011; Brown *et al.* 2013) have modeled future impacts of climate change in the Delta and projected how this will affect delta smelt. These models used the B1 and A2 scenarios from the 2007 IPCC report. Each scenario included both a warmer-wetter and warmer-dryer sub scenario. Modeled predictions presented in these publications are based on current baseline conditions (no increased outflow, no breeching of levees) which may or may not change in the future. Temperature increases are likely to lead to a continued rise in sea level, further increasing salinity which will increasingly restrict delta smelt's already limited geographic range (Feyrer *et al.* 2011; Cloern *et al.* 2011; Brown *et al.* 2013). Higher air temperatures will reduce snowpacks, melt snow earlier in the winter or spring, and increase water temperatures. These changes will likely alter freshwater flows, possibly shifting and condensing the timing and location of delta smelt reproduction (Brown *et al.* 2013).

Projections indicate that temperature and precipitation changes will diminish snowpack, changing the availability of natural water supplies (Reclamation 2011). Warming may result in more precipitation falling as rain and less storage as snow. This would result in increased rain on snow events and increase winter runoff with an associated decrease in runoff for the remainder of the year (Reclamation 2011). Sacramento Valley Ecoregion projections include a 27 percent decrease in annual freshwater flows and earlier snowmelts, with increased freshwater flows in January and February but reduced throughout the rest of the year (PRBO Conservation Science 2011). Earlier seasonal warming increases the likelihood of rain-on-snow events, which are associated with mid-winter floods. Smaller snowpacks that melt earlier in the year may result in increased drought frequency and severity (Rieman and Isaak 2010). Thus overall, these changes may lead to increased frequency of flood and drought cycles during the 21st century (Reclamation 2011).

Sea level rise is likely to increase the frequency and range of saltwater intrusion. Salinity within the northern San Francisco Bay is projected to rise by 4.5 by the end of the century (Cloern *et al.* 2011). Elevated salinity levels could push the position of X2 farther up the estuary if outflows were not increased to compensate for it. Fall X2 mean values are projected to increase by a mean of about 7 km to the area of Antioch for a distance of about 90 km from the Golden Gate Bridge by 2100 (Brown *et al.* 2013). This increase in the position of X2 in the fall is expected to result in a decrease in suitable physical habitat (Brown *et al.* 2013) if current levees and channel structures are maintained. A decrease in spring habitat due to the movement of X2 upstream due to sea level rise is also expected to result from climate change.

We expect warmer estuary temperatures to be yet another significant conservation challenge based on climate change models. Mean annual water temperatures within the upper Sacramento River portion of the Bay-Delta estuary are expected to approach or exceed 14 °C during the second half of this century (Cloern *et al.* 2011). Warmer water temperatures could reduce delta smelt growth, increase delta smelt mortality and constrict suitable habitat within the estuary during the summer

months. Due to warming temperatures, delta smelt are projected to spawn an average of 10 to 25 days earlier in the season depending on the location (Brown *et al.* 2013). Also due to expected temperature increases, total number of high mortality days is expected to increase for all IPCC climate change scenarios (Brown *et al.* 2013). The number of stress days is expected to be stable or decrease partly because many stress days will become high mortality days. This could lead to delta smelt being forced to grow under highly stressful conditions during summer and fall with less time to mature because of advanced spawning (Brown *et al.* 2013). Growth rates have been shown to slow as water temperatures increase therefore requiring delta smelt to consume more food to reach growth rates that are normal at lower water temperatures (Rose *et al.* 2013a). Delta smelt are already often smaller than they used to be (Sweetnam 1999; Bennett 2005) and expected temperature increases due to climate change will likely further slow growth rates.

At the same time, warmer water will tend to move the spawning season earlier in the year (Brown *et al.* 2013). That means the fish will have to grow faster still to compensate for that shorter growing season to produce even as many eggs as they do now – and that may already be a serious limitation on their population fecundity (Rose *et al.* 2013b). Higher temperatures may restrict delta smelt distribution into the fall, limiting their presence in Suisun Bay for more than just salinity reasons and force greater inhabitation of cooler high salinity waters (Brown *et al.* 2013). Water temperatures are already presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding 25 °C for short periods.

The delta smelt is currently at the southern limit of the inland distribution of the family Osmeridae along the eastern Pacific coast. That indicates that this region was already about as warm as that fish family can handle. Increased temperatures associated with climate change may result in a habitat in the Bay-Delta that is outside of the species ecological tolerance limits.

Giant Garter Snake

The Service is aware of other projects currently under review by the State, county, and local authorities where biological surveys have documented the occurrence of federally-listed species. These projects include such actions as urban expansion, water transfer projects that may not have a Federal nexus, and continued agricultural development. The cumulative effects of these known actions pose a significant threat to the eventual recovery of the species. Additionally, an undetermined number of future land use conversions and routine agricultural practices are not subject to Federal permitting processes and may alter the habitat or increase incidental take of snakes, and are, therefore, cumulative to the proposed project. For example other cumulative effects include: (1) unpredictable fluctuations in aquatic habitat due to water management and diversions; (2) dredging and clearing of vegetation from irrigation canals; (3) discing or mowing upland habitat; (4) increased vehicular traffic on access roads adjacent to aquatic habitat; (5) use of burrow fumigants on levees and other potential upland refugia; (6) human intrusion into habitat; (7) use of inappropriate plastic erosion control netting (Stuart *et al.* 2001); (8) riprapping or lining of canals and stream banks; (9) fluctuations in acreages of rice production due to market conditions or water availability; (10) ornamental cultivation; (11) routine grounds maintenance of upland habitat; (12) contaminated runoff from agriculture and urbanization; (13) maintenance of non-Federal flood control structures; and (14) predation by feral animals and pets. Specific cumulative effects related to the proposed project include maintenance activities and/or an increased potential for vandalism, which may degrade or destroy habitat or cause unpredictable fluctuations in habitat.

Yellow-Billed Cuckoo

Habitat that is currently occupied by the yellow-billed cuckoo occurs on public and privately owned lands. Activities on non-Federal lands that may affect the yellow-billed cuckoo include the construction and maintenance of recreational hiking and bicycle trails; restoration of native riparian habitat; transportation related projects like construction and maintenance of State, county, and private roads and bridges; flood channel maintenance by the State water resources agencies, and conversion of riparian habitat to agriculture on private lands.

Conclusion

After reviewing the current status of the valley elderberry longhorn beetle, delta smelt, giant garter snake and yellow-billed cuckoo, the environmental baseline for the action area, the effects of the proposed ARFC project, and the cumulative effects on these species, it is the Service's biological opinion that the proposed AFRC project, is not likely to jeopardize the continued existence of these species. The Service reached this conclusion because the project-related effects to the species, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding recovery or reducing the likelihood of survival of the species based on the conservation measures proposed by the Corps including: creating additional riparian habitat for the valley elderberry longhorn beetle and the yellow-billed cuckoo; purchasing credits at conservation banks for giant garter snake and delta smelt; and restoring any temporarily affected habitat to pre-project conditions.

After reviewing the current status of designated critical habitat for delta smelt, the environmental baseline of critical habitat in the action area, the effects of the proposed ARFC project, and the cumulative effects, it is the Service's biological opinion that the proposed ARFC project, as proposed, is not likely to destroy or adversely modify designated critical habitat. The Service reached this conclusion because the project-related effects to the designated critical habitat, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding the function of the delta smelt critical habitat, to serve its intended conservation role for the species based on the Corps proposal to purchase credits at a conservation bank for permanent effects to the substrate of the Sacramento River. The effects to delta smelt critical habitat are small and discrete, relative to the entire area designated, and are not expected to appreciably diminish the value of the critical habitat or prevent it from sustaining its role in the conservation of the delta smelt.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action

is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by the Corps and SAFCA so that become binding conditions of any contract issued for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions, or (2) fails to require their contractor or SAFCA or to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

Valley Elderberry Longhorn Beetle

The Service anticipates that incidental take of valley elderberry longhorn beetle will be difficult to detect due to its life history and ecology. Specifically, valley elderberry longhorn beetles can be difficult to locate due to the fact that a majority of their life cycle is spent in the elderberry shrub and finding a dead or injured individual is unlikely due to their relatively small size. There is a risk of harm, harassment, injury and mortality as a result of the proposed construction activities; therefore, the Service is authorizing take incidental to the proposed action as harm, harassment, injury, and mortality of all valley elderberry longhorn beetles within 263 shrubs that will be transplanted as a result of construction and 40 acres of elderberry shrubs that will be trimmed for maintenance purposes over the project's 50 year life.

Delta Smelt

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults, their occurrence in turbid aquatic habitat makes them difficult to detect, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in the 46 acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion. Incidental take of delta smelt for maintenance activities is not covered in this biological opinion.

Giant Garter Snake

The Service anticipates that incidental take of the snake will be difficult to detect or quantify for the following reasons: snakes are cryptically colored, secretive, and known to be sensitive to human activities. Snakes may avoid detection by retreating to burrows, soil crevices, vegetation, and other cover. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. It is not possible to make an accurate estimate of the number of snakes that will be harassed during construction activities, including in staging areas and roads carrying vehicular traffic. In instances when take is difficult to detect, the Service may estimate take in numbers of species per acre of habitat lost or degraded as a result of the action as a surrogate measure for quantifying individuals.

Therefore, the Service anticipates the number of giant garter snakes that may be found in 125.5 acres of aquatic and upland habitat will be harmed or killed as a result of habitat modification due to the proposed project. Incidental take of giant garter snake for maintenance activities is not covered in this biological opinion.

Yellow-Billed Cuckoo

The Service anticipates that incidental take of yellow-billed cuckoo will be difficult to detect due to its life history and ecology. Specifically, yellow-billed cuckoos can be difficult to locate due to their cryptic appearance and behavior and finding a dead or injured individual is unlikely. There is a risk of harm and harassment as a result of proposed construction activities and operations and maintenance of the restoration plantings; therefore, the Service is authorizing take incidental to the proposed action as harm of all yellow-billed cuckoos within 135 acres. Incidental take of yellow-billed cuckoo for maintenance activities is not covered in this biological opinion.

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Reasonable and Prudent Measures

All necessary and appropriate measure to avoid or minimize effects on the species resulting from implementation of this project have been incorporated into the project's proposed conservation measures. Therefore, the Service believes the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the species.

1. All conservation measures, as described in the biological assessment and restated here in the Project Description section of this biological opinion, shall be fully implemented and adhered to. Further, this reasonable and prudent measure shall be supplemented by the terms and conditions below.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. The Corps shall include full implementation and adherence to the conservation measures as a condition of any permit or contract issued for the project.

2. The Corps will develop a Riparian Planting Plan. The plan will evaluate locations for riparian vegetation planting based on land use in the lower American River Parkway, effects from future projects, such as the reoperation of Folsom Dam, where existing riparian and valley elderberry longhorn beetle habitat exists, creating and maintaining connectivity between large riparian patches, and coordination with Sacramento County Parks. The plan will maximize habitat quality for both the valley elderberry longhorn beetle and the yellow-billed cuckoo.

3. In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the Corps shall adhere to the following reporting requirements. Should this anticipated amount or extent of incidental take be exceeded, the Corps must immediately reinitiate formal consultation as per 50 CFR 402.16.

   (a) For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, the Corps will provide monthly updates to the Service with a precise accounting of the total acreage of habitat impacted. Updates shall also include any information about changes in project implementation that result in habitat disturbance not described in the Project Description and not analyzed in this biological opinion.
   (b) For those components of the action that may result in direct encounters between listed species and project workers and their equipment whereby incidental take in the form of harassment, harm, injury, or death is anticipated, the Corps shall immediately contact the Service's Sacramento Fish and Wildlife Office (SFWO) at (916) 414-6600 to report the encounter. If the encounter occurs after normal working hours, the Corps shall contact the SFWO at the earliest possible opportunity the next working day. When injured or killed individuals of the listed species are found, the Corps shall follow the steps outlined in the Salvage and Disposition of Individuals section below.
   (c) Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as a Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, and the name of the person who found it. The bag containing the specimen must be frozen in a freezer located in a secure site, until instructions are received from the Service regarding the disposition of the dead specimen. The Service contact persons are the Habitat Conservation Division Chief at the Sacramento Fish and Wildlife Office at (916) 414-6600; the Assistant Field Supervisor of ESA/Regulatory Division at the Bay Delta Fish and Wildlife Office at (916) 930-5603; and the Resident Agent-in-Charge of the Service's Office of Law Enforcement at (916) 569-8444.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1. The Service recommends the Corps develop and implement restoration measures in areas designated in the Delta Fishes Recovery Plan (Service 1996) the Giant Garter Snake Recovery Plan (1999) and the Valley Elderberry Longhorn Beetle Recovery Plan (1984).

2. The Corps and SAFCA should develop and implement projects that support DWR's Central Valley Flood System Conservation Strategy. This document provides goals and measurable objectives and potential projects which could be implemented in a manner that while improving the riverine ecosystem also will improve the flood system.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation with the Corps on the American River Common Features GRR Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

(a) If the amount or extent of taking specified in the incidental take statement is exceeded;

(b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or

(d) If a new species is listed or critical habitat designated that may be affected by the identified action.

If you have any questions regarding this biological opinion, please contact Jennifer Hobbs (jennifer_hobbs@fws.gov or (916) 414-6541) or Doug Weinrich, Assistant Field Supervisor at the letterhead address, (916) 414-6600.

Sincerely,

Jennifer M. Norris
Field Supervisor

cc:
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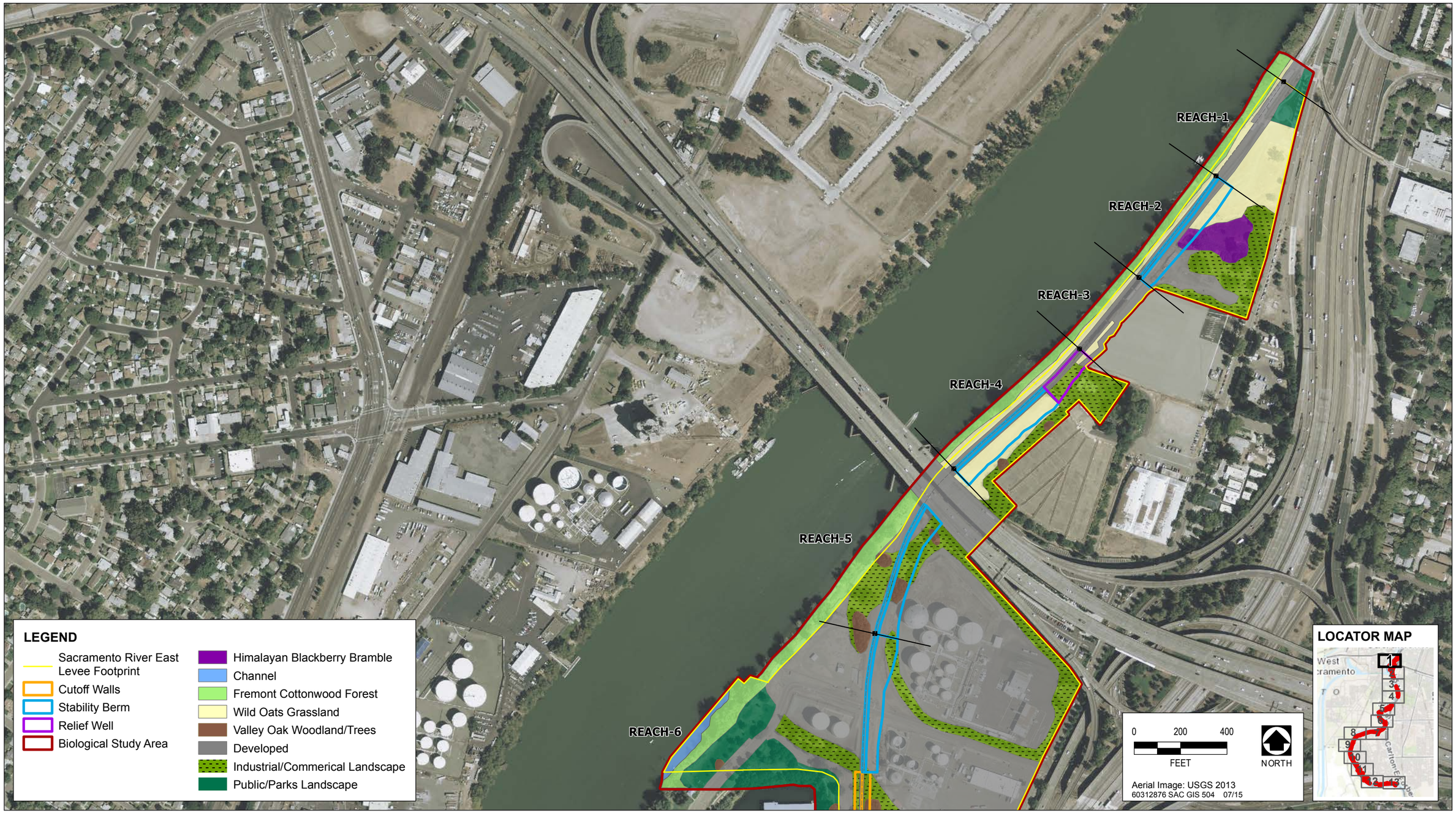


Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 1

Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 2

Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

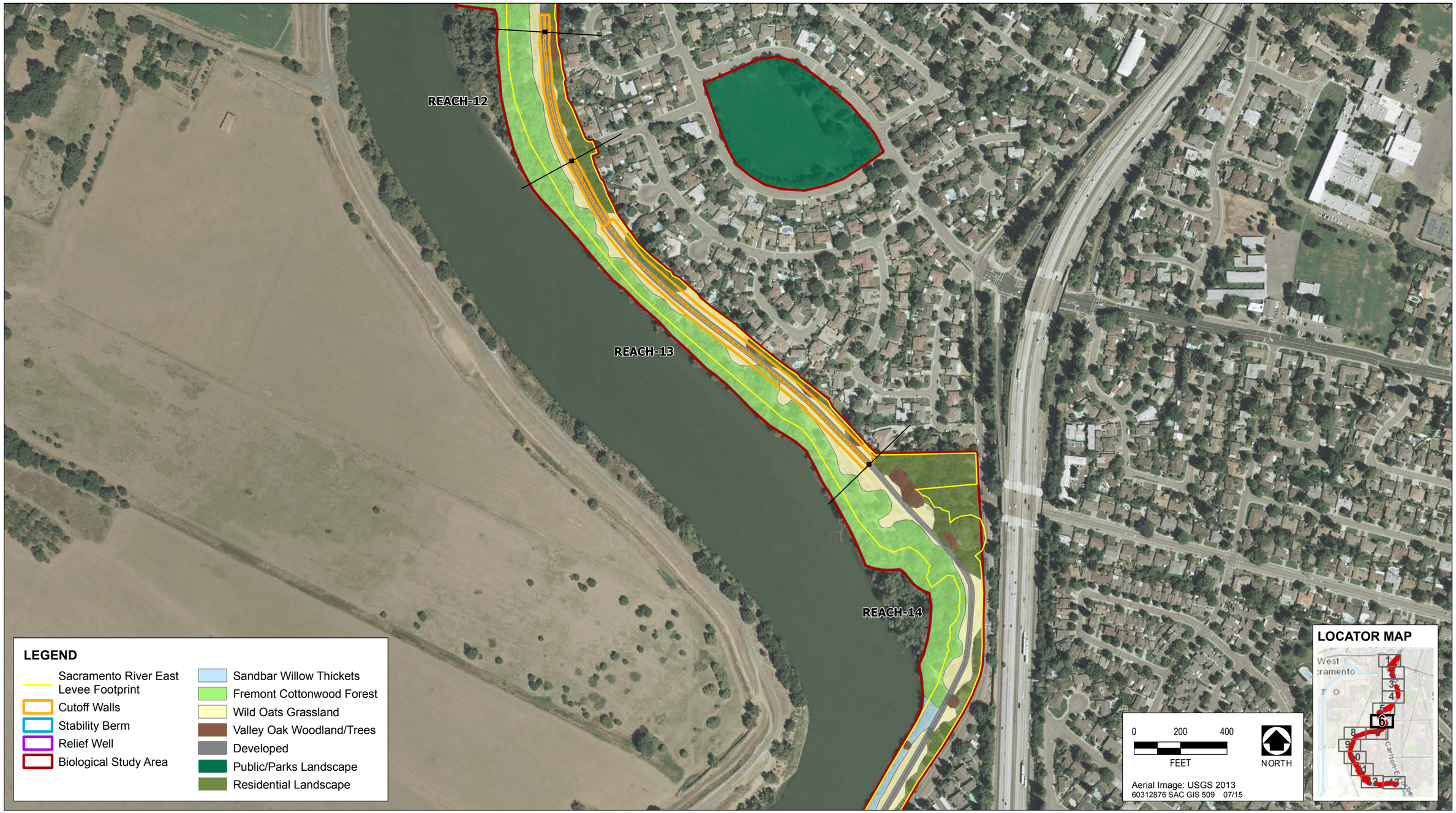
Sacramento River East Levee Habitat Map 3

Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 4

Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 5



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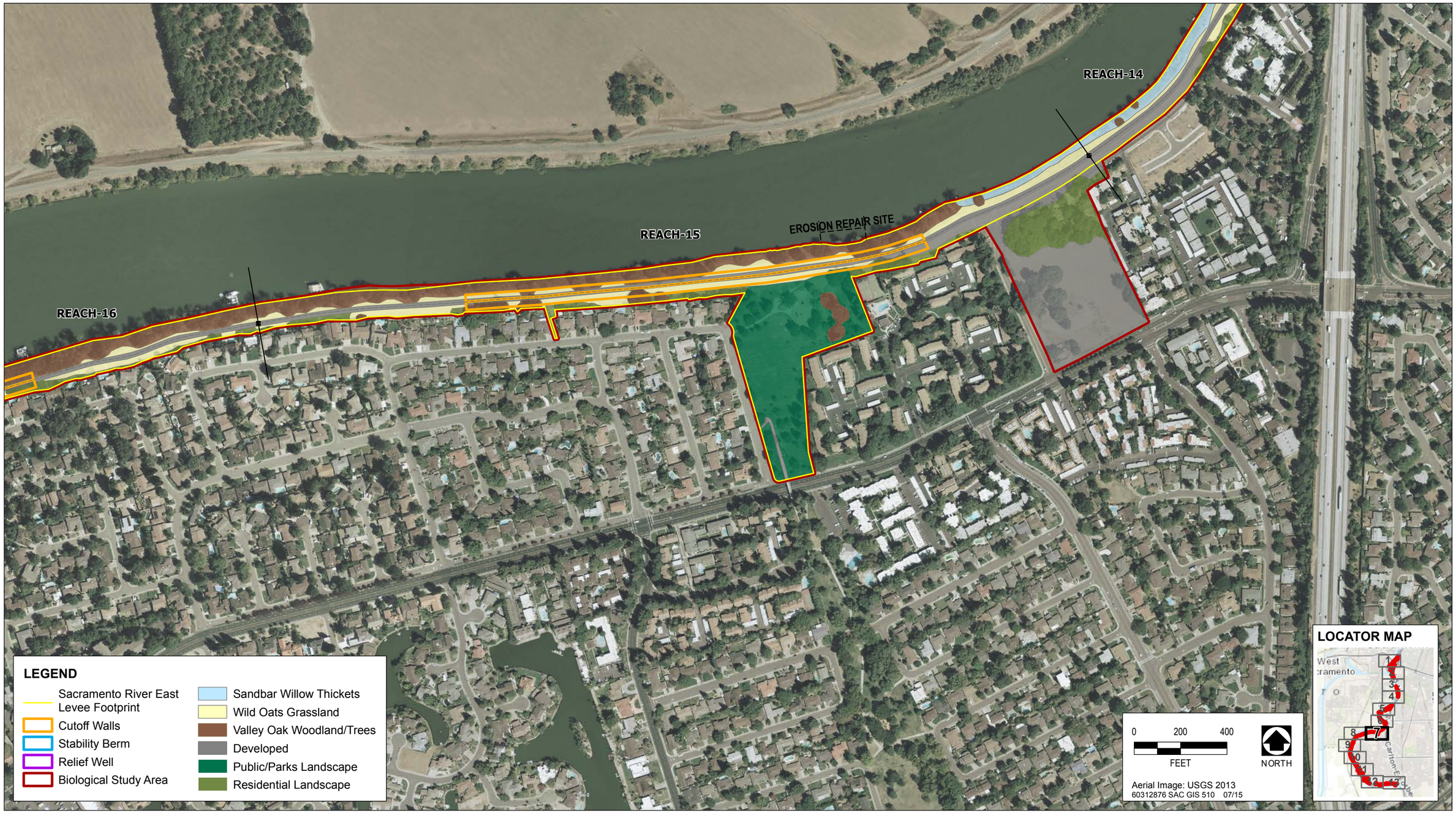
Sacramento River East Levee Habitat Map 6

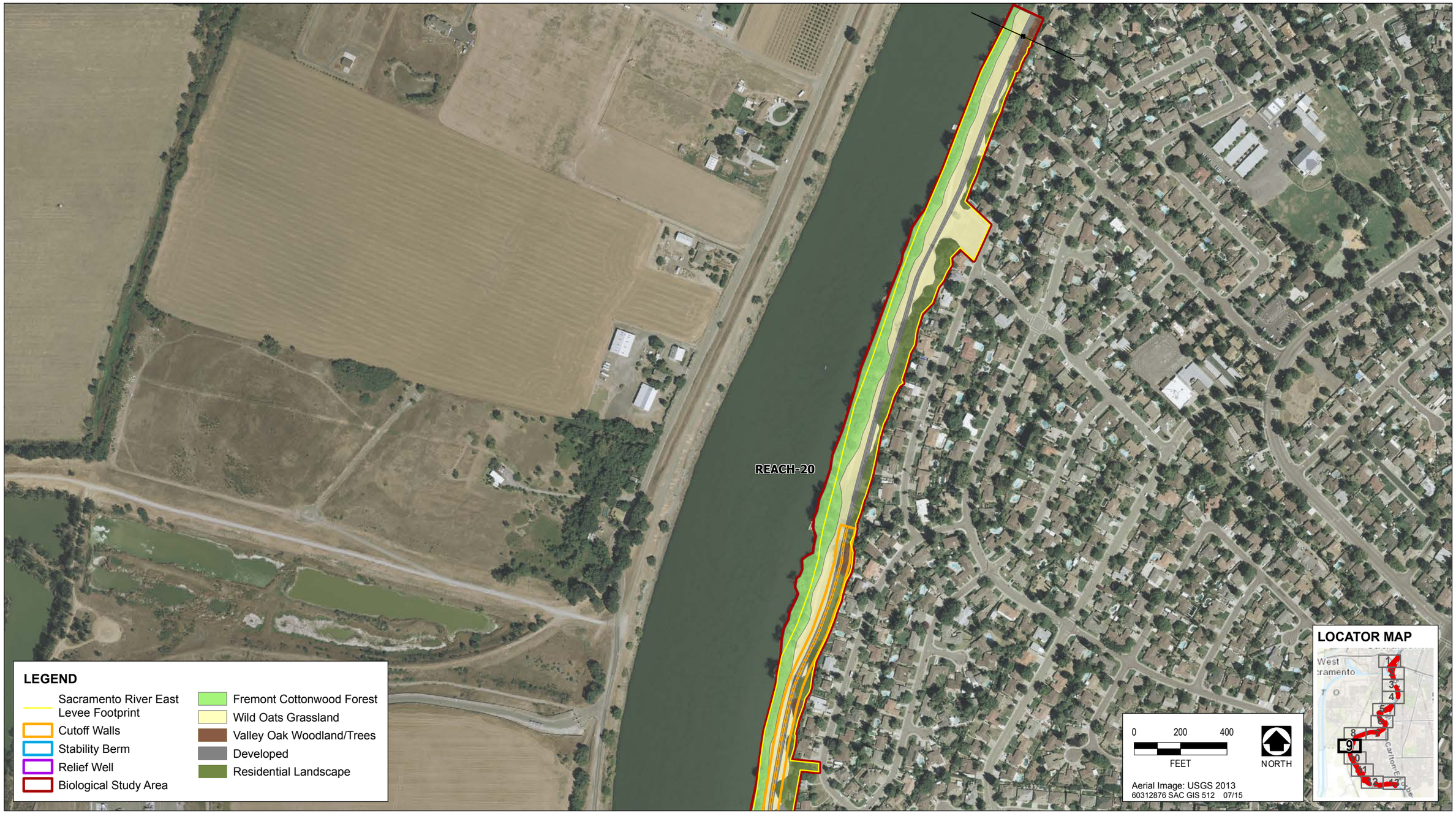


Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 7

Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 8



Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

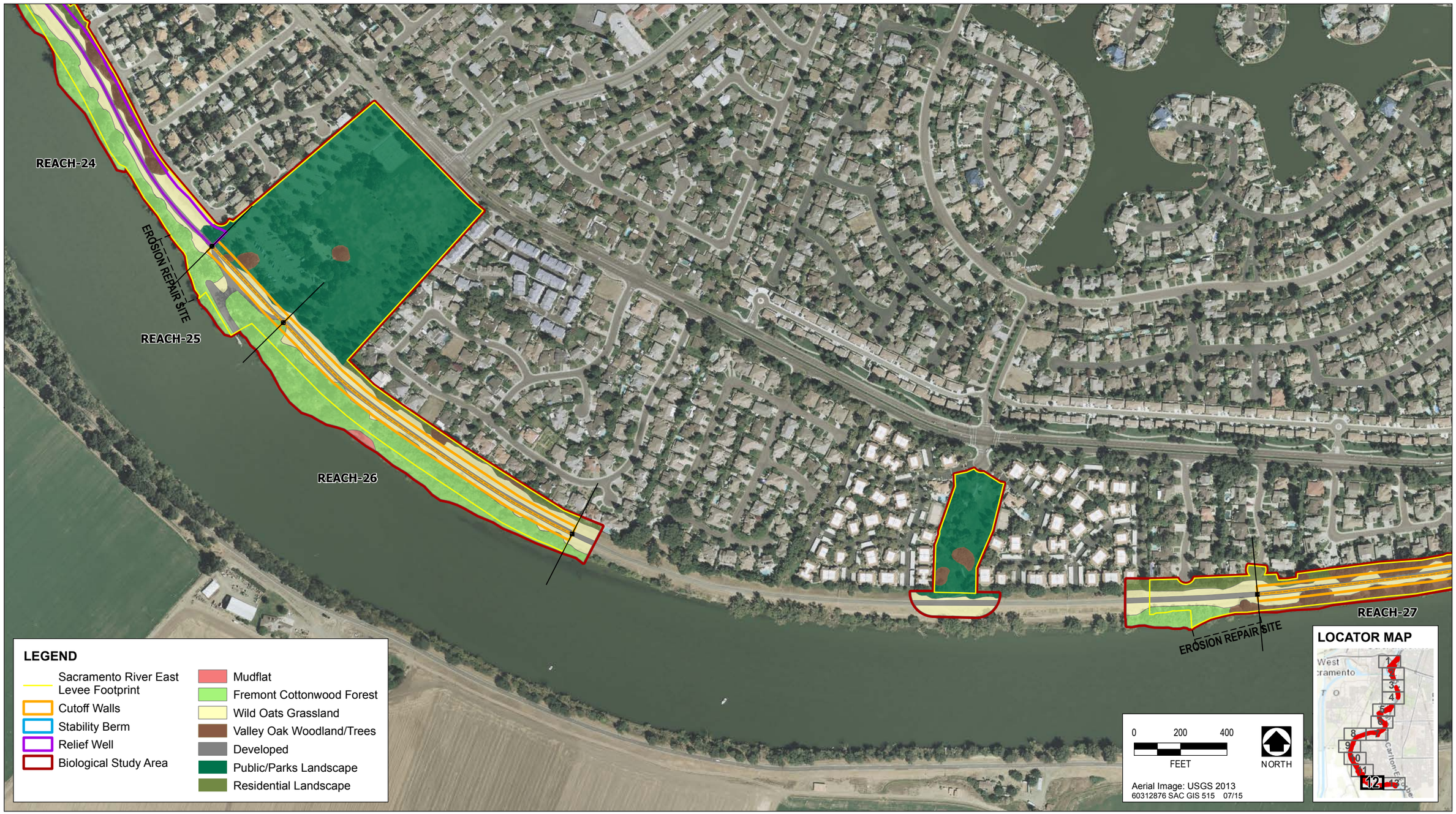
Sacramento River East Levee Habitat Map 9

Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 10

Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 11



Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 12

REACH-27

EROSION REPAIR SITE

LEGEND

- Sacramento River East Levee Footprint
- Cutoff Walls
- Stability Berm
- Relief Well
- Biological Study Area
- Agriculture
- Channel
- Wild Oats Grassland
- Valley Oak Woodland/Trees
- Developed
- Industrial/Commerical Landscape
- Public/Parks Landscape
- Residential Landscape

0 200 400

FEET

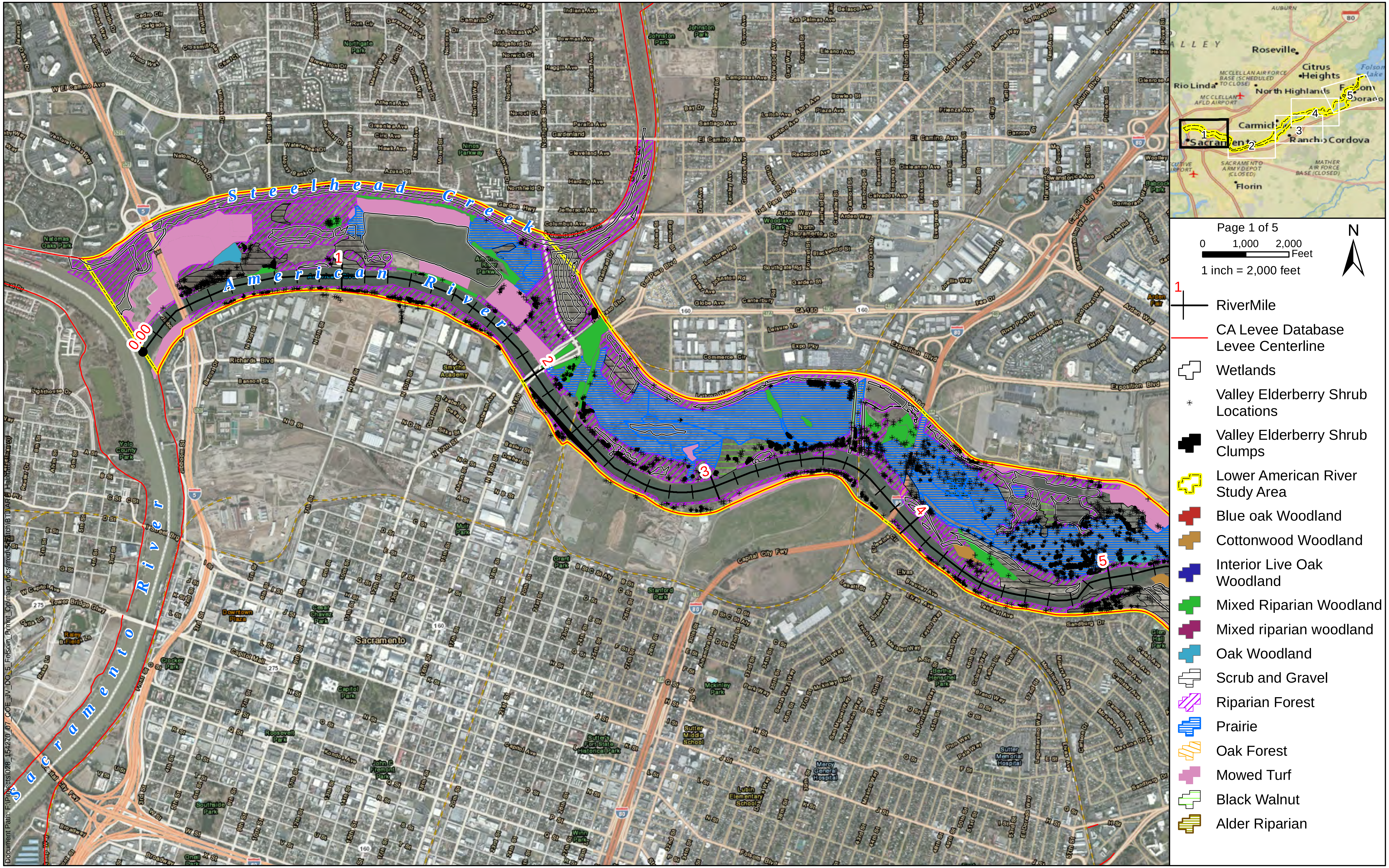
NORTH

Aerial Image: USGS 2013
60312876 SAC GIS 516 07/15

LOCATOR MAP

Source: GEI Consultants, Inc. 2014, MBK Engineers 2014, data collected and compiled by AECOM in 2014

Sacramento River East Levee Habitat Map 13


Steelhead Creek
American River
Sacramento River
Sacramento
Page 1 of 5
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1 inch = 2,000 feet
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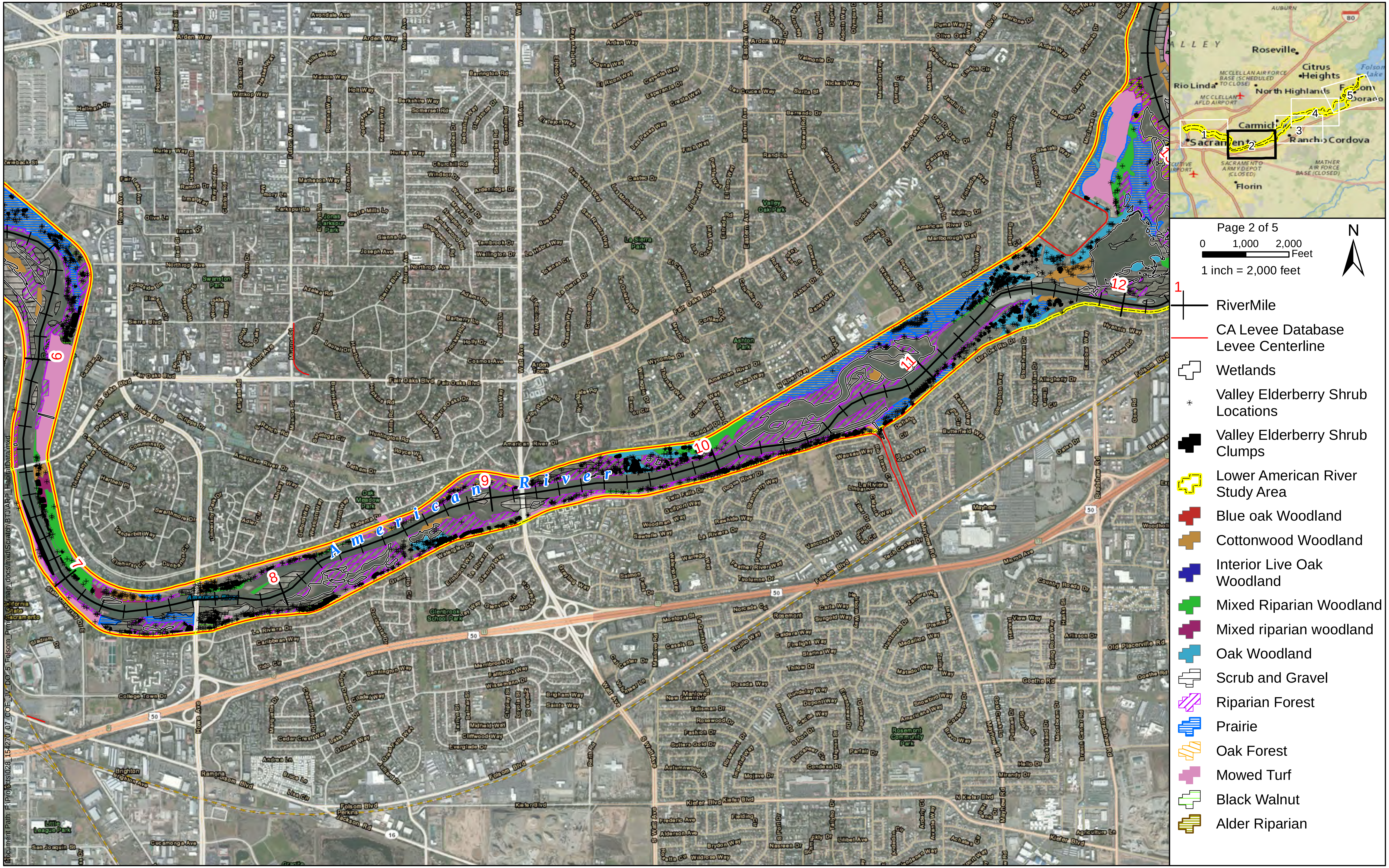
RiverMile
CA Levee Database Levee Centerline
Wetlands
Valley Elderberry Shrub Locations
Valley Elderberry Shrub Clumps
Lower American River Study Area
Blue oak Woodland
Cottonwood Woodland
Interior Live Oak Woodland
Mixed Riparian Woodland
Mixed riparian woodland
Oak Woodland
Scrub and Gravel
Riparian Forest
Prairie
Oak Forest
Mowed Turf
Black Walnut
Alder Riparian
Roseville
Citrus Heights
Rio Linda
North Highlands
Carmichael
Rancho Cordova
Florin
AUBURN



American River
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Wetlands
Valley Elderberry Shrub Locations
Valley Elderberry Shrub Clumps
Lower American River Study Area
Blue oak Woodland
Cottonwood Woodland
Interior Live Oak Woodland
Mixed Riparian Woodland
Mixed riparian woodland
Oak Woodland
Scrub and Gravel
Riparian Forest
Prairie
Oak Forest
Mowed Turf
Black Walnut
Alder Riparian
Roseville
Citrus Heights
Rio Linda
North Highlands
Carmichael
Rancho Cordova
Florin

American River Common Features GRR

EIS Cultural Resources Appendix

Enclosure 1

Programmatic Agreement

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT, SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

WHEREAS, the U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the American River Common Features Project (Project) as authorized in the Water Resources Development Act (WRDA) of 1996, Pub L. No. 104-303, §101(a)(1), 110 STAT. 3658, 3662-3663 (1996), as amended by the WRDA 1999, Pub. L. No. 106-53, Section 366, 113 STAT. 269, 319-320 (1999) and the Energy and Water Development and Related Agencies Appropriations Act of 2008, Pub. L. No. 110-161, Section 130, 121 STAT. 1844, 1947 (2008), and as authorized by Section 7002 of the Water Resources Reform and Development Act (WRRDA) of 2014 (Pub. L. No. 113-121, § 7002, 128 Stat. 1193, 1366); and

WHEREAS, the Project is being developed to provide flood risk management to the City of Sacramento, including areas along the Sacramento and American Rivers, and around and within the Natomas Basin, including the Natomas Cross Canal, the Sacramento Bypass, the Pleasant Grove Creek Canal, the Natomas East Main Drain Canal, Arcade Creek, Dry Creek, Robla Creek, and Magpie Creek located in Sacramento and Yolo Counties, California. The authorized project is a single purpose flood risk management project shown in **Attachment 1** and further described in **Attachment 2**; and

WHEREAS, the Corps proposes to construct levee improvements including, but not limited to: seepage cutoff walls, seepage berms, levee slope flattening, relief wells, adjacent levees, stability berms, drained stability berms, levee raising, floodwalls, bypass widening, riverbank erosion protection, and launchable rock erosion protection; and

WHEREAS the State of California Central Valley Flood Protection Board (CVFPB) is the non-Federal sponsor for the Project and the CVFPB has been invited to be a Concurring Party to this Programmatic Agreement (Agreement); and

WHEREAS, the Corps has determined that the Project activities constitute an Undertaking, as defined in 36 C.F.R. § 800.16(y), and therefore is subject to Section 106 of the National Historic Preservation Act of 1966, 54 U.S.C. § 306108 (NHPA); and

WHEREAS, the Corps has determined that the Project may have an effect on properties that are either listed or eligible for listing in the National Register of Historic Places (NRHP) and has consulted with the California State Historic Preservation Officer (SHPO) pursuant to the NHPA; and

WHEREAS, pursuant to 36 C.F.R. § 800.4(b)(2), the Corps may implement the Project in phases as funding is available and construction authority is provided and, as a result, efforts to identify and evaluate Historic Properties and the determination of effects to those properties may be deferred until more specific project information for each phase is known; and

WHEREAS, this Agreement shall establish the process the Corps shall follow for compliance with 54 U.S.C. § 306108 (formerly 16 U.S.C. § 470f, referred to hereinafter as "Section 106"), taking into consideration the views of the Signatory and Concurring Parties; and

WHEREAS, a total of 69 cultural resources are known to be present within the Area of Potential Effects (APE) and although extensive archaeological inventory has been completed within the APE under other projects, portions of the APE have not been inventoried; and

WHEREAS, the presence of levees, alluvial deposition, and other built environment features have obscured the presence of cultural resources and a full assessment of archaeological sites cannot be made in advance of construction; and

WHEREAS, the levees of the Sacramento and American Rivers are the one known potential Historic Property within the APE that will be affected by the Project; and

WHEREAS, the Corps is aware that there is a high probability for buried cultural resources that may not be identified prior to construction and that also may be eligible for inclusion in the NRHP, and therefore this Agreement documents a framework for managing post-review discoveries per 36 C.F.R. § 800.13; and

WHEREAS, the Corps, with the concurrence of SHPO, has decided to comply with Section 106 of the NHPA for the Undertaking through the execution and implementation of this Programmatic Agreement (Agreement) because the Corps cannot fully determine the effects of the Undertaking on Historic Properties [36 C.F.R. § 800.14(b)(1)(ii)], for all phases and segments of the Project at this time; and

WHEREAS, in accordance with 36 C.F.R. §§ 800.2(c)(2)(ii)(A), 800.3(f)(2), and 800.14(b)(2)(i), the Corps has contacted federal and state recognized Native American Tribes, via letter(s), phone call(s), and meetings, to invite them to consult on the Project and this Agreement, including the Buena Vista Rancheria of the Me-Wuk Indians of California, the Cachil DeHe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria, the Colfax-Todds Valley Consolidated Tribe, the Cortina Wintun Environmental Protection Agency, the El Dorado Miwok Tribe, the Enterprise Rancheria of

Maidu Indians of California, the Ione Band of Miwok Indians of California, the Mechoopda Indian Tribe of Chico Rancheria, the Mooretown Rancheria of Maidu Indians, the Nashville-El Dorado Miwok, the Shingle Springs Band of Miwok Indians, the Strawberry Valley Rancheria, the T'si-Akim Maidu, the United Auburn Indian Community of the Auburn Rancheria, the Wilton Rancheria, the Yocha Dehe Wintun Nation, and interested Native American individuals; the Corps has invited them (and others who may be identified in the future as appropriate Concurring Parties) to participate as Concurring Parties to this Agreement; and the Corps will continue consultation throughout the duration of this agreement; and

WHEREAS, the Corps shall make the terms and conditions of this Agreement part of the conditions of any contracts issued by the Corps for this Project; and

WHEREAS, the definitions set forth in 36 C.F.R. § 800.16 are incorporated herein by reference and apply throughout this Agreement; and

WHEREAS, the definitions for Signatory Parties set forth in 36 C.F.R. § 800.6(c)(1), and the definitions for Concurring Parties set forth in 36 C.F.R. § 800.6(c)(3), are incorporated herein by reference and apply throughout this Agreement; and

WHEREAS, in accordance with 36 C.F.R. § 800.14(b)(3), the Corps notified and invited the Advisory Council on Historic Preservation (ACHP) per 36 C.F.R. § 800.6(a)(1)(C) to participate in consultation to resolve potential adverse effects of the Project, including development of this Agreement, and the ACHP has declined to participate pursuant to 36 C.F.R. § 800.6(a)(1)(iii) in a letter dated August 7, 2012; and

WHEREAS, in accordance with 36 C.F.R. § 800.6(a)(4) and 36 C.F.R. § 800.14(b)(2)(ii), the Corps has notified the public of the Project and provided an opportunity for members of the public to comment on the Project and the Section 106 process as outlined in this Agreement; and

NOW, THEREFORE, the signatories agree that the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the undertaking on Historic Properties and to satisfy the Corps' Section 106 responsibilities for all individual aspects of the undertaking.

The Corps shall ensure that the following measures are carried out:

STIPULATIONS

I. TIME FRAMES AND REVIEW PROCEDURES

For all documents and deliverables produced in accordance with the stipulations of this Agreement, the Corps shall provide a draft document to the SHPO, Concurring Parties, and Native American interested parties and Tribes for review. Any written comments provided by the SHPO, Concurring Parties, and Native American interested parties and Tribes, within thirty (30) calendar days from the date of receipt, shall be considered in the revision of the document or deliverable. The Corps shall document and report the written comments received for the document or deliverable and how comments were addressed. The Corps shall provide a revised final document or deliverable to the SHPO for concurrence. The SHPO shall have thirty (30) calendar days to respond. Failure of the SHPO, Concurring Parties, and Native American interested parties and Tribes to respond within thirty (30) calendar days of any submittal shall not preclude Corps from moving to the next step in this Agreement.

Should the SHPO object to the final document or deliverable submitted for concurrence, the Corps and SHPO shall consult for a period not to exceed fifteen (15) calendar days following the receipt of the SHPO's written objection in an effort to come to agreement on the issues to which the SHPO has objected. Should the SHPO and the Corps be unable to agree on the issues to which the SHPO has objected, the SHPO and the Corps shall proceed in accordance with **Stipulation XV (Dispute Resolution)**, below. The timeframe to consult to resolve a disagreement or objection may be extended by mutual consent of the Corps and the SHPO.

II. AREA OF POTENTIAL EFFECTS

The APE for Project activities shall include the construction footprint of the activity and a reasonable buffer determined through consultation between SHPO and the Corps, and shall take into account the likelihood of direct and indirect effects to Historic Properties resulting from the Project. **Attachment 1** includes an overall APE map for the Project. Because the Project will occur in phases, it may be necessary to further define the APE for each phase as phases are authorized and funded for design and construction. Prior to activities under **Stipulation IV (Identification and Evaluation)**, the Corps shall submit to the SHPO, Concurring Parties, and Native American interested parties and Tribes a map of the APE for the current phase and a description of the Project activities occurring for that phase, in accordance with **Stipulation I (Timeframes and Review Procedures)**. Revisions to the APE will not necessitate modifications to this Agreement.

A. For purposes of this Agreement, the APE for each phase shall be defined to meet, at a minimum, the following criteria:

The APE for any segment of the levees that are being improved as part of the phase of the Project shall include the levee segment and a corridor extending not less than 150 meters from the landside toe of the levee segment.

B. The APE also shall include:

(1) The extent of all Project construction and excavation activity required to construct flood control facilities and to modify irrigation and drainage infrastructure; and

(2) The additional right-of-way/easements obtained by the Corps as part of the Project's features; and

(3) All areas used for excavation of borrow material and habitat creation; and

(4) All construction staging areas, access routes, spoil areas, and stockpiling areas.

C. After the APE has been defined and consulted on in accordance with **Stipulation II (Area of Potential Effects)** above, construction or other Project activities may require revisions to the APE. If the APE is revised, the Corps shall consult on that revision in accordance with **Stipulation I (Timeframes and Review Procedures)**, and the Corps shall determine the potential for Project activities in a revised APE to affect potential Historic Properties, in accordance with **Stipulation IV (Identification and Evaluation)**.

III. HISTORIC PROPERTIES MANAGEMENT PLAN

The Corps, in consultation with the SHPO, Concurring Parties, and Native American interested parties and Tribes, shall develop a Historic Property Management Plan (HPMP), which provides the framework by which remaining identification, evaluation of eligibility, findings of effect, and resolution of adverse effect efforts to Historic Properties will occur. The HPMP shall include consideration of property types, treatment of property types, expected methodology for identification and evaluation of potential historic properties, potential templates for work plans, provisions for avoidance or protection of historic properties, and consideration for identification and treatment of human remains. The HPMP shall be appended to this Agreement (**Attachment 3)** and will form the basis for any Historic Property Treatment Plans (HPTPs) that may be required for one or more phases of the Project. The HPMP shall be developed after execution of the Agreement, but before construction commences. For the overall Project and individual phases, the HPMP shall be the means for the Corps to comply with 36 C.F.R. § 800.6 and provide standardized methods for dealing with unanticipated discoveries in accordance with 36 C.F.R. § 800.13(a).

The HPMP may be amended and appended to this Agreement without amending the Agreement.

A. Review: The Corps shall submit the Draft HPMP to the SHPO, Concurring Parties, and Native American interested parties and Tribes for review and comment pursuant to **Stipulation I (Timeframes and Review Procedures)**.

B. Historic Property Treatment Plans: The Corps shall consult the SHPO, pursuant to 36 C.F.R. § 800.5, when the Corps has determined that a Project activity will result in adverse effects to a Historic Property. An HPTP specific to the phase of the Project or the Historic Property will be drafted to describe how the Corps intends to resolve adverse effects and that HPTP may be appended to the HPMP. HPTPs shall be consistent with the HPMP and may incorporate by reference historic contexts, methods, procedures, and research designs, as appropriate. When incorporating portions of the HPMP by reference, the HPTP shall at a minimum include the date of the HPMP and where the HPMP is available to be viewed.

(1) An HPTP may address individual or multiple Historic Properties or Historic Property types. An HPTP shall stipulate those actions the Corps shall take to resolve the adverse effects of the Project on Historic Properties within the project phase or specific action specified by the HPTP. For properties eligible under criteria specified in 36 C.F.R. § 60.4 (A) through (D), mitigation other than data recovery may be considered in the treatment plan (e.g., HABS/HAER, oral history, historic markers, exhibits, interpretive brochures or publications, or other means as deemed appropriate by the signatories). In addition to the SHPO, Concurring Parties, and Native American interested parties and Tribes the Corps may invite the interested public, in accordance with **Stipulation XIII (Public Consultation and Public Notice)**, to comment on the means of mitigation, as appropriate. HPTPs shall include specifications (including content and number of copies) for publication of brochures, pamphlets or synthesis reports for distribution to the general public. The Corps shall ensure that all provisions of an HPTP are carried out as stipulated in the HPTP.

(2) Historic Context, Recordation, and Treatment of Levees: The Sacramento and American River levees are a known potential Historic Property within the APE that may be affected by the Project. Sections of the levees have been recorded and evaluated for their individual eligibility for listing in the NRHP but no overall historic context or evaluation of the levee system has been developed. Because the specific project design that may alter the levees will not be developed until after the Project has been approved for design, a determination of effect and, if necessary, an HPTP, cannot be developed until after approval and execution of this Agreement. In order to document the levees for evaluation, the Corps will

develop a historic context and HPTP for recordation of the Sacramento and American River levees as historic structures within the APE in order to evaluate the effects of the Project on the levees. If a historic context and/or HPTP for the levees within the APE has already been developed, the Corps may incorporate it as deemed appropriate by the Corps. The HPTP shall consider the levees in the context of the entire Sacramento and American River levee systems. Additionally, the HPTP shall require the development of clear and specific criteria for determining: (1) recordation guidelines for the levees within the APE, (2) contributing and non-contributing elements of the levee system, (3) thresholds of adverse effect, and (4) treatment of adverse effects. The HPTP shall be developed after execution of the Agreement and before construction commences. The Corps shall submit the HPTP for review, in accordance with **Stipulation I (Timeframes and Review Procedures)**.

(3) HPTPs will be submitted and reviewed in accordance with **Stipulation I (Timeframes and Review Procedures)**, except for those HPTPs developed for Historic Properties discovered during construction activities, which shall follow the review timeframes identified in **Stipulation IX (Discovery of Unknown Historic Properties)**. Circulation of an HPTP shall not include a recirculation of the HPMP.

D. Reporting: Reports and other data pertaining to the inventory of Historic Properties and the treatment of effects to Historic Properties will be distributed to Concurring Parties to this Agreement, Native American Tribes, and other members of the public, consistent with **Stipulation XIV (Confidentiality)** of this Agreement, unless parties have indicated through consultation that they do not want to receive a report or data.

E. Amendments/Addendums/Revisions: If an Historic Property type that is not coveredby an existing HPTP is discovered within the APE subsequent to an initial inventory effort for a phase, or if there are previously unexpected effects to an Historic Property, and the Corps and SHPO agree that the Project may adversely affect the Historic Property, the Corps shall submit an addendum to the HPTP or a new HPTP to the SHPO and Concurring Parties for review and comment, and shall follow the provisions of **Stipulation IX (Discovery of Unknown Historic Properties)**. The HPTP may cover multiple discoveries for the same property type.

F. Data Recovery: When data recovery is proposed, the Corps, in consultation with the SHPO, shall ensure that HPTPs are developed consistent with the *Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* and the ACHP's "Recommended Approach for Consultation on Recovery of Significant Information from Archaeological Sites" (ACHP, May 18, 1999).

G. Final Phase Report Documenting Implementation of the Historic Properties Treatment Plan(s): Within one year after the completion of all work for each phase of the Project, the Corps shall submit to the SHPO, Signatory Parties, Concurring Parties, and Native American interested parties and Tribes, a Final Phase Report documenting the results of all work prepared for that phase under the HPTPs, and the information learned from each of the Historic Properties. The submittal of the Final Phase Report shall be in accordance with **Stipulation I (Timeframes and Review Procedures)**.

IV. IDENTIFICATION AND EVALUATION

Should the HPMP not be finalized at the time that a phase of the Project may be proceeding to design and construction, the Corps shall consult with the Signatory Parties before issuing a notice to proceed on any phase of the Project. Should the Signatory Parties agree that the work may proceed, the Corps shall comply with **Stipulation IV A., B., and C. (Identification and Evaluation)** and, as necessary, **Stipulation VI (Determination of Effects)**. The Corps shall complete any identification and evaluation, and as necessary, any evaluation of effects to Historic Properties prior to proceeding with construction. If the Signatory Parties do not agree to proceed with the phase of the Project the Corps shall follow **Stipulation XV (Dispute Resolution)**.

A. **Identification of Potential Historic Properties:** An inventory of Historic Properties within the APE, consistent with the *Secretary of Interior's Standards and Guidelines for Archeology and Historic Preservation* (48 FR 44716–44740) will be initiated for the Project, or for individual phases of the Project, as construction details become available.

Survey recordation shall include features, isolates, and re-recordation of previously recorded sites, as necessary. The survey shall ensure that potential Historic Properties such as historical structures and buildings, historical engineering features, landscapes, viewsheds, and traditional cultural properties (TCPs) with significance to Native American communities, are recorded in addition to archeological sites. Recordation of historic structures, buildings, objects, and sites shall be prepared using the California Department of Parks and Recreation (DPR) 523 Site Record forms.

B. Property Types Exempt from Evaluation: Attachment 4 to this Agreement lists the property types that the Signatories agree shall be exempt from evaluation as determined by the Corps in consultation with the SHPO. The Corps shall evaluate all other identified properties in accordance with **Stipulation IV.C** (**Evaluation of Potential Historic Properties)**.

C. Evaluation of Potential Historic Properties: After recordation on DPR 523 Site Record forms, potential Historic Properties shall be evaluated by a qualified professional for their eligibility for listing in the NRHP consistent with

the *Secretary of Interior's Standards for Evaluation*, 36 C.F.R. § 60.4. In accordance with **Stipulation I (Timeframes and Review Procedures),** the Corps shall submit a completed inventory and evaluation for each phase of Project work.

V. GEOTECHNICAL INVESTIGATIONS

For the purposes of gathering engineering data and for project planning, it may be necessary for the Corps to conduct limited geotechnical investigations at areas within the APE.

A. The Corps may conduct geotechnical investigations (e.g., borings, potholing, or trenches) for planning and exploratory efforts. The Corps shall follow Stipulation V.A(1) and (2), or may follow Stipulation V.A(3) if unable to follow Stipulation V.A(1) and (2):

(1) A records and literature search and consultation with Native Americans has been conducted and it has been determined there are no known existing potential Historic Properties located within 50 feet of the areas identified for geotechnical investigations, and an archeological field survey of the areas identified for geotechnical investigations has been conducted and it has been determined there are no known potential Historic Properties present;

(2) A potential Historic Property is identified during the records and literature search or field survey and consultation process as being within an area where geotechnical investigation will occur, and the geotechnical investigation is relocated at least 50 feet outside the site boundaries; or

(3) Provisions for an archeological monitor meeting the qualifications described in **Stipulation VII.C. (Archeological Monitor Standards)** are included in the contract specifications for the geotechnical investigations. As appropriate, or when geotechnical activities may occur in sensitive areas, an archeological monitor will be present for all ground disturbing activities.

B. If potential Historic Properties are discovered during geotechnical investigations, **Stipulation IX (Discovery of Unknown Historic Properties)** shall be followed;

C. A Memorandum for Record shall be written documenting the results of the records and literature search, the archeological field survey, any decisions to relocate geotechnical investigation areas, the determination for inclusion of an archeological monitor for ground disturbing activities, and a record of communication with Native American interested parties and Tribes, as appropriate.

VI. DETERMINATION OF EFFECTS

Avoidance of adverse effects to Historic Properties is the preferred treatment approach. The Corps will consider redesign of Project elements in order to avoid Historic Properties and Project effects that may be adverse. However, it may not be possible to redesign the Project in order to avoid adverse effects to Historic Properties.

The Corps will apply the criteria of adverse effect, pursuant to 36 C.F.R. § 800.5(a)(1), to all Historic Properties within the APE that will be affected by the Project. The Corps shall submit determinations of effects in accordance with **Stipulation I (Timeframes and Review Procedures)**.

If effects to Historic Properties are determined to be adverse, **Stipulation III (Historic Properties Management Plan)**, above, will be followed.

VII. QUALIFICATIONS

A. Professional Qualifications: All technical work required for historic preservation activities implemented pursuant to this Agreement shall be carried out by or under the direct supervision of a person or persons meeting, at a minimum, the *Secretary of Interior's Professional Qualifications Standards* for archeology or history, as appropriate (48 FR 44739). "Technical work" here means all efforts to inventory, evaluate, and perform subsequent treatment such as data recovery excavation or recordation of potential Historic Properties that is required under this Agreement. This stipulation shall not be construed to limit peer review, guidance, or editing of documents by SHPO and associated Project consultants.

B. Historic Preservation Standards: Historic preservation activities carried out pursuant to this Agreement shall meet the *Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation* (48 FR 44716-44740), as well as standards and guidelines for historic preservation activities established by the SHPO. The Corps shall ensure that all reports prepared pursuant to this Agreement will be provided to the Signatories, Concurring Parties, and Native American interested parties and Tribes and are distributed in accordance with **Stipulation XIV (Confidentiality),** and meet published standards of the California Office of Historic Preservation, specifically, *Preservation Planning Bulletin* Number 4(a), "Archaeological Resources Management Reports (ARMR): Recommended Contents and Format" (December 1989).

C. Archeological Monitor Standards: Archeological monitoring activities required for exploratory, construction, or construction related ground disturbing activities implemented pursuant to this Agreement shall be carried

out by a person meeting, at a minimum, the *Secretary of Interior's Professional Qualifications Standards* for prehistoric or historic archaeology, as appropriate (48 FR 44739). "Archeological monitoring" here includes monitoring ground disturbing activities that have been determined by the Corps to be occurring in areas potentially sensitive for Historic Properties or buried resources.

VIII. NOTICES TO PROCEED WITH CONSTRUCTION

Notices to Proceed may be issued by the Corps for individual construction segments, defined by the Corps in its construction specifications, after a Historic Properties inventory has been completed [per **Stipulation III (Historic Properties Management Plan)** or **Stipulation IV (Identification and Evaluation)**], and prior to treatment of adverse effects on Historic Properties within the APE provided that:

A. A plan to respond to inadvertent archeological discoveries is prepared by the Corps, and approved by SHPO, prior to the commencement of Project activities anywhere in the APE for that phase of the Project; and

B. Project development activities do not encroach within 30 meters (100 feet) of the known boundaries of any Historic Property as determined from archeological site record forms, other documentation, or as otherwise defined in consultation with the SHPO and other parties, as appropriate; and

C. An archeological monitor meeting the professional qualifications as described in **Stipulation VII (Qualifications)**, is present during any Project activities that are anticipated to extend either vertically or horizontally into any areas designated to be archeologically sensitive by the Corps, in consultation with SHPO, except in phases of construction for slurry walls where visual inspection of the construction area cannot be safely or feasibly accomplished.

IX. DISCOVERY OF UNKNOWN HISTORIC PROPERTIES

The Corps is responsible for complying with 36 C.F.R. § 800.13(a) in the event of inadvertent discoveries of Historic Properties during implementation of the Project. The HPMP will provide procedures for complying with post review and inadvertent discoveries of Historic Properties. If the Corps authorizes work before the HPMP is finalized and there is a discovery of an unknown Historic Property, the Corps shall follow 36 C.F.R. § 800.13(b). Additionally, the following procedures shall be followed:

A. Workforce Training: During implementation of Project activities, the Corps, or archeologists meeting the professional qualifications as described in **Stipulation VII (Qualifications)**, will provide training to all construction

personnel, before they begin work, regarding proper procedures and conduct in the event that archeological materials are encountered during construction.

B. Human Remains: Treatment of human remains is governed by **Stipulation XII (Tribal Consultation and Treatment of Human Remains)**.

X. CURATION

To the extent that curation is determined to be appropriate mitigation to resolve adverse effects to Historic Properties, curation shall be conducted in accordance with 36 C.F.R. § 79, except those materials identified as Native American human remains and items associated with Native American burials. Archeological items and materials from State or privately owned lands shall be maintained in accordance with 36 C.F.R. § 79 until any specified analyses are complete. Although the Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. § 3001 et seq.) does not apply to this Project, as there is no federally owned or administered property within the APE and the Corps will not be curating cultural materials subject to NAGPRA, this Agreement incorporates by reference the definitions for "human remains" and "funerary objects" set forth in 43 C.F.R § 10.2(d) and those definitions shall apply to actions under this Agreement. Further treatment of human remains is addressed in **Stipulation XII (Tribal Consultation and Treatment of Human Remains)**.

XI. TRIBAL INVOLVEMENT

A. In consultation with Native American interested parties and Tribes, the Corps will make a reasonable and good-faith effort to identify Historic Properties of traditional religious and cultural importance. The Corps shall ensure that consultation with Native American Tribes is initiated early with respect to the Project and continues throughout the Section 106 process.

B. In accordance with the guidance provided in National Register Bulletin 38 and Preservation Brief 36, the Corps will seek comments from all potentially interested Native American interested parties and Tribes in making determinations of NRHP eligibility for any Traditional Cultural Properties (TCPs) and Cultural Landscapes (as defined in Bulletin 38 and Preservation Brief 36). Review of documentation shall be consistent with **Stipulation I (Timeframes and Review Procedures)**.

C. Pursuant to 36 C.F.R. § 800.6(c)(2)-(3), the Corps shall consider requests by Native American Tribes to become Concurring Parties to this Agreement. In accordance with **Stipulation XIV (Confidentiality)**, Concurring Parties to this Agreement will receive documents produced under this Agreement, as appropriate.

D. Native American Tribes may choose not to sign this Agreement as a Concurring Party. Native American Tribes and individuals not acting as Concurring Parties to the Agreement will be contacted when the Corps identifies potential interest in a specific phase or action of the project. The Corps will make a good faith effort to identify any Native American organizations and individuals with interest in the proposed treatment of Historic Properties. The identification effort may include contacting the Native American Heritage Commission (NAHC), using online databases, and using personal and professional knowledge. The Corps will then contact each identified organization and individual by mail, inviting them to consult about the specific treatment of Historic Properties. If interest from the contacted parties is received by the Corps, the Corps will proceed to consult in accordance with **Stipulation XI.A. (Tribal Involvement)**. Further consultation may also be carried out through either letters of notification, public meetings, environmental assessments/environmental impact statements, site visits, and/or other method requested by a Native American interested party and Tribe. Failure of any contacted group to comment within thirty (30) calendar days shall not preclude the Corps from proceeding with the Project.

E. The Corps shall make a reasonable and good-faith effort to ensure that Native American Tribes, acting as either Concurring Parties or those expressing interest in the project, will be invited to participate in the development and implementation of the terms of this Agreement, including, but not limited to, the identification of the APE, identification of potential Historic Properties, determinations of eligibility, findings of effect, and the resolution of adverse effect for those Historic Properties. Review periods shall be consistent with **Stipulation I (Timeframes and Review Procedures)** except in situations involving unanticipated discoveries and treatment, which shall follow the review schedules of **Stipulation IX (Discovery of Unknown Historic Properties)**. The Corps shall ensure that all interested Native American reviewers shall receive copies of all final survey and evaluation reports.

XII. TRIBAL CONSULTATION AND TREATMENT OF HUMAN REMAINS

There is no federally owned property within the designated APE, therefore NAGPRA would not apply. The CVFPB and landowner shall ensure that Native American human remains and grave goods encountered during the Undertaking that are located on state or private land are treated in accordance with the requirements in California State Health and Safety Code, Section 7050.5 and Public Resources Code 5097.98. If Native American human remains are encountered within the context of a National Register eligible archaeological site, a clear means of identifying those remains and grave goods will be described in the HPMP. Any procedures described in the HPTP regarding the handling or treatment of human remains will be coordinated with the landowner to ensure

that they are consistent with Public Resources Code 5097.98. In the event that any Native American human remains or associated funerary items are identified, the Most Likely Descendant (MLD), as identified by the Native American Heritage Commission, shall be invited to advise the CVFPB and landowner in the treatment of any Native American human remains and items associated with Native American burials.

XIII. PUBLIC CONSULTATION AND PUBLIC NOTICE

A. Pursuant to 36 C.F.R. § 800.6(c)(2)-(3), the Corps will consider requests by interested parties to become Concurring Parties to this Agreement. Within thirty (30) calendar days of the effective date of this Agreement, the Corps shall consult with the SHPO to compile a list of members of the interested public who shall be provided notice of this Agreement.

B. The interested public will be invited to provide input on the identification, evaluation, and proposed treatment of Historic Properties. This may be carried out through either letters of notification, public meetings, environmental assessment/environmental impact statements, and/or site visits. The Corps shall ensure that any comments received from members of the public are taken under consideration and incorporated where appropriate. Review periods shall be consistent with **Stipulation I (Timeframes and Review Procedures)**. In seeking input from the interested public, locations of Historic Properties will be handled in accordance with **Stipulation XIV (Confidentiality)**. In cases where the release of location information may cause harm to the Historic Property, this information will be withheld from the public in accordance with Section 304 of the NHPA (54 U.S.C. § 307103).

XIV. CONFIDENTIALITY

Confidentiality regarding the nature and location of the archaeological sites and any other cultural resources discussed in this Agreement shall be limited to appropriate Corps personnel, Corps contractors, Native American tribes, the SHPO, and those parties involved in planning, reviewing and implementing this Agreement in accordance with Section 304 of the NHPA (54 U.S.C. § 307103).

XV. DISPUTE RESOLUTION

A. Should any Signatory Party to this Agreement object in writing to any action proposed or carried out pursuant to this Agreement, the Corps will immediately notify the SHPO and the Concurring Parties of the objection and proceed to consult with the objecting party for a period of time, not to exceed thirty (30) calendar days, to resolve the objection. If the objection is resolved through consultation, the Corps may authorize the disputed action to proceed in accordance with the terms of such resolution. If the Corps determines that the objection cannot be resolved, the Corps shall forward all documentation

relevant to the dispute to the ACHP. Within forty-five (45) calendar days after receipt of all pertinent documentation, the ACHP shall either:

(1) Advise the Corps that the ACHP concurs in the Corps' proposed response to the objection, whereupon the Corps will respond to the objection accordingly; or

(2) Provide the Corps with recommendations, which the Corps shall consider in reaching a final decision regarding the objection; or

(3) Notify the Corps that the ACHP will comment in accordance with the requirements of Section 106 of the NHPA, and proceed to comment. Any ACHP comment provided in response shall be considered by the Corps, pursuant to the requirements of Section 106 of the NHPA.

B. Should the ACHP not exercise one of the options under **Stipulation XV.A. (Dispute Resolution)** within forty-five (45) calendar days after receipt of all submitted pertinent documentation, the Corps' responsibilities under Section 106 of the NHPA are fulfilled upon implementation of the proposed response to the objection.

C. The Corps shall consider any ACHP recommendation or comment and any comments from the SHPO to this Agreement provided in accordance with this stipulation with reference only to the subject of the objection; the Corps' responsibility to carry out all actions under this Agreement that are not the subjects of the objection shall remain unchanged.

D. The Corps shall provide the SHPO with a written copy of its final decision regarding any objection addressed pursuant to **Stipulation XV.A. (Dispute Resolution)**.

E. At any time during implementation of the measures stipulated in this Agreement should an objection pertaining to the Agreement be raised by a Concurring Party, Native American Tribe, or a member of the public, the Corps shall notify the Signatory and Concurring Parties and take the objection under consideration, consulting with the objecting party and, should the objecting party request, any of the Signatory and Concurring Parties to this Agreement, for no longer than fifteen (15) calendar days. The Corps shall consider the objection, and in reaching its decision, will consider all comments provided by the other parties. Within fifteen (15) calendar days following closure of the comment period, the Corps will render a decision regarding the objection and respond to the objecting party. The Corps will promptly notify the other parties of its decision in writing, including a copy of the response to the objecting party. The Corps' decision regarding resolution of the objection will be final. Following issuance of its final decision, the Corps may authorize the action that was the subject of the dispute to proceed

in accordance with the terms of that decision. The Corps' responsibility to carry out all other actions under this Agreement shall remain unchanged.

XVI. NOTICES

A. All notices, demands, requests, consents, approvals or communications from all parties to this Agreement to other parties to this Agreement shall be personally delivered, sent by United States Mail, or emailed, and all parties shall be considered in receipt of the materials five (5) calendar days after deposit in the United States mail, certified and postage prepaid, return receipt requested.

B. Signatory and Concurring Parties agree to accept facsimiles or copies of signed documents and agree to rely upon such facsimiles or copies as if they bore original signatures.

XVII. AMENDMENTS, NONCOMPLIANCE, AND TERMINATION

A. Amendment: Any Signatory Party to this Agreement may propose that the Agreement be amended, whereupon the Corps shall consult with the SHPO to consider such amendment. The Agreement may be amended only upon written concurrence of all Signatories.

All attachments to this Agreement, and other instruments prepared pursuant to this agreement including, but not limited to, the Project's description, initial cultural resource inventory report and maps of the APE, the HPMP, HPTPs, and monitoring and discovery plans, may be individually revised or updated through consultation consistent with **Stipulation I (Timeframes and Review Procedures)** and agreement in writing of the Signatories without requiring amendment of this Agreement, unless the Signatories through such consultation decide otherwise. In accordance with **Stipulation XI (Tribal Involvement)** and **Stipulation XIII (Public Consultation and Public Notice)**, the Concurring Parties, interested Native American Tribes, and interested members of the public, will receive amendments to the Project's description, initial cultural resource inventory report and maps of the APE, the HPMP, HPTPs, and monitoring and discovery plans, as appropriate, and copies of any amendment(s) to the Agreement.

B. Termination: Only the Signatories may terminate this Agreement. If this Agreement is not amended as provided for in **Stipulation XVII.A. (Amendment)**, or if any Signatory proposes termination of this Agreement for other reasons, the Signatory proposing termination shall notify the other Signatory in writing, explain the reasons for proposing termination, and consult with the other Signatory to seek alternatives to termination, within thirty (30) calendar days of the notification.

Should such consultation result in an agreement on an alternative to termination, the Signatories shall proceed in accordance with that agreement.

Should such consultation fail, the Signatory proposing termination may terminate this Agreement by promptly notifying the other Signatory and Concurring Parties in writing.

Beginning with the date of termination, the Corps shall ensure that until and unless a new agreement is executed for the actions covered by this Agreement, such undertakings shall be reviewed individually in accordance with 36 C.F.R. § 800.4-800.6.

C. Duration: This Agreement shall remain in effect for a period of ten (10) years after the date it takes effect and shall automatically expire and have no further force or effect at the end of this ten-year period unless it is terminated prior to that time. No later than ninety (90) calendar days prior to the expiration date of the Agreement, the Corps shall initiate consultation to determine if the Agreement should be allowed to expire automatically or whether it should be extended, with or without amendments, as the Signatories may determine. Unless the Signatories unanimously agree through such consultation on an alternative to automatic expiration of this Agreement, this Agreement shall automatically expire and have no further force or effect in accordance with the timetable stipulated herein.

XVIII. ANNUAL REPORTING

At the end of every calendar year following the execution of this Agreement, the Corps shall provide all parties to this Agreement a summary report detailing work carried out pursuant to its terms, if any. Such report shall describe progress made implementing the terms of the Agreement as well as include any scheduling changes proposed, any problems encountered, and any disputes and objections received in the Corps' efforts to carry out the terms of this Agreement. Any Signatory party may request to meet with the other Signatories to discuss implementation of this Agreement.

XIX. EFFECTIVE DATE

This Agreement shall take effect on the date that it has been fully executed by the Corps and the SHPO.

EXECUTION of this Agreement by the Corps and the SHPO, its transmittal to the ACHP, and subsequent implementation of its terms evidence that the Corps has afforded the ACHP an opportunity to comment on the undertaking and its effects on Historic Properties, that the Corps has taken into account the effects of the undertaking on Historic Properties, and that the Corps has satisfied its

responsibilities under Section 106 of the NHPA and applicable implementing regulations for all aspects of the undertaking.

SIGNATORIES TO THIS AGREEMENT:

U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

BY:_____ DATE : 9 Sep 15
Michael J. Farrell, Colonel, U.S. Army Corps of Engineers, District Commander

CALIFORNIA STATE HISTORIC PRESERVATION OFFICER

BY:_____ DATE: 10 Sept 2015
Julianne Polanco, State Historic Preservation Officer

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

STATE OF CALIFORNIA CENTRAL VALLEY FLOOD PROTECTION BOARD

BY:_____DATE:_____
Leslie Gallagher, Executive Officer

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

BUENA VISTA RANCHERIA OF THE ME-WUK INDIANS OF CALIFORNIA

BY:_____DATE: _____
Rhonda L. Morningstar Pope, Chairwoman

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

CACHIL DEHE BAND OF WINTUN INDIANS OF THE COLUSA INDIAN COMMUNITY OF THE COLUSA RANCHERIA

BY:_____DATE: _____
Ambar Mohammed

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

COLFAX-TODDS VALLEY CONSOLIDATED TRIBE

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

CORTINA WINTUN ENVIRONMENTAL PROTECTION AGENCY

BY:_____DATE: _____
Charlie Wright, Chairperson

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

EL DORADO MIWOK TRIBE

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

BY:_____DATE: _____
Rose Enos

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

ENTERPRISE RANCHERIA OF MAIDU INDIANS OF CALIFORNIA

BY:_____DATE: _____
Glenda Nelson, Chairperson

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

FAIR OAKS HISTORICAL SOCIETY

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

BY:_____DATE: _____
Kesner Flores

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

GOLDEN GATE STATE MUSEUM

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

IONE BAND OF MIWOK INDIANS OF CALIFORNIA

BY:_____DATE: _____
Crystal Martinez, Chairperson

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

MECHOOPDA INDIAN TRIBE OF CHICO RANCHERIA

BY:_____DATE: _____
Dennis Ramirez, Chairperson

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

MOORETOWN RANCHERIA OF MAIDU INDIANS

BY:_____DATE: _____
Guy Taylor, Representative

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

NASHVILLE-EL DORADO MIWOK

BY:_____DATE: _____
Cosme Valdez, Interim Chief Executive Officer

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

SACRAMENTO COUNTY HISTORICAL SOCIETY

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

SHINGLE SPRINGS BAND OF MIWOK INDIANS

BY:_____DATE: _____
Nicholas Fonseca, Chairperson

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

SOCIETY FOR CALIFORNIA ARCHAEOLOGY

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

STRAWBERRY VALLEY RANCHERIA

BY:_____DATE: _____
Cathy Bishop, Chairperson

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

SUTTER COUNTY HISTORICAL SOCIETY

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

T'SI-AKIM MAIDU

BY:_____DATE: _____
Don Ryberg, Chairman

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

UNITED AUBURN INDIAN COMMUNITY OF THE AUBURN RANCHERIA

BY:_____DATE: _____
Gene Whitehouse, Chairman

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

WEST SACRAMENTO HISTORICAL SOCIETY

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

WILTON RANCHERIA

BY:_____DATE: _____
Raymond Hitchcock, Chairperson

PROGRAMMATIC AGREEMENT
AMONG
THE U.S.ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

YOLO COUNTY HISTORICAL SOCIETY

BY:_____DATE: _____

PROGRAMMATIC AGREEMENT
AMONG
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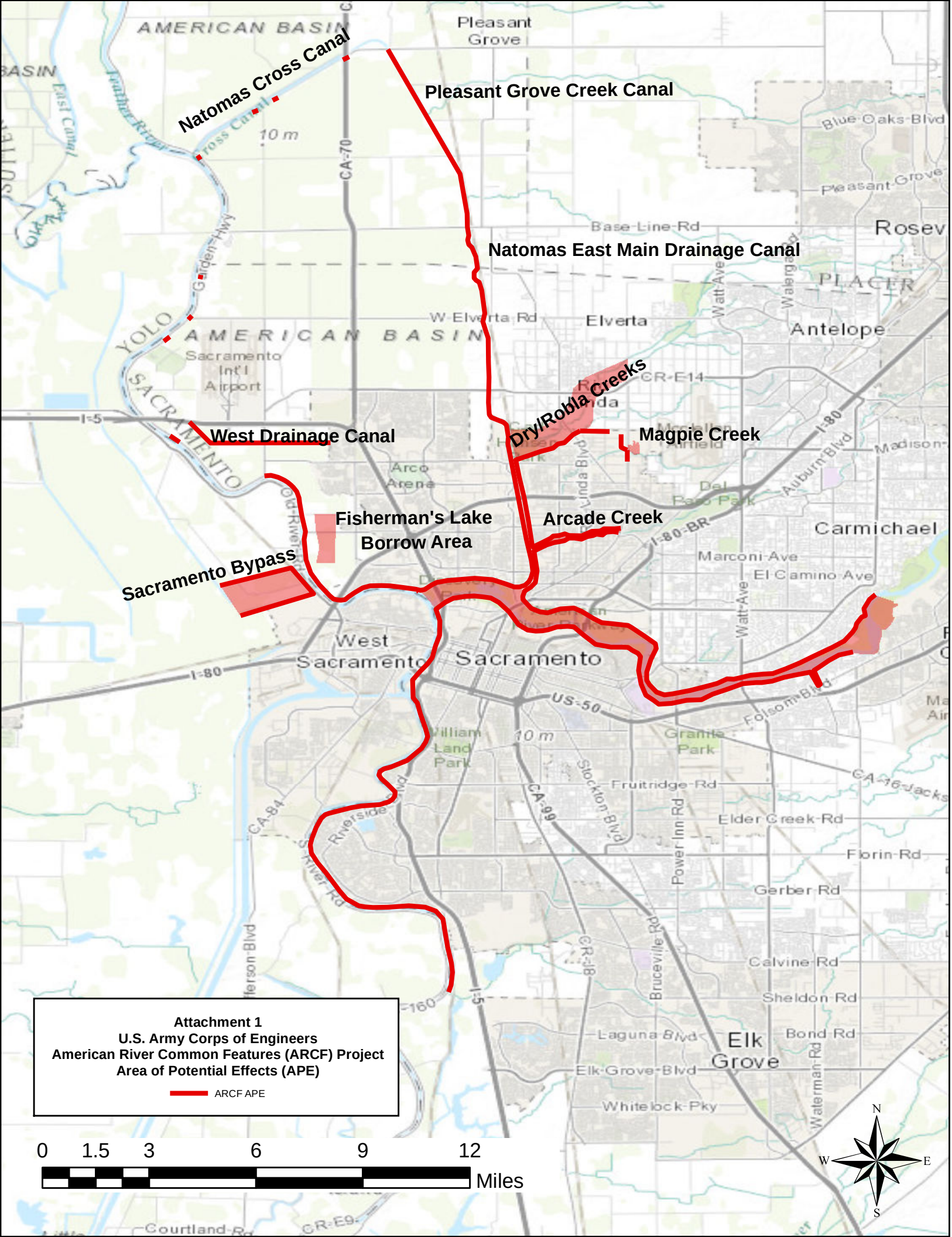
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE AMERICAN RIVER COMMON FEATURES PROJECT,
SACRAMENTO, SACRAMENTO AND YOLO COUNTIES, CALIFORNIA

CONCURRING PARTIES:

BY:_____DATE: _____
Randy Yonemura


Natomas Cross Canal
Pleasant Grove Creek Canal
Natomas East Main Drainage Canal
Dry/Robla Creeks
Magpie Creek
West Drainage Canal
Fisherman's Lake Borrow Area
Arcade Creek
Sacramento Bypass
AMERICAN BASIN
YOLO
SACRAMENTO
PLACER
Pleasant Grove
Elverta
Antelope
Roseville
Carmichael
West Sacramento
Sacramento
Elk Grove
Sacramento Int'l Airport
Arco Arena
Base Line Rd
W Elverta Rd
CR-E14
Blue Oaks Blvd
Pleasant Grove
Watt Ave
Walerga Rd
Madison
Auburn Blvd
Del Paso Park
Marconi Ave
El Camino Ave
Folsom Blvd
Granite Park
William Land Park
Fruitridge Rd
Elder Creek Rd
Florin Rd
Gerber Rd
Calvine Rd
Sheldon Rd
Bond Rd
Laguna Blvd
Elk Grove Blvd
Whitelock Pky
Power Inn Rd
Bruceville Rd
Waterman Rd
Stockton Blvd
Riverside Blvd
Jefferson Blvd
Courtland Rd
CR-E9
CR-B
I-5
I-80
I-80-BR
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CA-70
CA-84
CA-99
CA-160
CA-16
Garden Hwy
Old Rivergate
Feather River
East Canal
10 m
Attachment 1
U.S. Army Corps of Engineers
American River Common Features (ARCF) Project
Area of Potential Effects (APE)
ARCF APE
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Attachment 2

American River Common Features Project
Project Description
November 2014

The American River Common Features (ARCF) Project is being developed to provide flood risk reduction to the city of Sacramento, including the Natomas Basin, areas along the North and South banks of the American River, and areas along the East bank of the Sacramento River below the American River. The non-Federal sponsor for the ARCF Project is the State of California Central Valley Flood Protection Board (CVFPB). The Sacramento Area Flood Control Agency (SAFCA) has a Local Cooperation Agreement with the CVFPB. Authorized Local Cooperation Agreements include requirements to: 1) Provide lands, easements, and rights-of-way; 2) Modify or relocate utilities, roads, bridges (except railroad bridges), and other facilities where necessary for the construction of the project; 3) Cost share the project per applicable laws; and 4) Bear all costs of operation, maintenance, repair, rehabilitation and replacement of flood control facilities.

Location

The Sacramento River Watershed covers approximately 26,000 square miles in central and northern California. Shasta Dam impounds the upper Sacramento River Watershed. Major tributaries of the Sacramento River include the Feather, Yuba and American rivers. The American River Watershed covers about 2,100 square miles northeast of the city of Sacramento and includes portions of Placer, El Dorado, Alpine, and Sacramento counties. The American River Watershed includes Folsom Dam and Reservoir; inflowing rivers and streams, including the North, South, and Middle forks of the American River; and the American River downstream to its confluence with the Sacramento River in the city of Sacramento. The Sacramento and American rivers, in the Sacramento area, form a flood plain covering approximately 110,000 acres in their confluence. The flood plain includes most of the developed portions of the city of Sacramento and encompasses the boundaries of the study area. Figure 1 shows the ARCF study area.

Area of Potential Effects (APE)

While the overall ARCF Project study area covers a broad geographic area, the ARCF Project area of potential effects (APE) includes those areas where the project will have potential direct or indirect effects to the character or use of historic properties. The ARCF Project APE includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; the Sacramento Bypass and Sacramento Weir; approximately 4 miles of the Pleasant Grove Creek Canal; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal. The APE is shown in Figure 2.

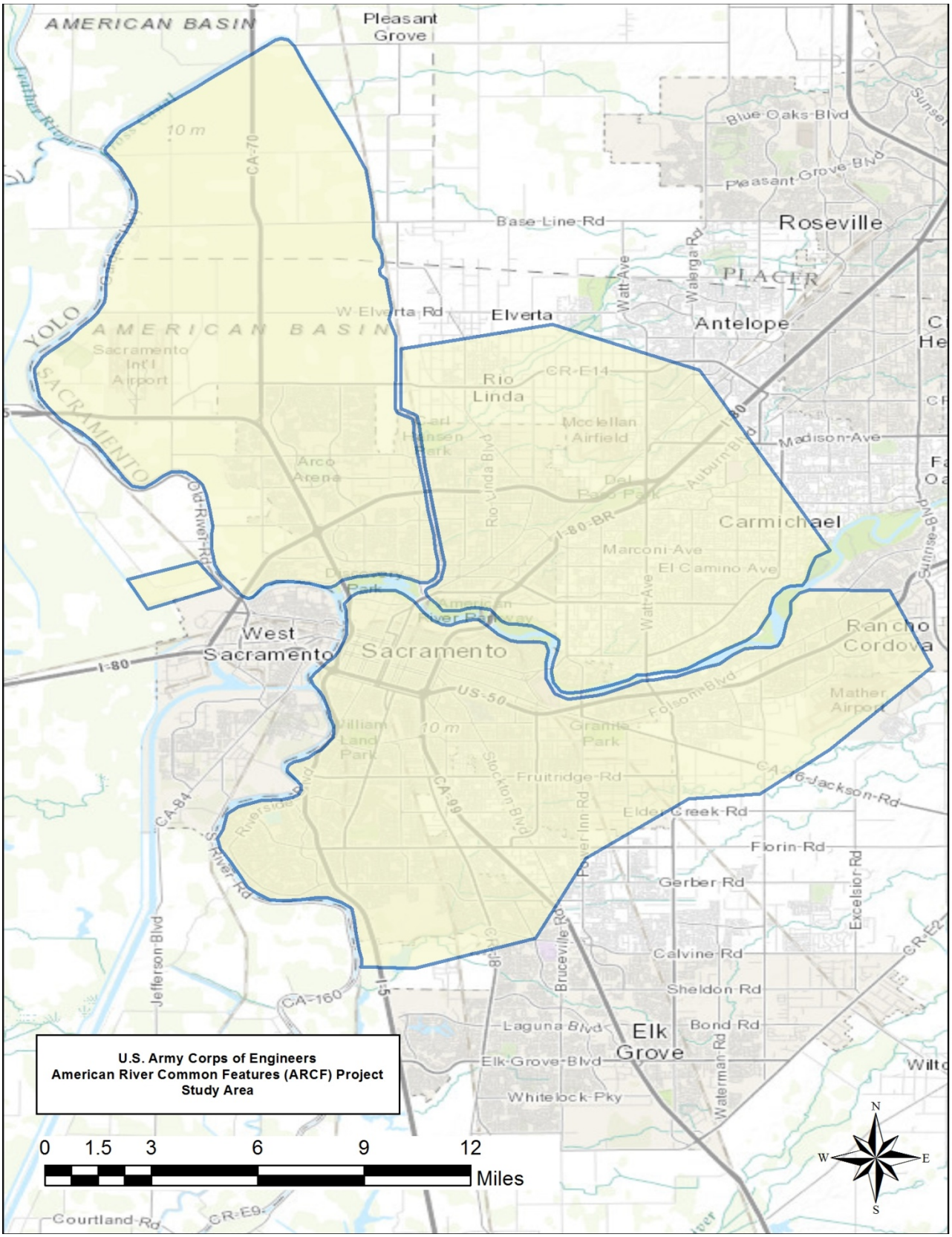

Figure 1. ARCF Project Study Area

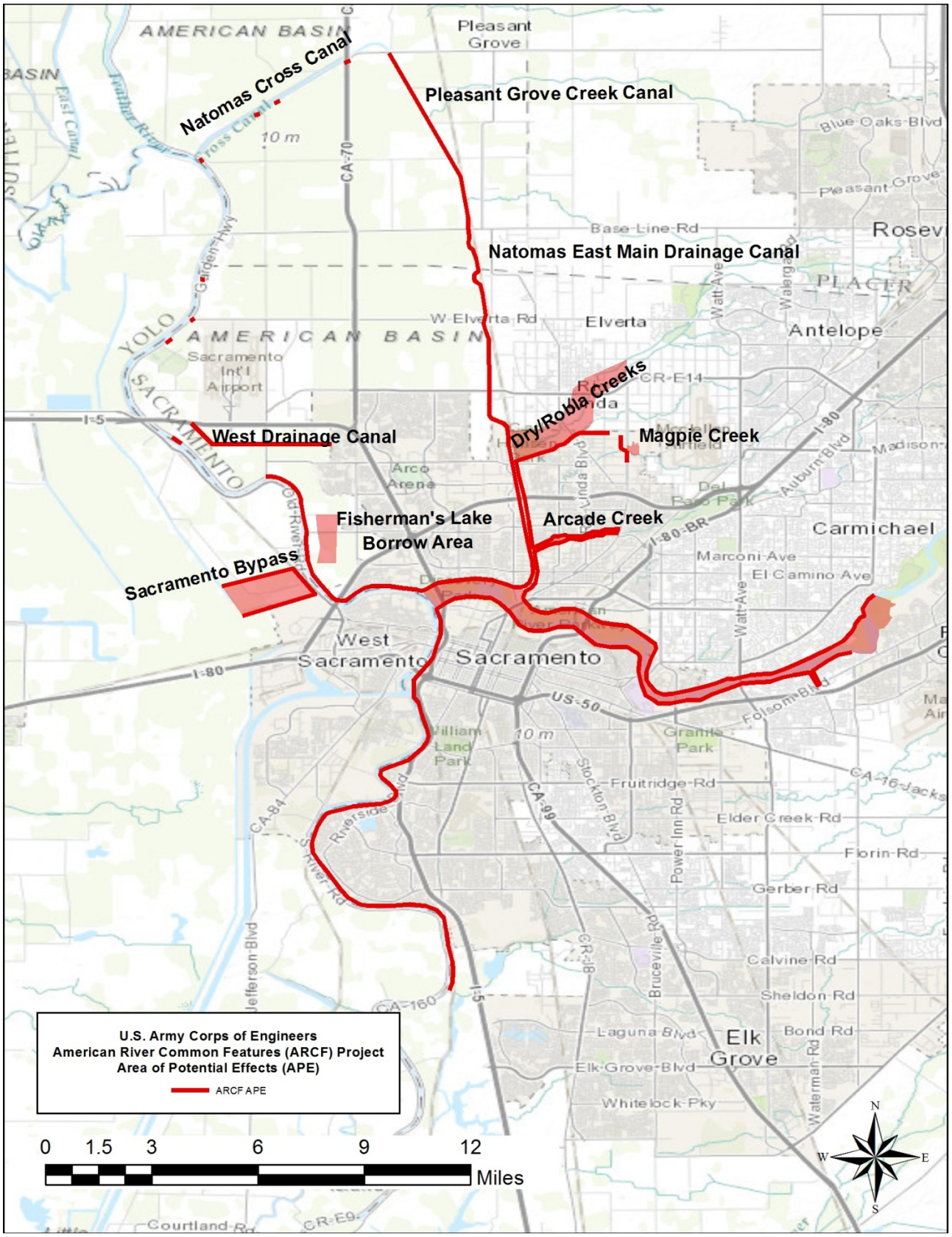

Figure 2. ARCF Project Area of Potential Effects

Project Authorization

The ARCF Project was authorized in the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. Significant changes to the project were approved via the Second Addendum to the Supplemental Information Report of March 2002. Additionally, the Energy and Water Development Appropriations Act of 2004 increased the authorized total cost of the project to $205,000,000. The current estimated cost of the authorized project is $277,563,000.

In the ARCF Project, authorized features are generally located in the Lower American River, Natomas Basin and Sacramento River. All Lower American River features authorized in WRDA 1996 and 1999 have been constructed or are scheduled for construction within the next three years. Construction of authorized Natomas features were deferred as a result of deep underseepage concerns raised after the 1997 flood event in the Sacramento Valley. In 1997, considerable deep underseepage occurred on the Sacramento River in areas that had previously undergone remediation after the 1986 flood event. The previous remediation consisted of shallow seepage cutoff walls and did not account for the deep underseepage problems revealed during the 1997 flood event. Significant seepage on the American River was also observed.

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress throughout the late 1990s and the early part of the 2000s were used for construction activities on the Lower American River instead of for design efforts in the Natomas Basin. Additionally, it was recognized that all work in the Natomas Basin would require significantly more features than was anticipated at the time of authorization. Additional levee improvements were also needed on the Sacramento River and the American River below Folsom Dam in order to truly capture the benefits of the Folsom Dam projects and the Common Features project already authorized and constructed. Therefore, the Corps decided that reevaluation studies would be required for the Natomas Basin and city of Sacramento portions of the ARCF Project. This reevaluation is now called the Common Features General Reevaluation Report (CFGRR).

Proposed Measures

In general, levees fail because of one of four reasons: seepage, slope stability, overtopping, and erosion. The CFGRR is looking at reducing the likelihood of having a levee failure in the city of Sacramento as a result of any of these reasons. Methods that were looked at to achieve this goal include, but are not limited to: seepage cutoff wall, seepage berm, levee slope flattening, relief wells, adjacent levee, stability berm, drained stability berm, levee raising, floodwall, bypass widening, riverbank erosion protection, and launchable rock erosion protection. These preliminary methods have been screened and refined to the following final array of measures. The ARCF Project is a single purpose flood risk management project with the measures shown in Table 1 below proposed for implementation. In addition to the measures listed in Table 1, the following measures would be implemented throughout the APE:

- Establish the Corps' standard levee footprint on all levees within the APE that are out of compliance, including a 10-foot-wide landside maintenance access easement.
- Bring utility encroachments, including pump stations, into compliance with Corps policy.
- Remove private encroachments.
- Relocate, as needed, irrigation canals within the Natomas Basin, to include the relocation of the West Drainage Canal south of the Airport Operations Area.
- Remediate the Highway 99/Natomas Cross Canal Bridge.

- Excavation of borrow materials at designated borrow sites, to include the South Fisherman's Lake Borrow Area and the West Lakeside School site in the Natomas Basin.

Table 1. Proposed Measures for the American River Common Features Project.

Waterway/Location	Extent of Action	Proposed Measure
American River	North and south levees from the confluence with the Sacramento River upstream for approximately 12 miles.	• Construct bank protection or launchable rock trenches
American River	North levee from the confluence with the Sacramento River upstream to approximately NEMDC.	• Flatten the levee slope • Install cutoff walls
Sacramento River	East levee from Power Line Road to the American River.	• Construct an adjacent levee with a flattened landside slope • Install cutoff walls • Construct seepage berms • Install relief wells • Construct levee raise • Establish compliance with Corps vegetation requirements for upper 2/3 slopes of the levee.
Sacramento River	East levee from the American River to Morrison Creek.	• Install cutoff walls • Construct bank protection • Construct levee raise • Establish compliance with Corps vegetation requirements for upper 2/3 slopes of the levee.
NEMDC	East levee from Dry/Robla Creek to the American River	• Install cutoff walls • Construct floodwalls • Establish compliance with Corps vegetation requirements.
NEMDC	West levee from Dry/Robla Creek to the American River	• Construct bank protection • Construct levee raise and flatten levee slope • Establish compliance with Corps vegetation requirements.
NEMDC	West levee from Sankey Road to Dry/Robla Creek	• Construct levee raise and flatten levee slope • Install cutoff walls • Establish compliance with Corps vegetation requirements.
Pleasant Grove Creek Canal	West levee	• Construct bank protection • Construct levee raise with a widened levee • Install cutoff walls • Upgrade or remove culverts

Waterway/Location	Extent of Action	Proposed Measure
		• Establish compliance with Corps vegetation requirements.
Arcade Creek	North and south levees from NEMDC to Marysville Boulevard	• Install cutoff walls • Raise floodwalls • Establish compliance with Corps vegetation requirements.
Dry/Robla Creek		• Raise floodwalls • Establish compliance with Corps vegetation requirements.
Magpie Creek Diversion Canal	Upstream of Raley Boulevard	• Construct floodwalls • Establish compliance with Corps vegetation requirements.
Magpie Creek area	South of Raley Boulevard	• Construct new levee
Magpie Creek area	East of Raley Boulevard	• Acquire property to create a flood detention basin • Widen the Raley Boulevard/Magpie Creek bridge and raise the elevation of the roadway • Remove the Don Julio Creek culvert
Sacramento Weir and Bypass	North bypass levee to 1,500 feet north.	• Widen the Sacramento Weir and Bypass by approximately 1,500 feet • Construct a new section of weir and levee • Remove the existing Sacramento Bypass north levee

Construction Activities

While the Corps began its reevaluation studies, SAFCA began final design and construction on certain areas in Natomas. A local sponsor or entity may request permission under Section 408 to alter a Federal project and a Section 404 permit to comply with the Clean Water Act. Generally a local sponsor or entity will request Section 408 permission and will move forward with the funding, planning, and constructing of the Federal project with the intention of seeking later credit under Section 104 for their share of an authorized Federal project. In 2008, the SAFCA requested consideration for a Section 104 credit, permission under Section 408, and requested a Section 404 permit for the Natomas Levee Improvement Project (NLIP). The Natomas Basin portions of the ARCF Project have been divided into a number of construction phases (Figure 3).

Shortly after receiving Section 408 permission and Section 404 approval, SAFCA, in cooperation with the California Department of Water Resources (DWR) and the CVFPB, implemented urgently needed improvements to the Federal project levee system around the Natomas Basin. SAFCA has completed construction for all of Phases 1, 2A, and 3 and is finishing construction of Phase 4a. When complete, SAFCA will have completed levee improvement construction on 18 miles of the 42 miles surrounding the Natomas Basin. The Corps will be constructing the remaining 24 miles of levee improvement once authorization and appropriations are received.

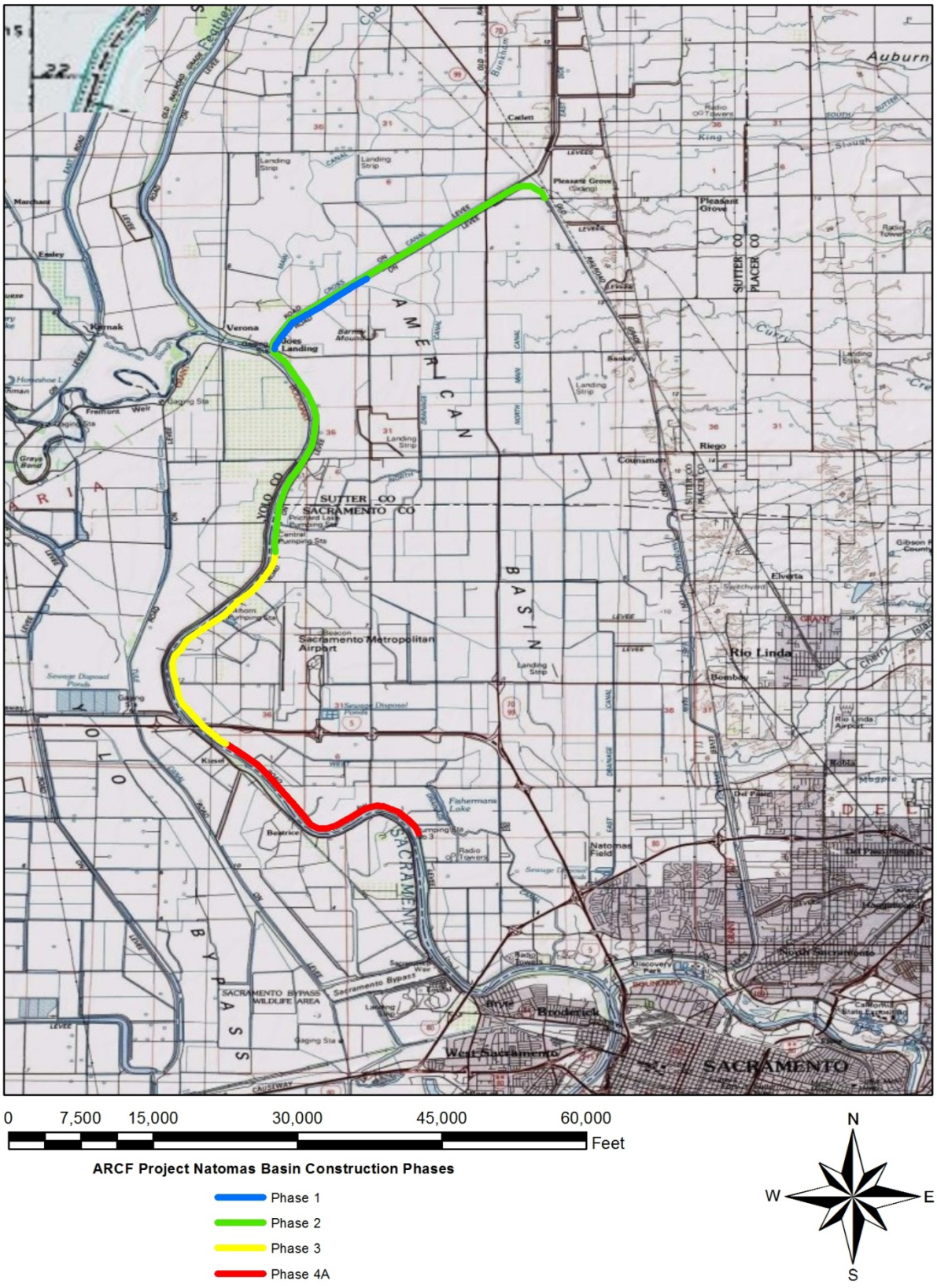

Figure 3. ARCF Project NLIP Construction Phases

Cultural Resources/NEPA Compliance

For NLIP Phases 1, 2, 3, and 4a, SAFCA, DWR and CVFPB were the lead decision makers on the planning, design, environmental and cultural resources compliance, and construction for NLIP. SAFCA contracted with EDAW (now AECOM) to complete EIS/EIRs for the overall Natomas Basin. In order to meet the requirements under the Section 404 permits and Section 408 permissions and because SAFCA planned to seek credit for their share of an authorized Federal project, SAFCA was required to comply with the National Environmental Policy Act of 1969 (NEPA) and the National Historic Preservation Act of 1966, as amended (NHPA).

Section 106 of the NHPA requires Federal agencies to take into account the effects of their undertaking on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on such undertakings. The Code of Federal Regulations 36 CFR § 800 outlines the steps and guidelines a Federal agency must follow in order to comply with Section 106. The NEPA compliance effort in the NLIP Environmental Impact Statement/Environmental Impact Report (EIS/EIR), completed in 2007, provided an overview of the known cultural resources and historic properties within the Natomas Basin and the ARCF study area. The records and literature search identified 175 cultural resources and 285 surveys and inventories conducted within the ARCF study area.

Because of the size of the study area and because the assessment of effects to historic properties could not be completed prior to the signing of the Record of Decision for the EIS/EIR, an alternate method was required to ensure that the construction efforts within the Natomas Basin undertaken by
SAFCA would comply with Section 106 of the NHPA. When effects on historic properties cannot be fully determined prior to approval of an undertaking and when there may be potential adverse effects of a complex or phased project a programmatic agreement (PA) may be executed for the undertaking.

On May 1, 2008, a PA for NLIP was executed between the Corps, SAFCA and the SHPO. The NLIP PA only covered actions under the Section 408 permissions and Section 404 permits within the Natomas Basin for which SAFCA was the construction lead. By executing the PA the NLIP was then in compliance with Section 106 and the signatories to the NLIP PA (the Corps, SAFCA and the SHPO) had an agreed upon series of stipulations that fulfilled the requirements of 36.CFR § 800. The Corps had the responsibility of determining if the actions by SAFCA complied with Section 106 and coordinating concurrence with those determinations with the SHPO. All construction efforts for NLIP Phases 1, 2, 3, and 4a were funded entirely by SAFCA, DWR and CVFPB.

Prior to the construction of Phases 1, 2, 3, and 4a, a series of NEPA compliance documents were completed as supplements to the original EIS/EIR completed in 2007. Phase 1 was covered in an Environmental Assessment/Impact Statement dated November 2007. Phase 2 was covered in a supplement to the EIS/EIR completed in November 2008. Phase 3 was covered in an EIS/EIR completed May 2009. And Phase 4a was covered in a EIS/EIR completed November 2009.

Because construction of Phases 1, 2, 3, and 4a does not address all of the flood risk concerns in the Natomas Basin, it does not provide complete flood protection for the entire Natomas Basin. Due to funding constraints with SAFCA, DWR and CVFPB, construction of the remaining perimeter of the Natomas Basin will not be completed under the Section 408 permissions and Section 404 permits. Therefore, as part of our reevaluation efforts (CFGRR), the Corps is implementing completion of the remaining phases in the Natomas Basin, as well as the other portions of the ARCF Project as the Federal lead on the project. The remaining Natomas construction was covered under NEPA/CEQA in

the NLIP Phase 4b EIS/EIR in October 2010. The Corps will also be preparing a NEPA/CEQA document for the CFGRR for those activities not covered in the previous NEPA/CEQA documents.

Although the NLIP PA covered Section 106 compliance for the entirety of possible construction activities in the Natomas Basin, the roles and responsibilities of the NLIP PA designated SAFCA as responsible for the execution of inventories, surveys, recordation of sites, determinations of eligibility, and development of historic properties treatment plans and mitigation measures. The NLIP PA includes the Corps and SAFCA in roles as regulatory authority but with no involvement in the production of technical studies or determinations of effect.

The previously completed EIS/EIRs are applicable for overall NEPA compliance for the Natomas Basin. However, in order for the Corps to be in compliance with Section 106 of the NHPA, and due to the changing roles and responsibilities and authorities, a new PA will need to be developed and executed for the remaining construction activities the Corps will undertake in the Natomas Basin as well as the other authorized project features for the rest of the ARCF Project.

Similar to the NLIP PA, the ARCF PA will outline the steps the Corps, as the lead Federal agency for NEPA, will take in order to comply with Section 106 of the NHPA. The ARCF PA must be executed in advance of any construction activities the Corps may undertake for the ARCF Project.

Attachment 3

Historic Properties Management Plan

Historic Properties Management Plan (HPMP) shall include:

I. Introduction and Description of the Undertaking
   a. Overview and Executive Summary
   b. Purpose and Application of the HPMP
   c. Regulatory context
   d. Description of the Undertaking

II. General Standards and Procedures
   a. Professional Qualifications
   b. Documentation Standards
   c. Dissemination and Confidentiality of Information
   d. Permits and Rights of Entry
   e. Curation

III. Background Information
   a. Records and Literature Search
   b. Archaeological Sensitivity Assessment Procedure
   c. Correspondence with Knowledgeable Individuals and Groups
   d. American Indian Outreach

IV. Historic Context
   a. Prehistoric Resource Types
   b. Historic Resource Types
   c. Environmental Context
      i. Regional Surface Geology
      ii. Regional Geomorphology
      iii. Climate
      iv. Flora and Fauna
   d. Cultural Context
      i. Prehistoric Archaeology
      ii. Ethnographic Context
      iii. Historic Context

V. Identification of Historic Properties
   a. General Methods
   b. Evaluation
   c. Documentation

VI. American Indian Consultation Procedures
   a. American Indians and Organizations as Concurring Parties
   b. American Indians and Organizations as Non-Concurring Parties

VII. Assessment of Effects
   a. Criteria of Adverse Effect
   b. Finding of Effect

c. Consultation and Documentation of Effect Findings

VIII. Resolution of Adverse Effects
a. Consultation and Documentation
b. Avoidance
c. Treatment Options
d. Development of Historic Properties Treatment Plans
e. Inadvertent Discoveries

Attachment 4

Property Types Exempt from Evaluation

This attachment defines categories of properties that do not warrant evaluation pursuant to Stipulation IV.B of this Agreement. Only individuals meeting the Secretary of the Interior's Professional Qualification Standards pursuant to Stipulation VII.A of this agreement are authorized to determine whether properties meet the requirements of this attachment and are therefore exempt from evaluation and consultation with SHPO. Exempted properties may be documented, if documentation is warranted, at a level commensurate with the nature of the property (e.g., DPR 523 Primary Form, Location Map, memo). The Corps Cultural Resources staff shall make any final determinations on level of documentation required under this agreement.

Exempt Property Type 1: Archaeological Property Types and Features

1. Isolated prehistoric finds consisting of fewer than three items per 100 m^2
2. Isolated historic finds consisting of fewer than three artifacts per 100 m^2 (several fragments from a single glass bottle, and similar vessels are to be counted as one artifact)
3. Refuse scatters less than 50 years old (scatters containing no material that can be dated with certainty as older than 50 years old)
4. Features less than 50 years old (those known to be less than 50 years old through map research, inscribed dates, etc.)
5. Isolated refuse dumps and scatters over 50 years old that lack specific associations
6. Isolated mining prospect pits
7. Placer mining features with no associated structural remains or archaeological deposits
8. Foundations and mapped locations of buildings or structures more than 50 years old with few or no associated artifacts or ecofacts, and with no potential for subsurface archaeological deposits

Exempt Property Type 2: Minor, Ubiquitous, or Fragmentary Infrastructure Elements

The following list does not apply to properties 50 years old or older that could be potentially important, nor does it apply to properties that may contribute to the significance of larger historic properties such as districts or cultural landscapes.

Water Conveyance and Control Features

- Natural bodies of water providing a water source, conveyance, or drainage
- Modified natural waterways

- Concrete-lined canals less than 50 years old and fragments of abandoned canals
- Roadside drainage ditches and secondary agricultural ditches
- Small drainage tunnels
- Flood storage basins
- Reservoirs and artificial ponds
- Levees and weirs
- Gates, valves, pumps, and other flow control devices
- Pipelines and associated control devices
- Water supply and waste disposal systems
- Rip-rap

Recent Transportation or Pedestrian Facilities

- Railroad grades converted to other uses, such as roads, levees, or bike paths
- Bus shelters and benches
- Vista points and rest stops
- Bike paths, off-road vehicle trails, equestrian trails, and hiking trails
- Parking lots and driveways

Highway and Roadside Features

- Isolated segments of bypassed or abandoned roads
- Retaining walls
- Highway fencing, soundwalls, guard rails, and barriers
- Drains and culverts, excluding culverts assigned a Caltrans bridge number
- Cattle crossing guards
- Roadside landscaping and associated irrigation systems
- Signs and reflectors
- Telecommunications services, including towers, poles, dishes, antennas, boxes, lines, cables, transformers, and transmission facilities
- Utility services, including towers, poles, boxes, pipes, lines, cables, and transformers
- Oil and gas pipelines and associated control devices

Adjacent Features

- Fences, walls, gates, and gateposts

- Isolated rock walls and stone fences
- Telephone booths, call boxes, mailboxes, and newspaper receptacles
- Fire hydrants and alarms
- Markers, monuments, signs, and billboards
- Fragments of bypassed or demolished bridges
- Temporary roadside structures, such as seasonal vendors' stands
- Pastures, fields, crops, and orchards
- Corrals, animal pens, and dog runs
- Open space, including parks and recreational facilities
- Building and structure ruins and foundations less than 50 years old

Movable or Minor Objects

- Movable vehicles
- Stationary vehicles less than 50 years old or moved within the last 50 years
- Agricultural, industrial and commercial equipment and machinery
- Sculpture, statuary, and decorative elements less than 50 years old or moved within the last 50 years

American River Common Features GRR

EIS Cultural Resources Appendix

Enclosure 2

Section 106 Consultation Record

American River Common Features Project SHPO, ACHP, Sponsor Consultation Record*

*May not include all communication for project.

12/31/15

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
2/1/2012	Outgoing Letter	ACHP	Reid Nelson	Inform ACHP of proposed project, process to be followed, ask for participation in PA.
2/1/2012	Outgoing Letter	SHPO	Milford Donaldson	Request comments on APE, proposed efforts to identify historic properties, plan to develop PA.
4/11/2012	Outgoing Email	State of CA	Erin Brehmer, Mary Hadden	Transmittal of draft PA for sponsor review, request comments.
4/13/2012	Incoming Email	State of CA	Erin Brehmer	Acknowledgement of receipt of PA and will sent to CVFPP and DWR cultural staff.
5/22/2012	Outgoing Email	State of CA	Erin Brehmer	Request timeframe for CVFPP and DWR review of PA.
6/13/2012	Incoming Email	State of CA	Erin Brehmer	Transmittal that DWR had no comments on PA and CVFPP transmittal of comments.
6/20/2012	Outgoing Phone Call	CVFPP	James Herota	Discussed CVFPP comments on PA, explained that CEQA specific language would not be included.
6/20/2012	Outgoing Email	State of CA	Erin Brehmer	Responses to CVFPP PA comments.
6/21/2012	Incoming Email	CVFPP	James Herota	Receipt of additional Native American contacts from CVFPP.
7/16/2012	Outgoing Letter	SHPO	Milford Donaldson, Susan Stratton, Dwight Dutsche	Letter transmitting PA for review and comment, determination of the APE, potential adverse effects, resolution of adverse effects through a PA, suggest meeting.
7/16/2012	Outgoing Letter	ACHP	Reid Nelson	Letter transmitting PA for review and comment, request notification if ACHP plans to participate in the PA.
7/16/2012	Outgoing Email	SHPO	Susan Stratton, Dwight Dutsche	Email transmittal of 7/16/12 formal letter.
7/16/2012	Outgoing Email	ACHP	Tom McCulloch	Email transmittal of 7/16/12 formal letter.
7/27/2012	Incoming Email	ACHP	Tom McCulloch	Acknowledgement of receipt of 7/16/12 letter, ask if ACHP participation is needed, ask if comments on PA needed.
7/27/2012	Outgoing Email	ACHP	Tom McCulloch	Request any comments from the ACHP on PA, ACHP participation in PA probably not needed unless ACHP thinks so after reading submitted information.
8/7/2012	Incoming Letter	ACHP	Raymond Wallace	ACHP decline to participate in PA, request final signed and executed PA once completed.
8/7/2012	Outgoing Email	ACHP	Tom McCulloch	Request for any comments on PA, acknowledge letter from ACHP declining to participate.
8/14/2012	Outgoing Email	SHPO	Susan Stratton, Dwight Dutsche	Follow up to 7/16/12 formal letter and email requesting comments on PA, proposing a meeting, transmittal of ACHP declining to participate.
9/17/2012	Outgoing Email	SHPO	Susan Stratton, Dwight Dutsche	Follow up to 7/16/12 formal letter, follow up emails on 7/16/12 and 8/14/12 requesting comments on PA and date for when comments would be available.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
10/10/2012	Outgoing Email	SHPO	Susan Stratton, Dwight Dutsche	Email request for consultation meeting with SHPO to include PDT (Dan Tibbitts and Sara Schultz) to discuss project and PA.
10/23/2012	Consultation Meeting	SHPO	Susan Stratton, Dwight Dutsche, Dan Tibbitts, Melissa Montag	Consultation meeting to discuss project and PA, SHPO provided comments on the PA.
10/25/2012	Outgoing Email	SHPO	Susan Stratton, Dwight Dutsche	Email addressing comments from 10/23/12 meeting, transmittal of revised PA, request concurrence on PA acceptability, propose meeting in November.
10/29/2012	Outgoing Email	SHPO	Susan Stratton, Dwight Dutsche, Brendan Greenaway, Dan Tibbitts, Melissa Montag	Email request for follow up consultation meeting to 10/23/12 meeting and 10/25/12 email and changes/revisions to PA.
11/5/2012	Consultation Meeting	SHPO	Susan Stratton, Dwight Dutsche, Brendan Greenaway, Dan Tibbitts, Sara Schultz, Melissa Montag	Consultation meeting to discuss project and PA, SHPO requested a Historic Properties Management Plan be included in PA.
11/7/2012	Outgoing Email	SHPO	Susan Stratton, Dwight Dutsche, Brendan Greenaway, Dan Tibbitts, Sara Schultz	Transmittal of current draft of PA after incorporating comments from 11/5/12 meeting, communication of project schedule and long term phasing, requested comments on draft PA by 12/31/12.
1/14/2013	Outgoing Email	SHPO	Brendan Greenaway	Email transmittal of draft PA sent 11/7/12, request comments from SHPO.
1/14/2013	Incoming Email	SHPO	Brendan Greenaway	Acknowledgement of 1/14/13 transmittal, no comments from SHPO yet. Will review, suggested sending draft PA to concurring parties.
1/14/2013	Outgoing Email	SHPO	Brendan Greenaway	Acknowledgement of 1/14/13 email from SHPO.
1/30/2013	Outgoing Email	SHPO	Susan Stratton, Brendan Greenaway	Transmittal of draft HPMP for SHPO review and comment.
2/11/2013	Outgoing Email	DWR	Jacqueline Wait	Transmittal of draft PA to sponsor, provided project information, CVFPP comments from 2012, requested comments on draft PA.
2/11/2013	Outgoing Email	SAFCA	Peter Buck	Email to inquire who at SAFCA would review PA.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
2/12/2013	Incoming Email	SAFCA	Peter Buck	Acknowledgement of 2/11/12, request PA be sent to Mr. Buck.
2/12/2013	Outgoing Email	SAFCA	Peter Buck	Transmittal of draft PA for SAFCA review.
3/14/2013	Incoming Email	SHPO	Brendan Greenaway	Acknowledgement of draft HPMP sent 1/30/13, agreed document was acceptable.
3/19/2013	Incoming Email	SAFCA	Peter Buck	Email informing Corps that draft PA is still being reviewed by SAFCA counsel.
4/10/2013	Outgoing Email	DWR	Jacqueline Wait	Follow up email to 2/11/13 email transmitting electronic documents again and requesting comments on draft PA by 5/20/13.
4/11/2013	Incoming Email	SAFCA	Peter Buck	Transmittal of SAFCA comments on draft PA.
6/13/2013	Incoming Email	SHPO	Brendan Greenaway	Queried status of PA.
6/13/2013	Outgoing Email	SHPO	Brendan Greenaway	Informed SHPO that the PA is undergoing additional review by Native Americans, ACHP has declined to participate and Corps would appreciate any comments SHPO may have on draft PA. Told SHPO of general project schedule.
6/13/2013	Incoming Email	SHPO	Brendan Greenaway	Acknowledgment of 6/13/13 email.
9/19/2013	Outgoing Email	DWR	Erin Brehmer, Jacqueline Wait	Transmittal of EIS Cultural Resources section for State/Sponsor CEQA review.
9/19/2013	Outgoing Email	DWR	Jacqueline Wait	Transmittal of Archaeological Sensitivity Analysis for State/Sponsor review.
6/12/2014	Outgoing Email	DWR	Brehmer, David Martasian, Wait	Transmittal of updated EIS/EIR Cultural Resources appendix and current version of final draft of the PA.
6/13/2014	Outgoing Email	SHPO	Brendan Greenaway	Transmittal of final draft of PA for SHPO review, summarized consultation efforts with DWR, ACHP, and tribes so far.
6/13/2014	Incoming Email	SHPO	Brendan Greenaway	Acknowledgement of 6/13/14 email transmittal. Stated SHPO will review once current draft of PA has been circulated to tribes. Asked for the review period for tribes on the current draft.
6/13/2014	Outgoing Email	SHPO	Brendan Greenaway	Response to SHPO email above, stating current review of draft PA for tribes is 30 days and that the tribes received the draft PA for a 45 day review period in 2013.
6/13/2014	Incoming Email	SHPO	Brendan Greenaway	Restated SHPO will review following the current 30 day review period. Asked to provide any response to the 30 day review period once it has passed.
6/13/2014	Outgoing Letter	SHPO	Brendan Greenaway	Outgoing letter (hand delivered) to SHPO. Requests that the SHPO concur on the Corps' determination of the APE, plans to identify cultural resources through sensitivity assessment, and provide comments on the final draft of the PA.
6/13/2014	Outgoing Letters	DWR, ACHP	Jacqueline Wait, Reid Nelson	Copy furnished (with enclosures) 6/13/14 letter to SHPO for DWR and ACHP files.
6/16/2014	Outgoing Email	SHPO	Brendan Greenaway	Response to 6/13/14 email, mentioned the Corps would like to execute the PA this fall, offered to arrange for site visit or hold a meeting to provide additional information that could help with SHPO's review.
6/17/2014	Incoming Email	SHPO	Brendan Greenaway	Response to 6/16/14 email that a field trip might be a good idea, asked for what and where the field trip could cover.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
6/17/2014	Outgoing Email	SHPO	Brendan Greenaway	Response to 6/17/14 email that the field trip could cover four locations where the Corps is proposing work to show the scope of the effort, provide information on the construction, as well as future efforts to identify cultural resources in accordance with the PA. Requested three available dates to schedule a site visit.
6/17/2014	Incoming Email	SHPO	Brendan Greenaway	Will check schedules for attendance for site visit to include Jessica Tudor and Susan Stratton.
6/26/2014	Outgoing Email	SHPO	Brendan Greenaway	Follow up to email from 6/17/14 to suggest 7/31/14 for a field visit, possibly to include stops for West Sac Project as well.
7/2/2014	Incoming Email	SHPO	Jessica Tudor	Ms. Tudor requested list of comments from Mr. Dutsche on the draft PA, and what comments may have been addressed, or not.
7/3/2014	Outgoing Email	SHPO	Jessica Tudor	Response to 7/2/14 email, provided Ms. Tudor with email from Ms. Montag to SHPO on 10/25/12 that addressed comments from SHPO and provided a new draft of the PA. Provided information that no written comments have been received, though the SHPO did suggest the development of a HPMP as an attachment to the PA, to be developed later. Also suggested the field visit, possibly for 7/31/14.
7/3/2014	Incoming Email	SHPO	Jessica Tudor	Requested information on proposed field trip on 7/31/14, as well as the timeline for the review of the draft PA, APE, and historic properties identification efforts.
7/3/2014	Outgoing Email	SHPO	Jessica Tudor	Response to 7/3/14 email, provided logistical information on proposed field trip, that the review of the draft PA can take place in a few weeks but preferably prior to field trip on 7/31/14, and the Corps' plan to release the draft PA with the draft EIS/EIR in mid-August, preferably with comments from SHPO incorporated and comments from tribes considered (if they have been received).
7/3/2014	Incoming Email	SHPO	Jessica Tudor	Ms. Tudor said she is available for field visit on 7/31/14, will check with Ms. Stratton and Mr. Greenaway on their availability.
7/3/2014	Outgoing Email	SHPO	Jessica Tudor	Forwarded 7/31/14 field visit meeting request to Ms. Tudor.
7/3/2014	Incoming Email	SHPO	Jessica Tudor	Accepted 7/31/14 field visit meeting request.
7/22/2014	Outgoing Email	DWR	Erin Brehmer, David Martasian, Jacqueline Wait	Sent email to let DWR that UAIC has requested to meet with the Corps regarding the project and PA. Asked that DWR check and confirm availability on August 4th or 5th. Asked for a response ASAP.
7/22/2014	Incoming Email	DWR	David Martasian	Acknowledged 7/22/14 email, said would check and respond ASAP.
7/22/2014	Outgoing Email	DWR	David Martasian	Acknowledged 7/22/14 email from Mr. Martasian.
7/25/2014	Incoming Email	DWR	Erin Brehmer	Response to 7/22/14 email, Ms. Wait has recommended that Anecita Agustinez attend the meeting for DWR and is available on August 5th.
7/28/2014	Incoming Phone Call	DWR	Erin Brehmer	Ms. Brehmer called to follow up to 7/25/14 email, left voice message.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
7/29/2014	Outgoing Phone Call	DWR	Erin Brehmer	Ms. Montag called Ms. Brehmer to discuss the potential meeting on August 5th, asked if Ms. Wait was planning to attend since much of the discussion may center on the project PA and Section 106 requirements. Ms. Brehmer said it was recommended that Ms. Agustinez attend for DWR.
7/29/2014	Outgoing Meeting Request	DWR	Erin Brehmer, David Martasian, Jacqueline Wait, Anecita Agustinez	Sent placeholder meeting request for 8/5/14 meeting with DWR and UAIC.
7/29/2014	Outgoing Email	SHPO	Jessica Tudor	Email to Ms. Tudor that field visit on 7/31/14 has to be cancelled due to logistical reasons. Asked for availability the week of August 11th or 18th.
7/29/2014	Incoming Email	SHPO	Jessica Tudor	Response to 7/29/14 email that those dates are generally open for Ms. Tudor.
7/31/2014	Outgoing Email	SHPO	Jessica Tudor	Asked Ms. Tudor if 8/13/14 or 8/14/14 would work better for the field visit.
7/31/2014	Incoming Email	SHPO	Jessica Tudor	Ms. Tudor responded that either date would work.
7/31/2014	Outgoing Meeting Request	SHPO	Jessica Tudor, Susan Stratton, Brendon Greenaway	Sent meeting request for field visit on 8/13/14.
7/31/2014	Incoming Email	SHPO	Jessica Tudor	Accepted 8/13/14 field visit request.
7/31/2014	Incoming Email	SHPO	Susan Stratton	Declined 8/13/14 field visit request.
7/31/2014	Incoming Email	SHPO	Jessica Tudor	Requested Word version of final draft of PA.
8/1/2014	Outgoing Email	SHPO	Jessica Tudor	In response to 7/31/14 email, sent Word version of final draft of PA.
8/1/2014	Outgoing Email	DWR	Erin Brehmer, David Martasian, Jacqueline Wait, Anecita Agustinez	Revised placeholder meeting sent on 7/29/14 to meeting times for meeting with UAIC on 8/5/14.
8/1/2014	Incoming Email	DWR	David Martasian	Accepted 8/5/14 meeting request.
8/4/2014	Incoming Email	DWR	Erin Brehmer	Accepted 8/5/14 meeting request.
8/4/2014	Incoming Email	DWR	Jacqueline Wait	Accepted 8/5/14 meeting request.
8/4/2014	Incoming Email	DWR	Anecita Agustinez	Declined 8/5/14 meeting request.
8/5/2014	Consultation Meeting	Corps, DWR, Tribes	David Martasian, Erin Brehmer, Jacqueline Wait	Consultation meeting held with UAIC and SSBMI.
8/8/2014	Incoming Email	SHPO	Jessica Tudor, Susan Stratton	Comments provided on draft PA sent 8/1/14.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
9/2/2014	Outgoing Email	DWR	David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez	Sent link to Doodle poll to schedule next meeting with UAIC and SSBMI for late October/early November. Requested response to poll by 9/17/14. Welcomed receiving any comments on the draft programmatic agreement.
9/4/2014	Incoming Email	DWR	David Martasian	Responded to Doodle poll.
11/17/2014	Outgoing Email	SHPO	Jessica Tudor	Sent track changes version of draft PA responding to comments sent 8/8/14, included additional language and current version of PA that will be included with draft EIS/EIR to be released to the public in mid-December. Suggested a face-to-face meeting to resolve any lingering issues before moving to a final draft of PA.
12/10/2014	Outgoing Email	DWR	David Martasian, Erin Brehmer, Jacqueline Wait	Sent current versions of cultural resources sections from the EIS/EIR to ask if DWR has any comments or changes needed in order to comply with CEQA because the EIS/EIR will be going to the CVFPB in January for approval for public release. Stated that comments would be needed in early January to make any changes.
7/1/2015	Outgoing Email	SHPO	Jessica Tudor	Sent an updated version of the PA with comments addressed (similar to 11/17/14 version) as well as merged changes as a result of consultation with tribes. Suggested a meeting to discuss and that the Corps would like to execute the PA around September.
8/6/2015	Outgoing Email	SHPO	Jessica Tudor, Anmarie Medin	Transmittal of updated clean draft of the PA with comments addressed. Suggested meeting to go over changes and edits, if needed, as the Corps is working to execute the PA in September.
9/10/2015	Meeting	SHPO	Anmarie Medin, Julianne Polanco	Signing and execution of final PA for ARCF Project.
10/30/2015	Outgoing Email	ACHP	Brian Lusher	Transmittal of signed and executed PA to the ACHP.
10/30/2015	Outgoing Email	SHPO	Jessica Tudor, Anmarie Medin	Transmittal of list of potential concurring parties to transmit notice of PA, requested a response from SHPO within two weeks.
11/2/2015	Incoming Letter	ACHP	Brian Lusher	Acceptance and acknowledgement of the PA by the ACHP.
11/9/2015	Incoming Email	SHPO	Jessica Tudor	In response to 10/30/15 email, Ms. Tudor suggested adding the Society for California Archaeology and potential historical societies/museums to the mailing list of possible concurring parties.
11/17/2015	Outgoing Email	SHPO	Jessica Tudor, Anmarie Medin	In response to 11/9/15 email, Ms. Montag stated the Society of California Archaeology and several historical societies have been added as potential concurring parties to the PA and if SHPO thinks of any additional parties to let the Corps know.
11/30/2015	Incoming Email	SHPO	Jessica Tudor	Acknowledgement of 11/17/15 email.

American River Common Features Project Native American Consultation Record*

*May not include all communication for project.

12/31/15

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
5/4/2011	Outgoing Letters	Mechoopda Indian Tribe of Chico Rancheria (MITCR), Shingle Springs Bank of Miwok Indians (SSBMI), Strawberry Valley Rancheria (SVR), Tsi-Akim Maidu (TAM), United Auburn Indian Community (UAIC), Wilton Rancheria (WR), Nashville-El Dorado Miwok (NEDM), Ione Band of Miwok Indians (IBMI), El Dorado Miwok Tribe (EDMT), Enterprise Rancheria of Maidu Indians (ERMI), Buena Vista Rancheria (BVR)	Various	Letter to Native American tribes with potential interest in the American River Common Features (ARCF) Project area of potential effects (APE) informing them of upcoming geotech borings and upcoming Programmatic Agreement (PA).
5/9/2011	Incoming Letter	MITCR	Mike DeSpain	Response letter from 5/4/11 letter expressing tribe's concerns about possible cultural resources sites, unaware of sites within the project area. Requested that is cultural resources are found that a funded tribal monitor be put in place.
6/2/2011	Incoming Letter	UAIC	Marcos Guerrero	Response letter from 5/4/11 letter expressing tribe's concerns about possible cultural resources sites impacted by development. Requested copies of archeological reports produced for the project, future environmental documents, and opportunity for UAIC consultants to accompany Corps during field surveys. Request to set up a field visit and concurring party status on
6/24/2011	Incoming Email	UAIC	Marcos Guerrero	Request initiation of Native American consultation for Natomas Levee Improvements Project (NLIP) and American River Common Features (ARCF) Project. Request environmental and cultural reports.
9/13/2011	Incoming Phone Call	SSBMI	Angela Rivera	Phone call requesting additional information on geotechnical investigations mentioned in 5/4/11 letter.

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9/13/2011	Outgoing Email	SSBMI	Angela Rivera	Follow up to 9/13/11 phone call, email transmittal of information on geotechnical investigations, committed to sending PA for comments when draft is ready.
9/19/2013	Incoming Email	SSBMI	Angela Rivera	Acknowledgement of 9/13/11 email transmittal, expressed interest in PA.
1/31/2012	Incoming Email	UAIC	Marcos Guerrero	Request construction schedule for NLIP Phase 4 and ARCF Project.
2/1/2012	Outgoing Email	UAIC	Marcos Guerrero	Clarification that NLIP Phase 4 will be pulled into ARCF Project and that construction schedule will be after environmental process, executing a PA, signed Chief's report, and Congressional authorization.
2/2/2012	Incoming Email	UAIC	Marcos Guerrero	Acknowledge receipt of information from 2/2/12 email, request to meet regarding ARCF and the PA.
4/3/2012	Incoming Letter	SSBMI	Daniel Fonseca	Request to meet regarding the project, to be added as a consulting party to identify TCPs in APE, and requested environmental and cultural reports.
4/25/2012	Outgoing Letter	SSBMI	Daniel Fonseca	Acknowledgement of 4/3/12 letter and plan to contact for a meeting and consult with the SSBMI on the ARCF Project.
4/25/2012	Outgoing Letter	UAIC	Gregory Baker, Marcos Guerrero	Acknowledgement of 5/9/11 request that UAIC be included survey efforts, as a concurring party to agreement documents, copies of reports, and to schedule a meeting.
4/25/2012	Outgoing Email	UAIC	Gregory Baker, Marcos Guerrero	Email transmittal of 4/25/12 letter and to schedule a tribal consultation meeting.
4/25/2012	Outgoing Email	SSBMI	Daniel Fonseca, Crystal Dilworth	Email transmittal of 4/25/12 letter and to schedule a tribal consultation meeting, suggested dates.
4/26/2012	Incoming Email	UAIC	Marcos Guerrero	Acknowledgment of 4/25/12 email and dates for meeting.
4/27/2012	Outgoing Email	UAIC	Marcos Guerrero	Follow up to 4/26/13 email, suggested dates for meeting.
4/30/2012	Outgoing Email	UAIC	Marcos Guerrero, Greg Baker	Sent meeting request for UAIC consultation meeting on 6/12/12.
4/30/2012	Outgoing Email	SSBMI	Daniel Fonseca, Crystal Dilworth	Sent meeting request for SSBMI consultation meeting on 6/14/12.
5/11/2012	Outgoing Letter	UAIC, SSBMI, EDMT, ERMI, NEDM, IBMI, TAM, SVR, WR, Mechoopda, BVR		Letter informing of planned geotechnical investigations, request for information, , request tribes to inform Corps if they are interested in additional Section 106 compliance efforts.

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6/12/2012	Consultation Meeting	UAIC	Marcos Guerrero, Melodi McAdams, Danny Rey, Melissa Montag, Dan Tibbitts, Sara Schultz, Jane Rinck	Consultation meeting with the UAIC to discuss project, upcoming schedule, description of work, plan for PA. Tribe requested the PA to review when it is ready.
6/14/2012	Consultation Meeting	SSBMI	Daniel Fonseca, Andrew Godsey, Melissa Montag, Jane Rinck, Dan Tibbitts	Consultation meeting with the SSBMI to discuss project, upcoming schedule, description of work, plan for PA. Tribe requested the PA to review when it is ready. Tribe was open to creative mitigation measures for sites Corps is unable to avoid during construction or unknown affected sites.
6/21/2012	Incoming Letter	BVR	Roselynn Lwenya	Response letter to 5/11/12 letter indicating interest in consultation on the project, Request additional information of proposed geotechnical investigations, schedule, site visit, copies of records and literature search, involvement in developing scopes, sampling strategy, research designs, field investigations, laboratory analysis, report writing, and consideration for a tribal monitor during
7/12/2012	Outgoing Letter	BVR	Roselynn Lwenya	Response letter to 6/21/12 letter informing tribe that geotechnical investigations mentioned in 5/11/12 letter would not be occurring, informing tribe of upcoming PA, and proposing a meeting to discuss Section 106 consultation efforts.
8/15/2012	Outgoing Phone Call	BVR	Roselynn Lwenya	Called to follow up from 6/21/12 and 7/12/12 letters. Spoke to Ms. Lwenya to discuss a meeting to address concerns in 6/21/12 letter. Ms. Lwenya stated she would respond with dates for a meeting.
8/15/2012	Outgoing Email	BVR	Roselynn Lwenya	Follow up to 8/15/12 phone call reiterating that geotech investigations mentioned in 5/11/12 letter would not be occurring, but requested the tribe's involvement in development of the PA for the project.
8/22/2012	Incoming Email	BVR	Roselynn Lwenya	Acknowledgement of 8/15/12 email, will follow up with available meeting dates.
8/22/2012	Outgoing Email	BVR	Roselynn Lwenya	Acknowledgement of 8/22/12 email.
11/1/2012	Outgoing Email	BVR	Roselynn Lwenya	Follow up email to 8/15/12 requesting available dates for the BVR to meet to discuss project.
1/8/2013	Incoming Email	BVR	Roselynn Lwenya	Request to set up tribal meeting with proposed dates.
1/9/2013	Outgoing Email	BVR	Roselynn Lwenya	Response to 1/8/13 email with suggested alternate dates.
1/22/2013	Outgoing Email	BVR	Roselynn Lwenya	Follow up to 1/9/13 email to request setting up a tribal meeting, provided dates.
1/22/2013	Incoming Email	BVR	Roselynn Lwenya	Acknowledgement of 1/22/13 email, will reply with proposed dates in the future.
1/24/2012	Incoming Email	BVR	Roselynn Lwenya	Email proposing tribal meeting on 2/22/13.

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1/25/2012	Outgoing Email	BVR	Roselynn Lwenya	Follow up to 1/24/13 email communicating Corps not available to meet on 2/22/13, suggested alternate dates before and after.
2/15/2013	Outgoing Email	BVR	Roselynn Lwenya	Follow up email to 1/25/13 email to request setting up a tribal meeting, suggested meeting dates in March.
4/5/2013	Outgoing Letter	MITCR, SSBMI, SVR, TAM, UAIC, WR, NEDM, IBMI, EDMT, ERMI, BVR, Cachil DeHe Band of Wintun Indians (Cachil DeHe), Mooretown Rancheria of Maidu Indians (MRMI)		Letter providing project information, determination of possible affects, transmittal of PA for tribal review and comment, request for involvement and review within 45 days.
4/19/2013	Incoming Voicemail	IBMI	Andrew Raimey	Received call from Andrew Raimey to coordinate Ione Band participation in PA with Randy Yonemura.
4/22/2013	Outgoing Phone Call	IBMI	Randy Yonemura	As requested in 4/19/13 voicemail, contacted Randy to discuss Ione Band concerns, participation in PA. Conversation and follow up communication efforts were documented in a telephone conversation log.
4/22/2013	Outgoing Email	IBMI	Randy Yonemura	Follow up email to 4/22/13 phone call to discuss Ione Band concerns, suggested several dates for possible meetings.
4/23/2013	Outgoing Email	BVR	Roselynn Lwenya	Follow up email to 2/15/13 email to request setting up a tribal meeting, emailed electronic versions of PA and supporting documents.
4/29/2013	Outgoing Email	IBMI	Randy Yonemura	As requested in 4/19/13 voicemail, contacted Randy to discuss Ione Band concerns, participation in PA. Follow up from 4/22/13 email.
5/6/2013	Incoming Email	UAIC	Marcos Guerrero	Requested updated signature page for the UAIC to sign the PA.
5/9/2013	Outgoing Email	UAIC	Marcos Guerrero	Response to 5/6/13 email letting Mr. Guerrero that the PA will not be ready for signature until fall/winter. Committed to continuing to keep the UAIC informed as the PA and EIS move forward.
5/13/2013	Outgoing Phone Call	IBMI	Randy Yonemura	As requested in 4/19/13 voicemail, contacted Randy to discuss Ione Band concerns, participation in PA. Follow up from 4/22/13 and 4/29/13 emails. Left
5/15/2013	Outgoing Phone Call	BVR	Roselynn Lwenya	Called to follow up from 4/5/13 letter, was directed to speak to Roselynn and call back the next day.
5/15/2013	Outgoing Phone Call	EDMT		Called to follow up from 4/5/13 letter, no answer.
5/15/2013	Outgoing Phone Call	ERMI	Cindi Smith	Called to follow up from 4/5/13 letter, was directed to speak to Cindi Smith. Cindi Smith was out.
5/15/2013	Outgoing Phone Call	IBMI	Yvonne Miller	Called to follow up from 4/5/13 letter, was told to reach Ms. Miller by email.
5/15/2013	Outgoing Phone Call	NEDM	Cosme Valdez	Called to follow up from 4/5/13 letter, no answer.
5/15/2013	Outgoing Phone Call	SSBMI	Daniel Fonseca	Called to follow up from 4/5/13 letter, no answer.

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5/15/2013	Outgoing Phone Call	SSBMI	Angela Rivera	Called to follow up from 4/5/13 letter, spoke with Ms. Rivera who said she would call back.
5/15/2013	Outgoing Phone Call	SVR	Cathy Bishop	Called to follow up from 4/5/13 letter, no option to leave a voicemail message.
5/15/2013	Outgoing Phone Call	WR	Mary Daniels-Tarango	Called to follow up from 4/5/13 letter, no answer.
5/15/2013	Outgoing Phone Call	MRMI	Guy Taylor	Called to follow up from 4/5/13 letter, no answer.
5/16/2013	Outgoing Email	IBMI	Yvonne Miller	Emailed Ms. Miller to follow up from 4/5/13 letter and 5/16/13 phone call, no answer.
5/16/2013	Outgoing Phone Call	EDMT		Called to follow up from 4/5/13 letter, left message.
5/16/2013	Outgoing Phone Call	NEDM	Cosme Valdez	Called back from 5/15/13 call, spoke with Mr. Valdez. He stated no comments on the PA, does not want to meet with the Corps.
5/16/2013	Outgoing Phone Call	ERMI	Cindi Smith	Call back from 5/15/13 call, left message with Ms. Smith's voicemail.
5/16/2013	Outgoing Phone Call	SSBMI	Daniel Fonseca	Call back from 5/15/13 call, left message with Mr. Fonseca's voicemail.
5/16/2013	Outgoing Phone Call	BVR	Roselynn Lwenya	Call back from 5/15/13 call, Roselynn said she received materials from 4/5/13 letter, will speak with the tribal committee and get back to the Corps.
5/16/2013	Outgoing Phone Call	SVR	Cathy Bishop	Call back from 5/15/13 call, no option to leave a voicemail message.
5/16/2013	Outgoing Phone Call	WR	Mary Daniels-Tarango	Call back from 5/15/13 call, left message with Ms. Daniels-Tarango's voicemail.
5/16/2013	Outgoing Phone Call	MITCR	Dennis Ramirez, Mike DeSpain	Called to follow up from 4/5/13 letter, called in AM, Mr. Ramirez and Mr. DeSpain were not available. Called in PM, no answer, left messages.
5/16/2013	Outgoing Phone Call	MRMI	Guy Taylor	Call back from 5/15/13 call, left message with Mr. Taylor's voicemail.
5/16/2013	Outgoing Phone Call	Cachil DeHe	Ambar Mohammed	Called to follow up from 4/5/13 letter, left message.
5/17/2013	Incoming Voicemail	MITCR	Mike DeSpain	Requested further information on project and asked if Cachil DeHe and UAIC had been contacted.
5/17/2013	Incoming Voicemail	IBMI	Randy Yonemura	Voicemail requesting to set up meeting between Corps and Ione Band.
5/17/2013	Incoming Voicemail	SSBMI	Andrew Godsey	Received voicemail from Mr. Godsey indicating the SSBMI would like the chance to comment on the PA.
5/20/2013	Outgoing Email	MITCR	Mike DeSpain	Provided information on project, consultation with Cachil DeHe, UAIC, offered to meet with Mechoopda and/or provide more information.
5/20/2013	Incoming Email	MITCR	Mike DeSpain	Recommended UAIC as the contact for the Section 106 for the project.
5/20/2013	Outgoing Email	IBMI	Randy Yonemura	Follow up email to 5/17/13 email requesting available dates for a tribal meeting.
5/20/2013	Outgoing Phone Call	TAM	Eileen Moon	Called to follow up from 4/5/13 letter, no answer.
5/20/2013	Outgoing Email	BVR	Roselynn Lwenya	Email request for tribal consultation meeting with BVR on 5/29/13.
5/23/2013	Outgoing Email	SSBMI	Andrew Godsey, Daniel Fonseca, Angela Rivera	Follow up to voice mail message from 5/17/13 providing electronic version of the PA for review and comment, requested comments from SSBMI.
5/23/2013	Incoming Email	SSBMI	Andrew Godsey	Acknowledgement of receipt of 5/23/13 email from Corps.

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5/29/2013	Consultation Meeting	BVR	Roselynn Lwenya, Rhonda Pope, Jeanette Simmons, Christy, Richard, Jane Rinck, Dan Tibbitts, Melissa Montag	Tribal consultation meeting to discuss project, Section 106 compliance, project schedule, draft PA, tribal involvement.
5/29/2013	Outgoing Phone Call	IBMI	Randy Yonemura	As requested in 4/19/13 voicemail, contacted Randy to discuss Ione Band concerns, participation in PA. Follow up from 4/22/13 and 4/29/13 emails and 5/13/13 voicemail. Left voicemail.
6/3/2013	Outgoing Email	BVR	Roselynn Lwenya	Email follow up to 5/29/13 tribal consultation meeting requesting comments from tribe by 6/28/13, providing additional project information.
6/5/2013	Outgoing Email	SSBMI	Andrew Godsey, Daniel Fonseca, Angela Rivera	Follow up to 5/23/13 providing electronic version of the PA for review and comment, requested comments by 6/28/13.
6/6/2013	Outgoing Letters	ERMI, WR, SVR, Kesner Flores, Cortina Band of Wintun Indians (CBWI), Marshall McKay, Yocha DeHe Wintun Nation, Rose Enos, Randy Yonemura, April Moore, Colfax-Todds Valley Consolidated Tribe (CTVCT), IBMI, SSBMI, TAM	Various	After receipt of additional Native American contacts from the NAHC, a second mailing of the 4/5/13 letter. Letter providing project information, determination of possible affects, transmittal of PA for tribal review and comment, request for involvement and review within 45 days.
6/13/2013	Incoming Letter	BVR	Rhonda Pope	Letter received 6/20/13 communicating the BVR comments on the draft PA, concerns about aspects of the PA and past tribal consultation efforts.
6/14/2013	Incoming Email	BVR	Roselynn Lwenya	Transmittal of attendee list requested in 6/3/13 email, noted postal mailing of comments from BVR on the PA.
6/18/2013	Outgoing Email	BVR	Roselynn Lwenya, Rhonda Pope	Acknowledge receipt of 6/14/13 email, responded to request for records and literature searches by noting confidentiality agreements with CHRIS.
6/19/2013	Incoming Phone Call	TAM	Grayson Coney	Mr. Coney called to express the interest of the T'Si-akim Maidu in the ARCF PA. He asked to be included in future EIS correspondence and said the tribe would be interesting in signing the PA as a concurring party. He also expressed that the tribe feels it would be the MLD for the project and that tribal monitors may be required. Conversation was documented in a telephone

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7/9/2013	Incoming Letter	Yocha Dehe Wintun Nation	Marshall McKay	Letter received 7/12/13 in response to 6/6/13 letter to tribes asking for comments on draft PA. The tribe reviewed the project and concluded it is not within the aboriginal territories of the tribe and declined comment on the project or the PA.
7/15/2013	Outgoing Email	BVR	Roselynn Lwenya, Rhonda Pope	Outgoing email in response to receipt of 6/13/13 letter from the tribe. Acknowledged receipt, plan to address comments from tribe, and request dates to meet to consult on project again at a later date.
9/13/2013	Outgoing Email	BVR	Roselynn Lwenya, Rhonda Pope	Requested dates to meet with Buena Vista in late October/early November regarding ARCF Project, PA, continuing consultation with the tribe.
9/18/2013	Incoming Email	UAIC	Marcos Guerrero	Contacted the Corps in regard to the Common Features Remaining Sites construction project and asked about status of the ARCF GRR PA.
9/18/2013	Outgoing Email	UAIC	Marcos Guerrero	Reply to 9/18/13 email, provided information that the PA is still in draft form, EIS is expected to be out for public review in the fall (UAIC and Shingle Springs will receive the EIS and draft PA for additional review) and PA is not expected to be signed until 2014, with construction to come in following years.
10/9/2013	Outgoing Phone Call		Rose Enos	Called regarding 6/6/13 letter and was told Ms. Enos was not available and to call back later.
10/9/2013	Outgoing Phone Call		April Wallace Moore	Called regarding 6/6/13 letter and spoke to Ms. Moore. She requested that a monitor be present during construction and to be kept up to date on the project.
10/9/2013	Outgoing Phone Call	CTVCT	Judith Marks	Called and left message regarding 6/6/13 letter.
10/9/2013	Outgoing Phone Call	CTVCT	Pamela Cubbler	Called regarding 6/6/13 letter, Ms. Cubbler indicated she would like to meet, suggested possible dates in late October.
10/9/2013	Outgoing Phone Call	IBMI	Anthony Burris	Called regarding 6/6/13 letter, message on phone said "the number is not assigned yet," unable to leave message.
10/9/2013	Outgoing Phone Call	SSBMI	Sam Daniels	Called regarding 6/6/13 letter, left message.
10/9/2013	Outgoing Phone Call	WR	Andrew Franklin	Called regarding 6/6/13 letter, was told to email Andrew Franklin.
10/9/2013	Outgoing Email	WR	Andrew Franklin	Emailed regarding 6/6/13 letter and as directed from 10/9/13 phone call to Mr. Franklin.
10/9/2013	Outgoing Email	WR	Steven Hutchason	Emailed regarding 6/6/13 letter.
10/9/2013	Outgoing Phone Call	ERMI	Art Angle	Called regarding 6/6/13 letter, was told to email Ren Reynolds.

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10/9/2013	Outgoing Email	ERMI	Ren Reynolds	Emailed regarding 6/6/13 and as directed from 10/9/13 phone call to Mr. Angle.
10/9/2013	Outgoing Email	SVR	Cathy Bishop	Emailed regarding 6/6/13 letter.
10/9/2013	Outgoing Email		Kesner Flores	Emailed regarding 6/6/13 letter.
10/9/2013	Outgoing Email	CBWI		Emailed regarding 6/6/13 letter.
10/10/2013	Outgoing Email		Randy Yonemura	Sent email regarding 6/6/13 letter and regarding project and comments on the PA.
10/10/2013	Outgoing Phone Call		Rose Enos	Called regarding 6/6/13 letter and following up from 10/9/13 call and was told Ms. Enos was not available and to call back later.
10/16/2013	Outgoing Email	BVR	Roselynn Lwenya, Rhonda Pope	Follow up to 9/13/13 email requesting dates to meet with Buena Vista in late October/early November regarding ARCF Project, PA, continuing consultation with the tribe.
10/18/2013	Outgoing Phone Call	CTVCT	Pamela Cubbler	Follow up to 10/9/13 phone call to schedule a meeting with the CTVCT and Ms. Cubbler. Left message.
10/18/2013	Outgoing Email	IBMI	Randy Yonemura, Yvonne Miller, IMBI Cultural Heritage	Follow up to previous attempts (last 5/20/13) to set up a meeting with the IBMI. Follow up to emails 5/20/13, 4/29/13, 4/22/13.
10/18/2013	Outgoing Phone Call		Rose Enos	Called following up from 6/6/13 letter and 10/9/13 and 10/10/13 phone calls. Ms. Enos stated she is concerned about burials and construction and asked to be kept on our mailing list and to be informed as the project moves forward. She did not want to meet with the Corps at this time.
10/18/2013	Outgoing Phone Call	BVR	Roselynn Lwenya	Follow up to 10/16/13 email requesting dates to meet with Buena Vista regarding the project, PA, continuing consultation with the tribe.
10/18/2013	Outgoing Phone Call	CTVCT	Judith Marks	Follow up to 6/6/13 letter and 10/9/13 phone call message.
10/18/2013	Outgoing Phone Call	IMBI	Anthony Burris	Follow up to 6/6/13 letter and 10/9/13 phone call, unable to leave message because message said "the number is not assigned yet."
10/18/2013	Outgoing Phone Call	SSBMI	Sam Daniels	Follow up to 6/6/13 letter and 10/9/13 phone call message, left message asking for SSBMI to contact the Corps if they have comments, concerns, or would like to meet.
10/18/2013	Outgoing Phone Call	WR	Steven Hutchason	Follow up to 10/9/13 email, Mr. Hutchason expressed interest in commenting on the PA, asked for a Word version to provide track changes. Ms. Montag committed to sending a Word version of the PA after current OC review and asked the WR to contact the Corps with any additional comments, concerns, or requests to meet.

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10/18/2013	Outgoing Phone Call	SVR	Cathy Bishop	Follow up to 6/6/13 letter and 10/9/13 email to try and leave a phone call message. Voice message on phone would not allow leaving a message.
10/18/2013	Outgoing Phone Call		Kesner Flores	Follow up to 6/6/13 letter and 10/9/13 email, Mr. Flores expressed an interest in reviewing the project area to determine if it is within his interest area. Ms. Montag committed to sending a Word version of the PA for review after current OC review is completed and a new draft is ready.
10/18/2013	Outgoing Phone Call	CBWI	Charlie Wright	Follow up to 6/6/13 letter and 10/9/13 email, left voice message with Chairman Charlie Wright.
11/15/2013	Incoming Phone Call	IBMI	Randy Yonemura	Phone call requesting that the Corps meet with the Bureau of Indian Affairs (Gerald Jones) regarding the Common Features Project and general requirements the Corps may have on water projects.
11/15/2013	Outgoing Phone Call	Bureau of Indian Affairs (BIA)	Gerald Jones	Spoke with Gerald Jones to get clarification on the proposed Corps/BIA/Ione Band meeting. Requested proposed agenda for proper coordination with Corps management.
11/19/2013	Outgoing Email	IBMI, BIA	Yonemura, Jones	Follow up to phone conversations on 11/15/13, requested agenda or discussion topics, proposed dates for a meeting. Provided contact information for Jane Rinck and Mark Gilfillan to coordinate if needed.
5/7/2014	Incoming Email	UAIC	Marcos Guerrero	Asked if the Corps has an electronic version of the Common Features PA.
5/13/2014	Outgoing Email	UAIC	Marcos Guerrero	Response to 5/7/14 email that a current draft of the Common Features PA is still being worked on, taking into account comments received so far and that Ms. Montag will be in touch when that draft is available for review.
6/5/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	As requested in emails dated 9/18/13 and 5/7/14, provided the draft PA and attachments in electronic form for review and comment. Mentioned an official letter will be transmitted soon with a review period in that letter. Asked to provide any questions or concerns, or interest in scheduling a meeting.
6/5/2014	Outgoing Email	WR	Steven Hutchason	As requested phone call on 10/18/13, provided the draft PA and attachments in electronic form for review and comment. Mentioned an official letter will be transmitted soon with a review period in that letter. Asked to provide any questions or concerns, or interest in scheduling a meeting.

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6/5/2014	Outgoing Email	BVR	Roselynn Lwenya, Rhonda Pope	Follow up to most recent email on 10/18/13, provided the draft PA and attachments in electronic form for review and comment. Mentioned an official letter will be transmitted soon with a review period in that letter. Asked to provide any questions or concerns, or interest in scheduling a meeting. Asked for three available dates in June and July to schedule a meeting.
6/5/2014	Outgoing Email		Kesner Flores	As requested phone call on 10/18/13, provided the draft PA and attachments in electronic form for review and comment. Mentioned an official letter will be transmitted soon with a review period in that letter. Asked to provide any questions or concerns, or interest in scheduling a meeting.
6/5/2014	Outgoing Email	WR	Steven Hutchason	Follow up to 6/5/14 email, earlier email did not attach PA attachments. Resent with PA attachments.
6/5/2014	Outgoing Email	BVR	Roselynn Lwenya, Rhonda Pope	Follow up to 6/5/14 email, earlier email did not attach PA attachments. Resent with PA attachments.
6/5/2014	Outgoing Email		Kesner Flores	Follow up to 6/5/14 email, earlier email did not attach PA attachments. Resent with PA attachments.

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6/12/2014	Outgoing Letters	SVR, IMBI, UAIC, TAM, CTVCT, SSBMI, WR, MITCR, EDMT, ERMI, BVR, Cachil DeHe, MRMI, NEDM, CBWI	Cathy Bishop, Anthony Burris, Jason Camp, Grayson Coney, Pamela Cubbler, Sam Daniels, Mary Daniels-Tarango, Michael DeSpain, Rose Enos, Kesner Flores, Daniel Fonseca, Nicholas Fonseca, Andrew Franklin, Reno Franklin, Marcos Guerrero, Steven Hutchason, Roselynn Lwenya, Judith Marks, Yvonne Miller, Ambar Mohammed, Eileen Moon, April Wallace Moore, Glenda Nelson, Rhonda Morningstar Pope, Dennis Ramirez, Guy Taylor, Cosme Valdez, Gene Whitehouse, Charlie Wright, Randy Yonemura	Letters providing final draft of PA, summarized previous actions to consult in April/June 2013, provided sensitivity assessment for review/comment, detailed previous Section 106 consultation efforts with SHPO, ACHP, CVFPP DWR, and tribes, communication with the public via letter, requested involvement in the PA as a potential concurring party, requested comments for consideration for the final PA, interest in scheduling a meeting, and to inform the Corps if there is interest in signing the PA as a Concurring Party and any edits to signature block.
6/20/2014	Incoming Email	UAIC	Marcos Guerrero	In response to 6/5/14 email, Mr. Guerrero asked if an MOA or addendum for sites within the APE with a high potential for adverse effects could be included with the PA, as well as if a map with sensitivity areas UAIC would like to have monitored could be included.

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6/23/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	Response to 6/20/14 email to iterate that the PA is the Corps' planned process to comply with Section 106, identify historic properties, and determine adverse effects once the project is authorized and that an MOA or addendum would be premature since historic properties have not yet been identified. Further iterated that the Corps welcomes UAIC's assistance identifying sensitive areas and would appreciate any information the tribe is willing to share.
6/26/2014	Outgoing Letters	BVR	Rhonda Pope, Roselynn Lwenya	Received 6/12/14 letters back as undeliverable. Re-dated letters to 6/26/14 and sent by mail again.
6/30/2014	Outgoing Email		Kesner Flores	Received hard copy of 6/12/14 letter back as unclaimed. Sent email to ask Mr. Flores for an address to re-send the hard copies to. Provided electronic copies of the documents (Letter to Mr. Flores, letter to SHPO, Word version of draft PA) sent in 6/12/14 postal mailing.
7/1/2014	Incoming Email	UAIC	Marcos Guerrero	Requested to meet regarding the project to share UAIC maps and to start to identify the need to ground truth locations. Requested to meet the week of July 21st.
7/1/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	Replied to 7/1/14 email from Mr. Guerrero that Ms. Montag is not available the week of the 21st, but would be available the week of the 14th, or the 28th or 29th. Or could scheduled for August. Also requested that UAIC let Ms. Montag know if they would like other Corps personnel to attend meeting.
7/14/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	Follow up to email sent on 7/1/14 to inquire if Mr. Guerrero would still like to schedule a meeting. Provided July 16-18, 28, 29, August 4-6 as available, or could schedule for later in August.
7/15/2014	Incoming Email	UAIC	Marcos Guerrero, Jason Camp	Response to 7/14/14 email, suggested 7/29/14 to meet.
7/15/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	Confirmed 7/29/14 would likely work, asked who from the Corps UAIC would like to have present at the meeting so Ms. Montag can coordinate.
7/15/2014	Incoming Email	UAIC	Marcos Guerrero, Jason Camp	Mr. Guerrero suggested the Corps PM and those in charge at SAFCA attend the 7/29/14 meeting.
7/15/2014	Returned Mailing	TAM	Grayson Coney	Received 6/12/14 letters back as unclaimed.
7/15/2014	Outgoing Phone Call	TAM	Grayson Coney	Called Mr. Coney to confirm mailing address, he confirmed the correct mailing and was out of town.
7/15/2014	Outgoing Letter	TAM	Grayson Coney	Resent 6/12/14 letter and draft PA.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
7/15/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	Reply to 7/15/14 email that Corps PM is not available on 7/29/14, suggested 8/1 or 8/4-8/6. Also explained that DWR is the non-Federal sponsor the ARCF Project and offered to coordinate their attendance at meeting, depending on UAIC's preference.
7/16/2014	Returned Mailing		Randy Yonemura	Received 6/12/14 letters back as unclaimed.
7/16/2014	Outgoing Phone Call		Randy Yonemura	Called and left message that 6/12/14 letter was returned and requested a current address to send the letter and final draft PA to.
7/16/2014	Outgoing Email		Randy Yonemura	Sent 6/12/14 letter, enclosures, and copy of 6/12/14 SHPO letter by email to email addresses on file. Asked if Mr. Yonemura has any questions or would like to discuss to contact Ms. Montag.
7/18/2014	Incoming Email		Randy Yonemura	Mr. Yonemura asked that the document be re-sent to him on 7/24/14. Prefers a hard copy be sent.
7/18/2014	Incoming Phone Call		Randy Yonemura	Mr. Yonemura asked that the document be re-sent to him on 7/24/14. Ms. Montag confirmed it will be sent by mail on 7/24/14. Mr. Yonemura said he would review the documentation and get back in touch with Ms. Montag.
7/22/2014	Incoming Email	UAIC	Marcos Guerrero	Reply to 7/15/14 email, suggested 8/4/14 or 8/5/14 for a meeting with the Corps and UAIC, agreed that DWR should be invited to attend.
7/22/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Andrew Godsey	Reply to 7/22/14 email, Ms. Montag said she would coordinate with DWR for availability for a 8/4/14 or 8/5/14 meeting. Noted that Mr. Guerrero included Mr. Godsey on his 7/22/14 and asked if UAIC is requesting a joint meeting with SSBMI invited to attend.
7/24/2014	Outgoing Letter		Randy Yonemura	Re-sent via USPS 6/12/14 mailing as Mr. Yonemura requested during phone call on 7/18/14 be sent on 7/24/14.
7/24/2014	Outgoing Email		Randy Yonemura	Followed up with email to Mr. Yonemura letting him know the 6/12/14 letter was re-sent in today's mail, as he requested.
7/28/2014	Incoming Email	UAIC	Marcos Guerrero	Email from Mr. Guerrero asking if there was still a meeting scheduled for 7/29/14 (which had been previously discussed to be moved to either 8/4/14 or 8/5/14).
7/29/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Andrew Godsey	Response to 7/28/14 email that Ms. Montag thought the 8/4/14 or 8/5/14 were the meeting dates being discussed. Suggested 8/5/14 and asked Mr. Guerrero to respond with an available time.
7/31/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Andrew Godsey	Follow up to 7/29/14 email to ask if 8/5/14 will work for a meeting, and the time UAIC would like to meet.
8/1/2014	Incoming Email	UAIC	Marcos Guerrero	Response to 7/31/14 email suggesting 10AM for meeting on 8/5/14.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
8/1/2014	Outgoing Meeting Request	UAIC, SSBMI	Marcos Guerrero, Jason Camp, Andrew Godsey	Sent meeting request for 8/5/14 for 10AM-12PM at UAIC offices in Auburn. Suggested the Corps would bring information on the project, the PA, and that DWR is planning to attend. Requested that UAIC indicate if there is specific information they are interested in or agenda items they want to discuss that they let Ms. Montag known.
8/1/2014	Incoming Email	UAIC	Marcos Guerrero	Accepted 8/5/14 meeting request.
8/4/2014	Incoming Email	UAIC	Melodi McAdams	Requested GIS shape files for APE to prepare for meeting on 8/5/14.
8/4/2014	Outgoing Email	UAIC	Melodi McAdams, Marcos Guerrero, Jason Camp	Sent GIS shape files of APE as requested, emphasized that the APE is very approximate and will be refined during planning and design for construction and potentially as a result of future environmental and cultural resources investigations.
8/4/2014	Incoming Email	UAIC	Melodi McAdams	Acknowledgement of receipt of 8/4/14 email with GIS shape files.
8/5/2014	Incoming Email	UAIC	Marcos Guerrero	Requested that Ms. Montag bring archeological site maps and a brief overview of cultural resources in the APE. Indicated UAIC's interest in discussing site eligibility, burial plans, and potential adverse effects.
8/5/2014	Consultation Meeting	UAIC, SSBMI, USACE, DWR	Peter Wakeland, Jason Camp, Melodi McAdams, Marcos Guerrero, Josh Stewart, Donald Rey, Andrew Godsey, Kara Perry, Dan Tibbitts, Melissa Montag, David Martasian, Erin Brehmer, Jacqueline Wait	Meeting with UAIC and SSBMI to discuss concerns of the tribes regarding the ARCF Project including treatment of burials, efforts to identify cultural resources of significance to the tribes, tribal monitors, the draft programmatic agreement. All parties agreed regular scheduled meetings would help ease the process along, comments on the programmatic agreement were requested from the tribes by late September for consideration in the version included in the draft EIS/EIR.
8/5/2014	Outgoing Email	SSBMI	Andrew Godsey, Kara Perry	As requested during consultation meeting with UAIC and SSBMI on 8/5/14, transmitted electronic version of the PA and attachments. The previous draft version of the PA was also transmitted via email on 5/23/13 and 6/5/13.
8/5/2014	Outgoing Email	UAIC	Melodi McAdams, Marcos Guerrero, Jason Camp	Requested meeting attendee list from 8/5/14 meeting with UAIC, SSBMI, Corps and DWR.
8/6/2014	Outgoing Email	SSBMI	Andrew Godsey, Kara Perry	Re-send of 8/5/14 email with draft PA attachments. Email sent on 8/5/14 did not attach the PA attachments correctly.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
8/7/2014	Incoming Email	UAIC	Melodi McAdams	Reply to 8/5/14 email request, sent meeting attendees list from 8/5/14 meeting.
8/19/2014	Incoming Letter	UAIC	Marcos Guerrero	(Letter received 10/16/14) Follow up letter from 8/5/14 consultation meeting requesting the Corps and DWR provide UAIC with: pre-burial plan, confidentiality and data sharing agreement, tribal signatory status on PA, tribal preference on scientific analysis, contractor selection, compensation for tribal monitors and information from tribes.
9/2/2014	Outgoing Email	UAIC, SSBMI	Marcos Guerrero, Jason Camp, Andrew Godsey	Sent link to Doodle poll to schedule next meeting with UAIC and SSBMI for late October/early November. Requested response to poll by 9/17/14. Welcomed receiving any comments on the draft programmatic agreement.
9/3/2014	Incoming Email	UAIC	Marcos Guerrero	Responded with available dates for next meeting, asked when comments on PA are due.
9/3/2014	Outgoing Email	UAIC, SSBMI, DWR	Jason Camp, Marcos Guerrero, Andrew Godsey, Dan Tibbitts, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez	Replied to 9/3/14 email from Mr. Guerrero that the last comment review period for the draft of the PA closed July 12, 2014, but that review of the draft is still open. The draft EIS/EIR will include comments received up to August 2014.
9/3/2014	Incoming Email	SSBMI	SSBMI	Responded to Doodle poll with available dates.
9/4/2014	Outgoing Email	UAIC, SSBMI, DWR	Jason Camp, Marcos Guerrero, Andrew Godsey, Dan Tibbitts, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez	Asked potential meeting attendees to double check their available dates since to date with six respondents there is not a date that lines up for a meeting from October 31-November 19.
9/24/2014	Outgoing Meeting Request	UAIC, SSBMI, DWR	Jason Camp, Marcos Guerrero, Andrew Godsey, Dan Tibbitts, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez	Sent meeting request for 11/3/14 10:00-12:00 meeting at Corps offices.
9/24/2014	Incoming Email	DWR	David Martasian	Declined 11/3/14 meeting request.
9/24/2014	Incoming Email	DWR	Anecita Agustinez	Accepted 11/3/14 meeting request.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
9/24/2014	Incoming Email	UAIC	Marcos Guerrero	Accepted 11/3/14 meeting request.
9/24/2014	Incoming Email	DWR	Erin Brehmer	Accepted 11/3/14 meeting request.
10/1/2014	Incoming Email	DWR	Jacqueline Wait	Declined 11/3/14 meeting request.
10/28/2014	Outgoing Email	UAIC, SSBMI, DWR	Jason Camp, Marcos Guerrero, Andrew Godsey, Dan Tibbitts, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez	Sent DRAFT meeting agenda for 11/3/14, requested any additional topics for discussion ASAP.
10/31/2014	Incoming Email	SSBMI	Kara Perry	Accepted 11/3/14 meeting request.
10/31/2014	Incoming Email	SSBMI	Cynthia Franco	Accepted 11/3/14 meeting request.
11/3/2014	Consultation Meeting	UAIC, SSBMI, DWR	Marcos Guerrero, Kara Perry, Cynthia Franco, Erin Brehmer, Anecita Agustinez	Consultation meeting to discuss ongoing ARCF project schedule and activities, outstanding topics: pre-burial plan, confidentiality and data sharing agreement, tribal signatory status on PA, tribal preference on scientific analysis, contractor selection, compensation for tribal monitors and information from tribes. Proposed a field visit of Natomas area in January.
11/6/2014	Incoming Email	UAIC	Marcos Guerrero	Asked to be sent the RFP for ARCF cultural services, asked if the tribe would be able to submit a bid and asked to be integrated into this process.
11/7/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Josh Garcia	In response to 11/6/14 email, Ms. Montag stated cultural resources work under the ARCF PA is not moving forward for several months or longer, will likely be awarded under the Planning IDIQ. Provided information that a new Planning IDIQ is likely to be advertised in the next 30-60 days, that the Corps is looking for a firm to address multiple disciplines (planning, environmental, economics, cultural), to check https://www.fbo.gov/ for listings of federal contracts, and further information cannot be provided because it could be perceived as providing a potential contractor an unfair advantage. For further information, suggested contacting Josh Garcia as the Planning IDIQ COR.

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11/7/2014	Outgoing Meeting Request	UAIC, SSBMI, DWR	Jason Camp, Marcos Guerrero, Andrew Godsey, Kara Perry, Cynthia Franco, Dan Tibbitts, Sara Schultz, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez, Mark Gilfillan	Sent meeting request for 1/6/15 field visit to Natomas Basin.
11/7/2014	Outgoing Meeting Request	UAIC, SSBMI, DWR	Jason Camp, Marcos Guerrero, Andrew Godsey, Kara Perry, Cynthia Franco, Dan Tibbitts, Sara Schultz, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez, Mark Gilfillan	Sent backup meeting request for 1/13/15 field visit to Natomas Basin.
11/7/2014	Incoming Email	SSBMI	Kara Perry	Accepted 1/6/15 and 1/13/15 meeting requests.
11/7/2014	Incoming Email	DWR	Jacqueline Wait	Accepted 1/6/15 and 1/13/15 meeting requests.
11/7/2014	Incoming Email	USACE	Sara Schultz	Accepted 1/6/15 and 1/13/15 meeting requests.
11/7/2014	Incoming Email	USACE	Dan Tibbitts	Accepted 1/6/15 and 1/13/15 meeting requests.
11/7/2014	Incoming Email	UAIC	Marcos Guerrero	Accepted 1/6/15 and 1/13/15 meeting requests.
11/7/2014	Incoming Email	USACE	Mark Gilfillan	Accepted 1/6/15 meeting, declined 1/13/15 meeting.
11/10/2014	Incoming Email	SSBMI	Cynthia Franco	Accepted 1/6/15 meeting request.
11/12/2014	Incoming Email	DWR	Erin Brehmer	Accepted 1/6/15 and 1/13/15 meeting requests.
11/12/2014	Incoming Email	DWR	Anecita Agustinez	Accepted 1/6/15 and 1/13/15 meeting requests.
12/1/2014	Incoming Email	SSBMI	Daniel Fonseca	Accepted 1/6/15 meeting request.
12/17/2014	Incoming Email	UAIC	Marcos Guerrero	In response to 6/5/14 email transmittal of electronic version of draft PA, UAIC submitted track changes of comments on the document.
12/18/2014	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Melodi McAdams, Donald Rey	In response to 12/17/14 email, thanked Mr. Guerrero for providing UAIC comments on the draft PA.

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
12/29/2014	Outgoing Email		Jason Camp, Marcos Guerrero, Andrew Godsey, Kara Perry, Cynthia Franco, Dan Tibbitts, Sara Schultz, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez, Mark Gilfillan	Sent updated meeting request for 1/6/15 field visit. Included meeting location, information on weather, tentative agenda.
12/29/2014	Incoming Email	UAIC	Marcos Guerrero	Accepted 1/6/15 meeting request.
1/5/2015	Incoming Email	UAIC	Jason Camp	Accepted 1/6/15 meeting request.
1/6/2015	Field Visit	UAIC, SSBMI, DWR, RD1000	Melissa Montag, Dan Tibbitts, Jason Camp, Marcos Guerrero, Donald Rey, Melodi McAdams, Kara Perry, Cynthia Franco, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez, Paul Devereux	Field visit of Natomas Basin, beginning south on Garden Highway with stops at San Juan Road, at pump station, Natomas Cross Canal, Pleasant Grove Creek Canal, Natomas East Main Drain Canal. Corps staff provided information on past NLIP work completed, types of alternatives being considered for Natomas, plans for compliance with Section 106.
1/6/2015	Outgoing Email	UAIC, SSBMI, DWR, RD1000	Melissa Montag, Dan Tibbitts, Jason Camp, Marcos Guerrero, Donald Rey, Melodi McAdams, Kara Perry, Cynthia Franco, David Martasian, Erin Brehmer, Jacqueline Wait, Anecita Agustinez, Paul Devereux	Ms. Montag transmitted the meeting attendance sheet for the 1/6/15 meeting and stated she would look to April to schedule the next quarterly meeting. Provided the general information that the draft EIS/EIR for the ARCF GRR will be released for public review soon and UAIC and SSBMI are on the mailing list to receive copies. Ms. Montag asked that if there is anything to discuss before the next meeting to please get in contact with her.

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1/8/2015	Consultation Meeting	SSBMI	Kara Perry, Cynthia Franco	Met with SSBMI representatives to specifically address Natomas Reach H borings, but also touched on overall ARCF GRR topics. Ms. Perry requested an electronic copy of the draft PA (previously emailed to Andrew Godsey 5/23/13 and Mr. Godsey and Ms. Perry on 8/61/14).
1/8/2015	Outgoing Email	SSBMI	Kara Perry, Cynthia Franco, Mark Gilfillan	Email transmittal of ARCF draft PA and PA attachments as requested in 1/8/15 consultation meeting. Explained that the PA covers Natomas activities, as well as future work in other basins, welcomed comments from the tribe.
1/8/2015	Outgoing Email	SSBMI	Kara Perry, Cynthia Franco, Mark Gilfillan	Resent 1/8/15 email with PA attachments only.
1/8/2015	Incoming Phone Call	BVR	Roselynn Lwenya	Ms. Lwenya returned a phone call regarding work for the ARCF Reach H project. Included in the conversation, Ms. Montag expressed that if BVR would like to meet to discuss the ARCF projects or any other Corps projects to notify the Corps. Ms. Lwenya stated she would provide this information to the BVR board and would respond to Ms. Montag if the tribe would like to meet.
3/17/2015	Outgoing Email	BVR, IBMI, SSBMI, UAIC, WR, MITCR, CWEPA, TAM, ERMI, NEDM,	Anthony Burris, Jason Camp, Grayson Coney, Michael DeSpain, Kesner Flores, Daniel Fonseca, Nicholas Fonseca, Reno Franklin, Marcos Guerrero, Steven Hutchason, Roselynn Lwenya, Yvonne Miller, Rhonda Morningstar Pope, Dennis Ramirez, Cosme Valdez, Randy Yonemura	Transmitted link to webpage where draft EIS/EIR and GRR are available for review from March 20 to May 4. Provided information on public workshop meetings. Sent by email to those addresses available, stated a letter and CD would also be sent by mail.
3/17/2015	Incoming Email		Kesner Flores	3/17/15 email to Mr. Flores returned as undeliverable.
3/17/2015	Incoming Email	ERMI	ERMI	3/17/15 email to main info address for ERMI returned as undeliverable.
3/17/2015	Incoming Email	NEDM	Cosme Valdez	3/17/15 email to Mr. Valdez returned as undeliverable.
3/17/2015	Incoming Email	TAM	TAM	3/17/15 email to main info address for TAM returned as undeliverable.
3/17/2015	Incoming Email	UAIC	Marcos Guerrero	In response to 3/17/15 email, requested the confidential cultural resources appendix and any survey, inventory, or evaluation reports.

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3/19/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	In reply to 3/17/15, stated there is not confidential information in the cultural resources appendix relating to cultural resources and that the Corps has not yet conducted any survey, inventory or evaluation for the Common Features Project. Transmitted the archaeological sensitivity assessment.
3/19/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Melodi McAdams	Transmitted GIS shape files as was requested in February 2015 UAIC Outreach Day. These GIS shape files were previously sent 8/4/15.
3/19/2015	Incoming Email	UAIC	Melodi McAdams	In reply to 3/19/15, acknowledged receipt of GIS shape files.
3/23/2015	Incoming Email	UAIC	Marcos Guerrero	Asked for the MMRP for the Common Features and Marysville Ring Levee Projects.
3/24/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	In reply to 3/23/15 email, asked for definition of MMRP.
3/24/2015	Incoming Email	UAIC	Marcos Guerrero	MMRP is Mitigation and Monitoring Report Plan, as part of EIR.
3/24/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	Provided contact information for DWR staff POCs for Common Features and Marysville Ring Levee Projects.
4/13/2015	Outgoing Email and Poll	UAIC, SSBMI, DWR	Marcos Guerrero, Jason Camp, Andrew Godsey, Daniel Fonseca, Kara Perry, Cynthia Franco	Email request to set up next quarterly meeting with UAIC and SSBMI in May. Proposed five different days/times to possibly meet, asked for any agenda topics to be forwarded.
4/13/2015	Incoming Poll Response	SSBMI		Responded with availability in poll.
4/14/2015	Incoming Poll Response	UAIC	Marcos Guerrero	Responded with availability in poll.
4/16/2015	Incoming Email	UAIC	Marcos Guerrero	Email with comments from UAIC on the DEIS/DEIR.
4/17/2015	Outgoing Meeting Request	UAIC, SSBMI, DWR	Marcos Guerrero, Jason Camp, Andrew Godsey, Daniel Fonseca, Kara Perry, Cynthia Franco	Sent meeting request for meeting on 5/19/15 from 10AM-12PM for next quarterly meeting with UAIC and SSBMI. Agenda to come.
4/17/2015	Incoming Email	SSMBI	Cynthia Franco, Kara Perry	Accepted meeting request for 5/19/15 meeting.
4/17/2015	Incoming Email	UAIC	Marcos Guerrero	Accepted meeting request for 5/19/15 meeting.
4/17/2015	Incoming Email	UAIC	Marcos Guerrero	Received comments on DEIS/DEIR from UAIC.

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4/20/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	Acknowledged receipt of comments from 4/17/15.
4/20/2015	Incoming Email	UAIC	Marcos Guerrero	Asked when the comment period for DEIS/DEIR ends.
4/20/2015	Outgoing Email	UAIC	Marcos Guerrero	Responded to 4/20/15 email that comment period for DEIS/DEIR ends 5/4/15.
4/20/2015	Incoming Email	UAIC	Jason Camp	Accepted meeting request for 5/19/15 meeting.
4/21/2015	Incoming Email	UAIC	Marcos Guerrero	Asked if UAIC can be an invited signatory to the PA.
4/21/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	Replied to 4/21/15 email that Ms. Montag would have to get back to Mr. Guerrero regarding this question.
4/29/2015	Outgoing Email	UAIC	Marcos Guerrero	Provided information that comment review period on the DEIS/DEIR has been extended two weeks until 5/18/15.
5/15/2015	Outgoing Email	UAIC, SSBMI, DWR	Marcos Guerrero, Jason Camp, Andrew Godsey, Daniel Fonseca, Kara Perry, Cynthia Franco	Sent draft meeting agenda for 5/15/15, requested any additional topics for discussion.
5/18/2015	Incoming Letter	UAIC	Gene Whitehouse	Letter to Colonel Farrell requesting Government to Government consultation, notification to the Corps about sites of importance to the tribe in the project area, requesting signatory party status on the PA.
5/19/2015	Consultation Meeting	UAIC, SSBMI, DWR	Marcos Guerrero, Jason Camp, Melodi McAdams, Kara Perry, Cynthia Franco	Scheduled consultation meeting. Topics included an update on the EIS/EIR, draft PA. Requested to know if the tribes have any information on sites or areas of interest within the project area. Tribes expressed concerns about sharing information on sites with the Corps, and with indicating any information on sites of importance. Asked about the project phasing and construction. Corps staff reiterated that phases in Natomas Basin are at early stages of design and suggested those designs could be shared with the tribes so they could determine what concerns the tribes may have. Shape files for current design phases will be sent to tribes and a follow up meeting in July or August to discuss those phases. Mr. Guerrero and Mr. Camp asked if UAIC will be invited as a signatory, Ms. Montag stated that decision is still being considered by the Corps.
5/27/2015	Incoming Email	UAIC	Marcos Guerrero	Email requesting maps of areas currently being consulted on and designed for the project in the Natomas area. Stated UAIC would like to schedule a follow up meeting and field visit to show areas they are most concerned with and to discuss TCPs and historic properties.

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5/27/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp	In reply to 5/27/15 email, stated that GIS shape files have been requested internally but not received and will be forwarded on as soon as they are available. Stated the Corps is very interested in hearing the concerns from UAIC and continuing to discuss TCPs and historic properties.
6/16/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Melodi McAdams	Provided PDF of project areas for Natomas Reach I, shape files for project areas, and information/description on those areas. Requested potential dates to meet in July, who the tribe would like present at the meeting.
6/16/2015	Outgoing Email	SSBMI	Kara Perry, Cynthia Franco, Daniel Fonseca	Provided PDF of project areas for Natomas Reach I, shape files for project areas, and information/description on those areas. Requested potential dates to meet in July, who the tribe would like present at the meeting.
6/26/2015	Incoming Email	UAIC	Marcos Guerrero	In reply to 6/16/15 email, Mr. Guerrero suggested 7/6/15 as a possible meeting date and expressed concerns about the proposed APE. Stated no other tribes needed to be in attendance at meeting on 7/6/15.
6/26/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Melodi McAdams	In reply to 6/26/15 email, Ms. Montag stated she would coordinate the 7/6/15 date and would get back to UAIC.
6/30/2015	Outgoing Meeting Request	UAIC	Marcos Guerrero, Jason Camp, Melodi McAdams	Sent meeting request for site visit for Natomas Reach I for 7/6/15.
7/1/2015	Incoming Email	UAIC	Marcos Guerrero	Accepted 7/6/15 meeting request.
7/1/2015	Incoming Email	UAIC	Jason Camp	Accepted 7/6/15 meeting request.
7/7/2015	Outgoing Letter	UAIC	Gene Whitehouse	Letter requesting additional details and specific information regarding comments from UAIC in 4/16/15 email.
8/6/2015	Consultation Meeting	UAIC/Corps	Bill Welsh, Mike Kynett (Corps), Mark Boedker (Corps), Robin Rosenau (Corps), Marcos Guerrero, Melodi McAdams (UAIC), Donald Skip Rey (UAIC)	Staff-to-staff level consultation meeting regarding Natomas Reach I project and ARCF DEIS/DEIR, sites of concern to the tribe, construction activities of concern to the tribe. Additional topics included involvement of the tribe in surveying and monitoring, reporting, preferences on data recovery and curation, professional qualifications.
8/10/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Melodi McAdams	Sent comment responses to DEIS/DEIR and requested clarification/correction on notes taken during 8/6/15 consultation meeting with UAIC. Requested responses by 8/14/15.

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8/17/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Melodi McAdams	Transmitted meeting minutes from 8/6/15 meeting, attached email and document from 8/10/15 and requested any comments no later than 8/19/15.
8/24/2015	Outgoing Letter	UAIC	Gene Whitehouse	In response to 5/18/15 letter from UAIC, committed to continuing Government to Government consultation through Corps' Tribal Liaison, invited UAIC be be a concurring party on the PA.
11/30/2015	Incoming Email	UAIC	Marcos Guerrero	Mr. Guerrero asked if the Corps would still accept comments from UAIC on the draft EIS/EIR, despite comments being due 5/18/15.
12/7/2015	Outgoing Letters	Cortina Wintun, SVR, WR, CVTCT, Cachil Dehe, Mooretown Rancheria, Mechoopda, UAIC, TAM, SSBMI, NEDM, IBMI, ERMI, EDM, BVR, interested Native Americans	Various chairpersons, as well as Kesner Flores, Randy Yonemura, Rose Enos.	Letter transmitting the signed and executed PA and requesting parties to sign as concurring parties if they choose to.
12/31/2015	Outgoing Email	UAIC	Marcos Guerrero, Jason Camp, Courtney Coyle, Melodi McAdams, Jane Rinck, Mark Gilfillan	In response to 11/30/15 email, Ms. Montag stated that although the comment review period on the draft EIS/EIR is closed and the final document is being prepared, the Corps welcomes any comments from the tribe at any time, and anticipates extensive interactions with tribes for cuture environmental compliance efforts and while executing the stipulations of the PA.

American River Common Features Project Public Involvement Consultation Record*

*May not include all communication for project.

12/31/15

Date	Type of Contact	Organization	Person Contacted	Contents of Communication
4/5/2013	Outgoing Letter	Various Historic Societies/Groups of Interest	To all interested parties	Letter providing project description and map, requesting any information on significant cultural resources.
4/8/2013	Incoming Email	Center for Sacramento History	Pat Johnson	Acknowledgement of 4/5/13 letter.
4/22/2013	Returned Letter	California Historical Building Safety Board		4/5/13 letter returned marked as "Not Deliverable as Addressed, Unable to Forward."
4/22/2013	Returned Letter	California Institute for Rural Studies		4/5/13 letter returned marked as "Attempted Not Known."
4/22/2013	Returned Letter	Discovery Museum of Sacramento		4/5/13 letter returned marked as "Not Deliverable as Addressed, Unable to Forward."
4/22/2013	Returned Letter	West Sacramento Museum and Visitor Center		4/5/13 letter returned marked as "Not Deliverable as Addressed, Unable to Forward."
11/19/2013	Returned Letter	Association for Northern California Records and Research		4/5/13 letter returned marked as "Return to Sender."
12/7/2015	Outgoing Letter	Society for California Archaeology, Yolo County Historical Society, West Sacramento Historical Society, Sutter County Historical Society, Golden Gate State Museum, Fair Oaks Historical Society, Sacramento County Historical Society, Central Valley Flood Protection Board		Letter transmitting the signed and executed PA and requesting parties to sign as concurring parties if they choose to.

American River Common Features GRR

EIS Cultural Resources Appendix

Enclosure 3

Consultation with the SHPO

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

FEB 0 1 2012

Mr. Milford Wayne Donaldson
State Historic Preservation Officer
Office of Historic Preservation
P.O. Box 942896
Sacramento, California 94296-0001

Dear Mr. Donaldson:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project near Sacramento, California. The ARCF Project is being developed to reduce flood risk to the City of Sacramento, including the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River. The ARCF Project is a part of the Common Features General Reevaluation Report. The non-Federal sponsor for the ARCF Project is the State of California Central Valley Flood Protection Board.

Pursuant to 36 CFR Part 800.3 we are initiating the Section 106 process for the ARCF Project and we are asking for your concurrence with our determination of the area of potential effects (APE) for the ARCF Project in accordance with 36 CFR Part 800.4(a)(1). We are also asking for your comments on our proposed efforts to identify historic properties pursuant to 36 CFR Part 800.4. We are also proposing to develop a programmatic agreement (PA) for the ARCF Project in accordance with 36 CFR Part 800.14(b).

The Corps has undertaken or has been the regulatory agency for multiple efforts to reduce flood risk in the region and the Sacramento and American River watersheds. Many of these efforts have resulted from authority given in the Water Resources Development Acts of 1996 and 1999. Because of the complex nature of these different studies and efforts, we have prepared a short summary document describing the authorizations for the projects in the region, what has been constructed, what agency or partner completed the construction, previous compliance with the National Historic Preservation Act of 1966, as amended, and the National Environmental Policy Act of 1969, and the planned future activities within the watersheds (Enclosure 1).

The APE for the ARCF Project includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; approximately 18 miles of the east bank of the Sacramento River immediately downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; approximately 5 miles of the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; approximately 8 miles of the Natomas East Main Drainage Canal; approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison

Creek; approximately 1.5 miles of the north and south banks of Dry/Robla Creeks; and approximately 2 miles of the north and south banks of Arcade Creek. The APE is shown in Enclosure 2.

We have completed a records and literature search of the APE at the North Central Information Center at California State University, Sacramento and at the Northeast Information Center at California State University, Chico in 2008. The records and literature search identified 136 cultural resources and 285 surveys and inventories conducted within and nearby the ARCF Project APE. Portions of the APE have been previously surveyed but the majority of the APE has not been intensively surveyed for cultural resources in the last ten years.

Because the APE for the ARCF Project covers a large geographic area and is largely located along rivers, which have been shown to be sensitive for buried resources, we are developing two predictive models to extrapolate archaeological sensitivity over un-surveyed portions of the APE. The first model will be a general model of site locations that will anticipate the likelihood that any one or more spots in the study area will be in an archaeological site. The second model will highlight portions of the study area where we would be more or less likely to find buried archaeological materials. Once the predictive models have been completed we plan to demonstrate their accuracy through field testing. Ultimately we plan to use the predictive models to assist with planning and evaluating alternatives to avoid adverse effects to cultural resources whenever and wherever possible.

A number of possible measures may be considered in order to reduce the flood risk to the City of Sacramento. The measures under consideration are described in Enclosure 1. Because the ARCF Project will be a complex undertaking that may be constructed in multiple phases and may result in adverse effects to historic properties, we are proposing to develop a PA to govern the implementation of our compliance efforts. We are working on a draft PA and plan to coordinate the execution of the PA with you and other potential signatory and concurring parties.

We obtained a list of potentially interested Native Americans from the Native American Heritage Commission and contacted them in letters dated May 4, 2011 to inquire if they have knowledge of locations of archeological sites, or areas of traditional cultural value or concern in or near the ARCF Project APE. Both the United Auburn Indian Community of the Auburn Rancheria and the Mechoopda Indian Tribe of Chico Rancheria have contacted us and expressed interest in the ARCF Project. We plan to continue to communicate with those tribes, as well as others that may have an interest in the ARCF Project as we comply with Section 106 and develop a PA.

Pursuant to 36 CFR Part 800.4(a)(1), we request your comments on our preliminary determination of the APE for the ARCF Project. We also request any comments your office may have of our proposed efforts to identify historic properties under 36 CFR Part 800.4 and our plan

to develop a PA in accordance with 36 CFR Part 800.14(b). We would like to schedule a meeting to meet with you and your staff to discuss the ARCF Project and answer any questions your may have about the project or our proposed Section 106 compliance efforts.

Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information about the Section 106 compliance and consultation, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Milford Wayne Donaldson
State Historic Preservation Officer
Office of Historic Preservation
P.O. Box 942896
Sacramento, California 94296-0001

JUL 16 2012

Dear Mr. Donaldson:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to transmit a draft programmatic agreement (PA) for the proposed American River Common Features (ARCF) Project near Sacramento, California. The ARCF Project is being developed to reduce flood risk to the City of Sacramento, including the Natomas Basin, areas along the north and south banks of the American River, and the east bank of the Sacramento River. The ARCF Project is a part of the Common Features General Reevaluation Report. The non-Federal sponsor for the ARCF Project is the State of California Central Valley Flood Protection Board.

We previously contacted you in a letter dated February 1, 2012, asking for your concurrence with our determination of the area of potential effects (APE), for your comments on our proposed efforts to identify historic properties, and to inform you of our proposed plan to develop a PA for the ARCF Project (Enclosure 1). The ARCF Project will be a complex undertaking that may be constructed in multiple phases, the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and it may result in adverse effects to historic properties. As a result, pursuant to 36 CFR § 800.14(b), we have drafted a PA to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project. The draft PA is enclosed for your review and comment (Enclosure 2).

Included as attachments to the PA are a map of the APE (Enclosure 2, Attachment 1) and a project description for the ARCF Project (Enclosure 2, Attachment 2). We have also contacted the Advisory Council on Historic Preservation to ask for their comments on the proposed ARCF Project. They have also received the draft PA for their review and comment.

On several prior occasions we have been in contact with potentially interested Native Americans, asking for their participation in the Section 106 compliance efforts for the ARCF Project. We have met with the United Auburn Indian Community of the Auburn Rancheria and Shingle Springs Band of Miwok Indians on the ARCF Project. As we develop the PA and comply with Section 106, we will continue to involve these tribes, as well as other tribes identified by the Native American Heritage Commission as having an interest in the APE.

Pursuant to 36 CFR § 800.14(b)(2)(i), we request your involvement in the development of the PA for the ARCF Project. We ask that you review the enclosed PA and provide us with comments within 45 days. Additionally, we would like to schedule a time to meet with you and your staff to discuss the ARCF Project and answer any questions you may have about the project or our proposed Section 106 compliance efforts.

Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information about the Section 106 compliance and consultation, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Dr. Carol Roland-Nawi
State Historic Preservation Officer
Department of Parks and Recreation
Office of Historic Preservation
1725 23rd Street, Suite 100
Sacramento, CA 94296-0001

Dear Dr. Roland-Nawi:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), we are writing to continue consultation on the American River Common Features (ARCF) Project near Sacramento, California. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We have previously contacted your office in letter dated February 1, 2012, which documented our determination of the area of potential effects (APE), and requested comments on our efforts to identify historic properties and our plan to develop a programmatic agreement (PA). In a letter July 16, 2012, we transmitted the draft PA for review and requested comments, provided an update of consultation with the Advisory Council on Historic Preservation (ACHP) and potentially interested Native American tribes, and requested to meet on the ARCF Project. Staff from my office met with Ms. Susan Stratton, Mr. Dwight Dutsche, and Mr. Brendan Greenaway of your office in meetings on October 29, 2012 and November 5, 2012 to discuss the ARCF Project and the planned efforts to comply with Section 106 of the NHPA. Previous consultation with your office on the ARCF Project is included in Enclosure 1.

Pursuant to 36 CFR Part 800.3 we are requesting your concurrence with our determination of the area of potential effects (APE) for the ARCF Project in accordance with 36 CFR Part 800.4(a)(1). We are also providing information on our efforts to identify historic properties pursuant to 36 CFR Part 800.4 and we

are providing the most recent final draft of the PA for the ARCF Project for your final review and comment before we plan to execute the PA. The final draft of the PA is included in Enclosure 2.

The Corps has undertaken or has been the regulatory agency for multiple efforts to reduce flood risk in the region and the Sacramento and American River watersheds. Many of these efforts have resulted from authority given in the Water Resources Development Acts of 1996 and 1999. Because of the complex nature of these different studies and efforts, we have prepared a short summary document describing the authorizations for the projects in the region, what has been constructed, what agency or partner completed the construction, previous compliance with the National Historic Preservation Act of 1966, as amended, and the National Environmental Policy Act of 1969, and the planned future activities within the watersheds (Enclosure 2, Attachment 4).

We have determined that the APE for the ARCF Project includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; the Sacramento Bypass and Sacramento Weir; approximately 4 miles of the Pleasant Grove Creek Canal; approximately 8 miles of the Natomas East Main Drainage Canal; approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal. Most of the activities planned for the ARCF Project will be confined to the levees or the immediately adjacent river banks near the levees, however, the APE for the ARCF Project includes areas within the American River Parkway and along Dry and Robla Creeks because it is anticipated that there may be visual or landscape impacts to potential historic properties in those areas. The APE is shown in Enclosure 2, Attachment 3.

We have completed a records and literature search of the APE at the North Central Information Center at California State University, Sacramento and at the Northeast Information Center at California State University, Chico in 2006 and 2007, and updated in 2010 and 2013. The records and literature search identified 61 known cultural resources within and nearby the ARCF Project APE. Portions of the APE have been previously surveyed but the majority of the APE has not been intensively surveyed for cultural resources in the last ten years.

Because the APE for the ARCF Project covers a large geographic area and is mostly located along rivers, which have been shown to be sensitive for buried resources, we have developed two predictive models to extrapolate archaeological sensitivity over un-surveyed portions of the APE. The first model is a general model of site locations that anticipates the likelihood that any one or more spots in the study area will be in an archaeological site. The second model highlights portions of the APE where we would be more or less likely to find buried archaeological materials. Ultimately we plan to use the predictive models to assist with planning and evaluating alternatives to avoid adverse effects to cultural resources whenever and wherever possible. The models and detailed information on the archaeological sensitivity assessment are included in Enclosure 3. We request any comments you may have on the archaeological sensitivity assessment.

A number of possible measures may be considered in order to reduce the flood risk to the City of Sacramento. The measures under consideration are described in Attachment 4 of Enclosure 2. Because the ARCF Project will be a complex undertaking that may be constructed in multiple phases and may result in adverse effects to historic properties, we have developed a PA to govern the implementation of our compliance efforts. The PA has been provided to your office, the ACHP, CVFPP, Department of Water Resources (DWR), SAFCA, and potentially interested American Indian Tribes and interested American Indian individuals for review and comment. In a letter dated August 7, 2012, the ACHP declined to participate in consultation for the ARCF Project (Enclosure 2, Attachment 2). Comments were received from the CVFPP, DWR, SAFCA, and American Indian Tribes and have been considered in this current final draft of the PA.

In April 2013, letters to 100 historical societies, museums, state historic parks, associations with historic interests, local city and county groups, and groups of various prehistoric and historic interests were sent providing a description and map of the project and requesting information on cultural resources within the APE. One response, from the Center for Sacramento History, was received, noting they would keep our letter on file. In accordance with 36 CFR § 800.14(b)(2)(ii), we will also provide the final draft PA with the forthcoming Environmental Impact Statement/Environmental Impact Report which will be released for public review this summer.

We obtained a list of potentially interested American Indian tribes and interested American Indian individuals from the Native American Heritage Commission and contacted them in 2011, 2012, and 2013 to inquire if they have knowledge of locations of archeological sites, or areas of traditional cultural value or concern in or near the ARCF Project APE. The United Auburn Indian Community of the Auburn

Rancheria (UAIC), the Shingle Springs Band of Miwok Indians (SSBMI), the Mechoopda Indian Tribe of Chico Rancheria, the Ione Band of Miwok Indians, and the Buena Vista Rancheria (BVR) have contacted us and expressed interest in the ARCF Project. We have met with the UAIC, the SSBMI, and the BVR and we plan to continue to communicate with those tribes, as well as others that may have an interest in the ARCF Project as we execute the PA in compliance with Section 106 of the NHPA. A consultation log of communications with American Indian tribes and American Indian individuals for the ARCF Project is included as Enclosure 4.

Pursuant to 36 CFR Part 800.4(a)(1), we request your comments on our determination of the APE for the ARCF Project. We also request any comments your office may have of our efforts to identify historic properties under 36 CFR Part 800.4 and any comments you may have on the final draft of the PA for the ARCF Project which was developed in accordance with 36 CFR Part 800.14(b).

Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information about the Section 106 compliance and consultation, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

FOR Alicia E. Kirchner
Chief, Planning Division

Enclosures

cc: (w/o enclosures)
Cathy Bishop, Chairperson, Strawberry Valley Rancheria, 1540 Strader Avenue, Sacramento, California 95815
Anthony Burris, Ione Band of Miwok Indians, P.O. Box 699, Plymouth, California 95669
Jason Camp, Tribal Historic Preservation Officer, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603
Grayson Coney, Tsi-Akim Maidu, P.O. Box 1316, Colfax, California 95713

Pamela Cubbler, Colfax-Todds Valley Consolidated Tribe, P.O. Box 734, Foresthill, California 95631
Sam Daniels, Shingle Springs Band of Miwok Indians, P.O. Box 1340, Shingle Springs, California 95682
Mary Daniels-Tarango, Chairperson, Wilton Rancheria, 7916 Farnell Way, Sacramento, California 95823
Michael D. DeSpain, Director of OEPP, Mechoopda Indian Tribe of Chico Rancheria, 125 Mission Ranch Boulevard, Chico, California 95926
El Dorado Miwok Tribe, P.O. Box 711, El Dorado, California 95623
Rose Enos, 15310 Bancroft Road, Auburn, California 95603
Kesner Flores, P.O. Box 1047, Wheatland, California 95692
Daniel Fonseca, Tribal Historic Preservation Officer, Shingle Springs Band of Miwok Indians, P.O. Box 1340, Shingle Springs, California 95682
Nicholas Fonseca, Chairperson, Shingle Springs Band of Miwok Indians, P.O. Box 1340, Shingle Springs, California 95682
Andrew Franklin, Wilton Rancheria, 9300 W. Stockton Blvd, Suite 200, Elk Grove, California 95758
Reno Franklin, Tribal Historic Preservation Officer, Enterprise Rancheria of Maidu Indians, 2133 Monte Vista Avenue, Oroville, California 95966
Marcos Guerrero, Cultural Resources Manager, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603
Steven Hutchason, Executive Director of Environmental Resources, Wilton Rancheria, 9300 W. Stockton Blvd, Suite 200, Elk Grove, California 95758
Roselynn Lwenya, Tribal Historic Preservation Officer, Buena Vista Rancheria, P.O. Box 162283, Sacramento, California 95816
Judith Marks, Colfax-Todds Valley Consolidated Tribe, 1068 Silverton Circle, Lincoln, California 95648
Yvonne Miller, Chairperson, Ione Band of Miwok Indians, P.O. Box 699, Plymouth, California 95669
Ambar Mohammed, Cachil DeHe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria, 3730 State Highway 45 #B, Colusa, California 95932
Eileen Moon, Vice Chairperson, 760 South Auburn Street, Suite 2-C, Grass Valley, California 95945
April Wallace Moore, 19630 Placer Hills Road, Colfax, California 95713
Rhonda Morningstar Pope, Chairperson, Buena Vista Rancheria, P.O. Box 162283, Sacramento, California 95816
Glenda Nelson, Chairperson, Enterprise Rancheria of Maidu Indians, 2133 Monte Vista Avenue, Oroville, California 95966

Dennis Ramirez, Chairperson, Mechoopda Indian Tribe of Chico Rancheria, 125 Mission Ranch Boulevard, Chico, California 95926
Guy Taylor, Representative, Mooretown Rancheria of Maidu Indians, 31 Alverde Drive, Oroville, California, 95966
Cosme Valdez, Interim Chief Executive Officer, Nashville-El Dorado Miwok, P.O. Box 580986, Elk Grove, California 95758
Gene Whitehouse, Chairperson, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603
Charlie Wright, Chairperson, Cortina Wintun Environmental Protection Agency, P.O. Box 1630, Williams, California 95987
Randy Yonemura, 4305 39th Avenue, Sacramento, California 95824

cc: (w/enclosures)
Reid Nelson, Advisory Council on Historic Preservation, 401 F Street NW, Suite 308, Washington, DC 20001-2637
Jacqueline Wait, Department of Water Resources, Division of Environmental Services, Environmental Compliance & Evaluation Branch, Cultural, Recreation, and Environmental Planning Section, 3500 Industrial Boulevard, West Sacramento, California 95691

American River Common Features GRR

EIS Cultural Resources Appendix

Enclosure 4

Consultation with the ACHP

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

FEB 01 2012

Mr. Reid Nelson
Advisory Council on Historic Preservation
Office of Federal Agency Programs
Old Post Office Building
1100 Pennsylvania Avenue, NW, Suite 803
Washington, DC 20004

Dear Mr. Nelson:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), we are writing to inform you of the proposed American River Common Features (ARCF) Project near Sacramento, California, and to request your participation in the ARCF Project. The ARCF Project is being developed by the U.S. Army Corps of Engineers (Corps) to reduce flood risk to the city of Sacramento. The reaches of the ARCF project include the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River. The ARCF Project will be described in the Common Features General Reevaluation Report. The non-Federal sponsor for the ARCF Project is the State of California Central Valley Flood Protection Board (CVFPB).

Because the ARCF Project will be a complex undertaking that may be constructed in multiple phases; covers a large geographic area largely located along rivers, which has been shown to be sensitive for buried resources; and may result in adverse effects to historic properties, we are proposing to develop a programmatic agreement (PA) to govern the implementation of our compliance efforts. We want to make every effort to include all parties with an interest in the project and those agencies with responsibilities under Section 106 of the NHPA. We are writing to provide you with information on the proposed project, to inform you of the process we plan to follow, and to potentially include your participation in accordance with 36 CFR § 800.2(a)(4)(b)(1).

The Corps has undertaken, or has been the regulatory agency, for multiple efforts to reduce flood risk in the region and the Sacramento and American River watersheds. Many of these efforts have resulted from authority given in the Water Resources Development Acts of 1996 and 1999. Because of the complex nature of these different studies and efforts, we have prepared a summary document describing the authorizations for the projects in the region; what has been constructed, and by whom; previous compliance with the NHPA and the National Environmental Policy Act of 1969; and the planned future activities within the watersheds (Enclosure 1).

The area of potential effects (APE) for the ARCF Project includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; approximately 18 miles of the east bank of the

Sacramento River from immediately downstream of the Natomas Cross Canal (NCC) to the confluence with the American River; approximately 5 miles of the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; approximately 8 miles of the Natomas East Main Drainage Canal; approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately 1.5 miles of the north and south banks of Dry/Robla Creeks; and approximately 2 miles of the north and south banks of Arcade Creek. The APE is shown in Enclosure 2.

Because of the possible adverse effects, and due to the complex, multi-phase nature of the ARCF Project, we are developing a PA that will include stipulations for determination of the APE for different phases of the project, identification of historic properties, evaluation of historic properties, determination of effects to historic properties, preparation of historic properties treatment plans, public participation, and communication with Native Americans. Pursuant to 36 CFR § 800.6(a)(1) after the PA has undergone coordination with the non-Federal sponsor, the CVFPB, and the State Historic Preservation Office, we plan to send a draft of the PA to you and ask for your review and comment.

We invite any comments you may have on the proposed ARCF Project. Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information about the Section 106 compliance and consultation, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUL 16 2012

Mr. Reid Nelson
Advisory Council on Historic Preservation
Office of Federal Agency Programs
Old Post Office Building
1100 Pennsylvania Avenue, NW, Suite 803
Washington, DC 20004

Dear Mr. Nelson:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to transmit a draft programmatic agreement (PA) for the proposed American River Common Features (ARCF) Project near Sacramento, California. The ARCF Project is being developed to reduce flood risk to the City of Sacramento, including the Natomas Basin, areas along the north and south banks of the American River, and the east bank of the Sacramento River. The ARCF Project is a part of the Common Features General Reevaluation Report. The non-Federal sponsor for the ARCF Project is the State of California Central Valley Flood Protection Board.

We previously contacted you in a letter dated February 1, 2012, inviting your comments on the proposed project and informing you of the proposed process we plan to follow, to include the development of a PA for the ARCF Project (Enclosure 1). The ARCF Project will be a complex undertaking that may be constructed in multiple phases, the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and it may result in adverse effects to historic properties. As a result, pursuant to 36 CFR § 800.14(b), we have drafted a PA to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project. The draft PA is enclosed for your review and comment (Enclosure 2).

Included as attachments to the PA are a map of the area of potential effects (APE) (Enclosure 2, Attachment 1) and a project description for the ARCF Project (Enclosure 2, Attachment 2). We have also contacted the California State Historic Preservation Officer to ask for their comments on the proposed ARCF Project. They have also received the draft PA for their review and comment.

On several prior occasions we have been in contact with potentially interested Native Americans, asking for their participation in the Section 106 compliance efforts for the ARCF Project. We have met with the United Auburn Indian Community of the Auburn Rancheria and Shingle Springs Band of Miwok Indians on the ARCF Project. As we develop the PA and comply with Section 106, we will continue to involve these tribes, as well as other tribes identified by the Native American Heritage Commission as having an interest in the APE.

Pursuant to 36 CFR § 800.14(b)(2)(i), we request your involvement in the development of the PA for the ARCF Project. We ask that you review the enclosed PA and provide us with comments within 45 days. Additionally, we ask you to notify us if you plan to formally participate in the execution of the PA.

Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information about the Section 106 compliance and consultation, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosures

Preserving America's Heritage

November 2, 2015

Ms. Melissa Montag
Historian/Senior Environmental Manager
U.S. Army Corps of Engineers
Cultural, Recreation & Social Assessment Section (CESPK-PD-RC)
1325 J Street
Sacramento, CA 95814-2922

Ref: *USACE American River Common Features Project*

Dear Ms. Montag:

The Advisory Council on Historic Preservation (ACHP) has received the Programmatic Agreement (PA) for the above referenced project. In accordance with Section 800.6(b)(1)(iv) of the ACHP's regulations, the ACHP acknowledges receipt of the PA. The filing of the PA, and execution of its terms, completes the requirements of Section 106 of the National Historic Preservation Act and the ACHP's regulations.

We appreciate your providing us with a copy of the PA and will retain it for inclusion in our records regarding this project. Should you have any questions or require additional assistance, please contact Brian Lusher at (202) 517-0221 or via e-mail at blusher@achp.gov.

Sincerely,

Artisha Thompson
Historic Preservation Technician
Office of Federal Agency Programs

American River Common Features GRR

EIS Cultural Resources Appendix

Enclosure 5

Consultation with American Indian Tribes and Individuals

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Mr. Dennis Ramirez, Chairperson
Mechoopda Indian Tribe of Chico Rancheria
125 Mission Ranch Boulevard
Chico, California 95926

Dear Mr. Ramirez:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

Enclosure 1 outlines the entire Common Features Project, including portions previously constructed by SAFCA. The Common Features Project is divided into three regions shown on Enclosure 1: the Natomas Basin (NAT) shown in yellow, American River North (ARN) shown in blue, and American River South (ARS) shown in purple. NAT Reaches C and D were entirely constructed by SAFCA, as well as a portion of NAT Reach B, some of which is presently still under construction.

As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Along NAT Reaches E, F, G, and H, a total of 45 CPTs at the PGCC and NEMDC levee toe and 16 geotechnical borings along the levee crown and in adjacent agricultural fields will be completed between May and October. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reaches E, F, G, and H are shown as blue and red dots on Enclosure 4. There are no known prehistoric resources located within the areas identified for borings and CPTs. Because the borings and CPTs are planned to occur within a heavily disturbed area along a manmade feature we do not plan to have an archeological monitor present during the geotechnical borings and CPTs along NAT Reaches E, F, G, and H.

Within ARN Reaches A and B and ARS Reaches A and B, three different types of geotechnical explorations are scheduled to be completed between August and September. These explorations include trenching, waterside berm borings, and in-channel borings. Enclosure 5 shows the probable locations of the various explorations along the American River. Shown as red lines in Enclosure 5, a total of 15 trenches will be dug to a maximum depth of 15 feet below the existing ground surface and a total linear footage of 150 feet at each location. Shown as red dots in Enclosure 5, a total of 10 waterside berm borings will be drilled to a maximum depth of 50 feet below the existing ground surface. And shown as blue dots in Enclosure 5, a total of 10 in-channel borings will be drilled to a maximum depth of 25 feet within the American River Channel.

There are no known prehistoric resources located within the areas identified for the trenching, waterside berm borings and in-channel borings. Prior to beginning the geotechnical explorations along Reaches A and B of ARN and ARS we will complete an archeological field investigation of the locations of the explorations. In the event that cultural resources are identified during the archeological field investigation, we will relocate those explorations to avoid possible sites. A qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil for the trenching and borings.

For all of the geotechnical explorations located at NAT A, B, E, F, G and H; ARN Reaches A and B; and ARS Reaches A and B, as well as for all future geotechnical explorations for the Common Features Project, in the event of an unanticipated discovery during the explorations all activity within the vicinity of the find would cease and a qualified archeologist would examine the find to determine treatment.

We are sensitive to traditional cultural properties and sacred sites, and make every effort to avoid them. Please let us know if you have knowledge of locations of archeological sites, or areas of traditional cultural interest or concern. If you are interested in further communication

regarding exploratory efforts or our continuing efforts to comply with Section 106 of the National Historic Preservation Act of 1966, as amended, we ask that you notify us. In accordance with 36 C.F.R. § 800.14 we plan to develop a Programmatic Agreement (PA) in order to initiate the Section 106 process early in the planning process for the Common Features Project and we will be contacting you in the future to determine your interest in involvement in the PA as a concurring party. Correspondence may be sent to: Ms. Melissa Montag (CESPK-PD-RC), U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922.

We request that you reply within 30 days of receipt of this letter. If you have any questions of comments, please contact Ms. Montag, Historian, at (916) 557-7907.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Mr. Nicholas Fonseca, Chairperson
Shingle Springs Band of Miwok Indians
P.O. Box 1340
Shingle Springs, California 95682

Dear Mr. Fonseca:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

Enclosure 1 outlines the entire Common Features Project, including portions previously constructed by SAFCA. The Common Features Project is divided into three regions shown on Enclosure 1: the Natomas Basin (NAT) shown in yellow, American River North (ARN) shown in blue, and American River South (ARS) shown in purple. NAT Reaches C and D were entirely constructed by SAFCA, as well as a portion of NAT Reach B, some of which is presently still under construction.

As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Ms. Cathy Bishop, Chairperson
Strawberry Valley Rancheria
P.O. Box 667
Marysville, California 95901

Dear Ms. Bishop:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

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As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Ms. Eileen Moon, Vice Chairperson
760 South Auburn Street, Suite 2-C
Grass Valley, California 95945

Dear Ms. Moon:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

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As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Mr. David Keyser, Chairperson
United Auburn Indian Community
Auburn Rancheria
Auburn, California 95603

Dear Mr. Keyser:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

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As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Ms. Mary Daniels-Tarango, Chairperson
Wilton Rancheria
7916 Farnell Way
Sacramento, California 95823

Dear Ms. Daniels-Tarango:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

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As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Mr. Cosme Valdez, Interim Chief Executive Officer
Nashville-El Dorado Miwok
P.O. Box 580986
Elk Grove, California 95758

Dear Mr. Valdez:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

Enclosure 1 outlines the entire Common Features Project, including portions previously constructed by SAFCA. The Common Features Project is divided into three regions shown on Enclosure 1: the Natomas Basin (NAT) shown in yellow, American River North (ARN) shown in blue, and American River South (ARS) shown in purple. NAT Reaches C and D were entirely constructed by SAFCA, as well as a portion of NAT Reach B, some of which is presently still under construction.

As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Ione Band of Miwok Indians
P.O. Box 699
Plymouth, California 95699

Dear Ione Band of Miwok Indians:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

Enclosure 1 outlines the entire Common Features Project, including portions previously constructed by SAFCA. The Common Features Project is divided into three regions shown on Enclosure 1: the Natomas Basin (NAT) shown in yellow, American River North (ARN) shown in blue, and American River South (ARS) shown in purple. NAT Reaches C and D were entirely constructed by SAFCA, as well as a portion of NAT Reach B, some of which is presently still under construction.

As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

El Dorado Miwok Tribe
P.O. Box 711
El Dorado, California 95623

Dear El Dorado Miwok Tribe:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

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As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

DEPARTMENT OF THE ARMY
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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Ms. Glenda Nelson, Chairperson
Enterprise Rancheria of Maidu Indians
2133 Monta Vista Avenue
Oroville, California 95966

Dear Ms. Nelson:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

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As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

DEPARTMENT OF THE ARMY
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REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 04 2011

Ms. Rhonda Morningstar Pope, Chairperson
Buena Vista Rancheria
P.O. Box 162283
Sacramento, California 95814

Dear Ms. Pope:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of proposed geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. The Sacramento Area Flood Control Agency (SAFCA) has implemented and constructed prior phases of the Common Features Project and the U.S. Army Corps of Engineers, Sacramento District (Corps) is now proceeding with future planned phases of the project. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal (NCC), the Pleasant Grove Cross Canal (PGCC), and the Natomas East Main Drain Canal (NEMDC).

Enclosure 1 outlines the entire Common Features Project, including portions previously constructed by SAFCA. The Common Features Project is divided into three regions shown on Enclosure 1: the Natomas Basin (NAT) shown in yellow, American River North (ARN) shown in blue, and American River South (ARS) shown in purple. NAT Reaches C and D were entirely constructed by SAFCA, as well as a portion of NAT Reach B, some of which is presently still under construction.

As part of the Corps' exploratory phase for the remaining reaches of the Common Features Project we are planning to complete a series of geotechnical explorations in the late spring, summer, and fall of 2011 along various project reaches. Along NAT Reach A, a total of 8 cone penetrometer tests (CPT) and 15 geotechnical borings at and adjacent to the Sacramento and American Rivers levees will be completed between May and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach A are shown red dots on Enclosure 2. Although there are no known prehistoric resources located within the areas identified for borings and CPTs, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil.

Within NAT Reach B, a total of 4 CPTs and 13 geotechnical borings along the Sacramento River levee crown and in adjacent agricultural fields will be completed between July and September. The maximum depth of the borings and CPTs would be 100 feet and all borings and CPTs would be backfilled. The boring locations and CPTs for NAT Reach B are shown as red dots on Enclosure 3. Although there are no known prehistoric resources located within the

Mechoopda Indian Tribe of Chico Rancheria

May 9, 2011

Department of the Army
U.S. Army Engineer District, Sacramento
Corps of Engineers
1325 J. Street
Sacramento, CA. 95814-2922

Re: American River Common Features General Reevaluation Project

Dear Ms. Montag,

I am writing in response to your letter that we received on May 5th. This letter indicates that you are proposing geotechnical explorations for the American River Common Features General Reevaluation (Common Features) Project. This is said to take place in Sacramento and Sutter Counties.

The Tribe is very concerned with the preservation of any Native American Archaeological or Cultural Sites within the project area, or which may be impacted as a result of project activities (pursuant to 14 CCR § 895.1) These sites include, but are not limited to: village sites, camp sites, petroglyphs, prehistoric trails, quarries, milling stations, cemeteries, ceremonial sites, or traditional cultural sites and properties. We are not aware of any cultural resources in the planned project area. If during project activities any cultural resources are found, we ask you to stop activities and that a funded monitor be placed on site for the remainder of the project.

It is also the Tribe's position that extreme care be taken to preserve all watersheds, all Riparian Habitat Conservation Areas; and in general, the prohibition of any project activities which would diminish water quality.

We appreciate your notification. Please also contact Shingle Springs Rancheria and United Auburn Indian Community because this may also be their ancestral area. If there is any other assistance that I can provide during this process, please do not hesitate to contact me.

Thank you.

Michael D. DeSpain

Michael D. DeSpain
Director of OEPP
mdespain@mechoopda-nsn.gov

MIWOK
MAIDU

United Auburn Indian Community
of the Auburn Rancheria

David Keyser, Chairperson | Kimberly DuBach, Vice Chair | Gene Whitehouse, Secretary | Brenda Conway, Treasurer | Calvin Moman, Council Member

June 2, 2011

Melissa Montag
CESPK-PD-RC
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: The American River Common Features General Re-evaluation Project

Dear Ms. Montag,

Thank you for requesting information regarding the above referenced project. The United Auburn Indian Community (UAIC) of the Auburn Rancheria is comprised of Miwok and Southern Maidu (Nisenan) people whose tribal lands are within Placer County and ancestral territory spans into El Dorado, Nevada, Sacramento, Sutter, and Yuba counties. The UAIC is concerned about development within its aboriginal territory that has potential to impact the lifeways, cultural sites, and landscapes that may be of sacred or ceremonial significance. We appreciate the opportunity to comment on this and other projects in your jurisdiction.

In order to ascertain whether or not the project could affect cultural resources that may be of importance to the UAIC, we would like to receive copies of any archaeological reports that have been, or will be, completed for the project. We also request copies of future environmental documents for the proposed project so that we have the opportunity to comment on potential impacts and proposed mitigation measures related to cultural resources. The UAIC would also like the opportunity to have our cultural consultants accompany you during the field survey. The information gathered will provide us with a better understanding of the project and cultural resources on site and is invaluable for consultation purposes.

The UAIC's preservation committee would like to set up a fieldvisit and consult about the proposed project. The UAIC would like to be concurring party on any sort of treatment plans, programmatic agreements, or memorandum of agreements. Thank you again for taking these matters into consideration, and for involving the UAIC early in the planning process. We look forward to reviewing the aforementioned documents as requested and setting up a meeting. Please contact Marcos Guerrero, cultural resources specialist, at (530) 883-2364 or email at mguerrero@auburnrancheria.com if you have any questions.

Sincerely,

Gregory S. Baker,
Tribal Administrator

CC: Marcos Guerrero, UAIC

SHINGLE SPRINGS RANCHERIA

Shingle Springs Band of Miwok Indians,
Shingle Springs Rancheria
(Verona Tract), California
5281 Honpie Road, Placerville, CA 95667
P.O. Box 1340, Shingle Springs, CA 95682
(530) 676-8010 Office (530)676-8033 Fax

April 3, 2012

Department of the Army
U.S. Army Engineer District, Sacramento
Corps of Engineers
1325 J Street
Sacramento, CA 95814-2922

RE: American River Common Features Project in Sacramento County

Dear Alicia E. Kirchner

The Most likely Descendant, Daniel Fonseca would like to initiate consultation process with the Department of the Army for the American River Common Features project located in Sacramento County. Among other things, we would like this consultation to address the cultural and historic resource issues, pursuant to the regulations implementing Section 106 of the National Historic Preservation Act.

Prior to meeting we would like to request any and all completed record searches and or surveys that were done in or around the project area up to and including environmental, archaeological and cultural reports.

Please let this letter serve as a formal request for the Shingle Springs Band of Miwok Indians to be added as a consulting party in identifying any Traditional Cultural Properties (TCPs) that may exist within the project's Area of Potential Effects (APE).

Please contact Crystal Dilworth, Cultural Resource Office Manager at 530-698-1471 to schedule a consultation meeting pursuant to Section 106 of the NHPA.

Sincerely,

Daniel Fonseca
Cultural Resources Director

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Daniel Fonseca
Cultural Resources Director
Shingle Springs Band of Miwok Indians
Shingle Springs Rancheria
P.O. Box 1340
Shingle Springs, California 95682

APR 25 2012

Dear Mr. Fonseca:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation on the American River Common Features General Reevaluation (Common Features) Project. We previously contacted you in reference to geotechnical explorations for this Project in a letter dated May 4, 2011. The U.S. Army Corps of Engineers, Sacramento District (Corps) has previously authorized work under the American River Common Features Project and additional levee improvements are being evaluated as part of the Project. The State of California is the non-Federal partner on the Project. The overall Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Creek Canal, the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks (Enclosure).

We received your letter dated April 3, 2012, where you requested to meet with us on the project in order to address cultural and historic issues. You also requested to be formally added as a consulting party in identifying any Traditional Cultural Properties (TCPs) within the Project's Area of Potential Effect (APE), and you requested completed records searches, surveys, and environmental, archaeological and cultural reports.

We look forward to meeting with you on the Project. As you requested, Ms. Melissa Montag of my office will contact Ms. Crystal Dilworth to schedule a consultation meeting. We will make every effort to avoid archeological sites, TCPs, areas of traditional cultural value, interest, or concern and your input during the early stages of planning for the Project is valuable in our efforts to identify historic properties within the Project APE.

You may request previously completed records searches, surveys, and archaeological and cultural reports from within the APE from the Northeast Information Center at California State University, Chico for Sutter County and the North Central Information Center at California State University, Sacramento for Sacramento County. You may also make a Freedom of Information Act (FOIA) request for those documents within our agency records to SPK-FOIA@usace.army.mil. If you have questions about submitting a FOIA request, please contact Ms. Phyllis Svetich, FOIA/Privacy Act Officer, at (916) 557-7236 or Phyllis.M.Svetich@usace.army.mil. Also included with this letter is a disc that includes various available environmental documents for the Project APE. Many other related documents are

available at http://www.safca.org/Programs_Natomas.html. We will add you to our mailing this to receive relevant future documents within the Project APE.

We will be contacting you soon with information on additional geotechnical explorations we are planning within the Project APE. In accordance with 36 CFR § 800.14 we are developing a Programmatic Agreement (PA) in order to initiate the Section 106 process early in the planning process for the Project and we will be contacting you to determine your interest in involvement in the PA as a consulting or concurring party. Correspondence may be sent to: Ms. Melissa Montag (CESPK-PD-RC), U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or comments, please contact Ms. Montag, Historian, at (916) 557-7907. For specific Project questions please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

CF (w/enclosures):
Ms. Crystal Dilworth, Cultural Resources Office Manager, Shingle Springs Band of Miwok Indians, Shingle Springs Rancheria, P.O. Box 1340, Shingle Springs, California 95682

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Gregory S. Baker
Tribal Administrator
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

APR 25 2012

Dear Mr. Baker:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation on the American River Common Features General Reevaluation (Common Features) Project. We previously contacted you in reference to geotechnical explorations for this Project in a letter dated May 4, 2011. The U.S. Army Corps of Engineers, Sacramento District (Corps) has previously authorized work under the American River Common Features Project and additional levee improvements are being evaluated as part of the Project. The State of California is the non-Federal partner on the Project. The overall Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Creek Canal, the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks (Enclosure).

We received your request for future environmental documents and we will add you to our mailing list to receive those documents as they are distributed to the public. You asked to have the opportunity to have your cultural consultants accompany us during future field surveys for the Project and you asked to set up a field visit to consult on the Project. Additionally, you requested to be a concurring party on any treatment plans, programmatic agreements, or memorandum of agreements for the Project, and you requested completed records searches, surveys, and environmental, archaeological, and cultural reports within the Project's Area of Potential Effect (APE).

We look forward to meeting with you on the Project. As you requested, Ms. Melissa Montag of my office will contact Mr. Marcos Guerrero to schedule a consultation meeting. We will make every effort to avoid archeological sites, traditional cultural properties, areas of traditional cultural value, interest, or concern and your input during the early stages of planning for the Project is valuable in our efforts to identify historic properties within the Project APE. For future field survey efforts we will contact you to determine if your cultural consultants are able to accompany us during the field survey. We will be contacting you soon with information on additional geotechnical explorations we are planning within the Project APE.

You may request previously completed records searches, surveys, and archaeological and cultural reports from within the APE from the Northeast Information Center at California State University, Chico for Sutter County and the North Central Information Center at California State

University, Sacramento for Sacramento County. You may also make a Freedom of Information Act (FOIA) request for those documents we have as a part of our agency records to SPK-FOIA@usace.army.mil. If you have questions about submitting a FOIA request, please contact Ms. Phyllis Svetich, FOIA/Privacy Act Officer, at (916) 557-7236 or Phyllis.M.Svetich@usace.army.mil.

In accordance with 36 CFR § 800.14 we are developing a Programmatic Agreement (PA) in order to initiate the Section 106 process early in the planning process for the Project and we will be contacting you to determine your interest in involvement in the PA and subsequent treatment plans and agreement documents as a consulting or concurring party. Correspondence may be sent to: Ms. Melissa Montag (CESPK-PD-RC), U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or comments, please contact Ms. Montag, Historian, at (916) 557-7907. For specific Project questions please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

CF (w/enclosures):
Mr. Marcos Guerrero, Cultural Resources Specialist, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 11 2012

Ms. Rhonda Morningstar Pope, Chairperson
Buena Vista Rancheria
P.O. Box 162283
Sacramento, California 95816

Dear Ms. Pope :

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

Additionally, 12 of the locations will include a second boring using the air rotary cased hammer method to collect undisturbed samples. Trenching will consist of excavating an area 15 feet deep and 150 feet long to perform a visual verification of the soil patterns. The maximum depth for borings will not exceed 80 feet and all borings and trenches will be backfilled upon completion. Enclosed is a map of the proposed locations for the geotechnical borings (shown as blue and white dots) and trenching (outlined in red) testing locations.

A comparison between the records search and the map of the boring/testing locations indicates that there are no known sites at any of these locations. An archaeological field investigation of the specific geotechnical exploration locations will be completed prior to any ground disturbing activities. In the event that cultural resources are identified during the archeological field investigation, we will relocate those explorations to avoid possible sites. Although there are no known prehistoric resources located within the areas identified for borings and testing locations, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil at every testing location.

For all the geotechnical explorations located on the American River, as well as for all future geotechnical explorations for the Common Features Project, in the event of an unanticipated discovery during the explorations all activity within the vicinity of the find would cease and a qualified archeologist would examine the find to determine treatment.

We are sensitive to traditional cultural properties and sacred sites, and make every effort to avoid them. Please let us know if you have knowledge of locations of archeological sites, or areas of traditional cultural interest or concern within the locations identified for the borings and testing. If you are interested in further communication regarding exploratory efforts or our continuing efforts to comply with Section 106 of the National Historic Preservation Act of 1966, as amended, we ask that you notify us. Correspondence may be sent to: Ms. Melissa Montag (CESPK-PD-RC), U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 11 2012

Mr. Dennis Ramirez, Chairperson
Mechoopda Indian Tribe of Chico Rancheria
125 Mission Ranch Boulevard
Chico, California 95926

Dear Mr. Ramirez:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

Additionally, 12 of the locations will include a second boring using the air rotary cased hammer method to collect undisturbed samples. Trenching will consist of excavating an area 15 feet deep and 150 feet long to perform a visual verification of the soil patterns. The maximum depth for borings will not exceed 80 feet and all borings and trenches will be backfilled upon completion. Enclosed is a map of the proposed locations for the geotechnical borings (shown as blue and white dots) and trenching (outlined in red) testing locations.

A comparison between the records search and the map of the boring/testing locations indicates that there are no known sites at any of these locations. An archaeological field investigation of the specific geotechnical exploration locations will be completed prior to any ground disturbing activities. In the event that cultural resources are identified during the archeological field investigation, we will relocate those explorations to avoid possible sites. Although there are no known prehistoric resources located within the areas identified for borings and testing locations, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil at every testing location.

For all the geotechnical explorations located on the American River, as well as for all future geotechnical explorations for the Common Features Project, in the event of an unanticipated discovery during the explorations all activity within the vicinity of the find would cease and a qualified archeologist would examine the find to determine treatment.

We are sensitive to traditional cultural properties and sacred sites, and make every effort to avoid them. Please let us know if you have knowledge of locations of archeological sites, or areas of traditional cultural interest or concern within the locations identified for the borings and testing. If you are interested in further communication regarding exploratory efforts or our continuing efforts to comply with Section 106 of the National Historic Preservation Act of 1966, as amended, we ask that you notify us. Correspondence may be sent to: Ms. Melissa Montag (CESPK-PD-RC), U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

Copy Furnished (w/enclosure):
Mr. Michael D. DeSpain, Director of OEPP, Mechoopda Indian Tribe of Chico Rancheria, 125 Mission Ranch Boulevard, Chico, California 95926

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 11 2012

Ms. Mary Daniels-Tarango, Chairperson
Wilton Rancheria
7916 Farnell Way
Sacramento, California 95823

Dear Ms. Daniels-Tarango:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 11 2012

Mr. Gregory Baker, Tribal Administrator
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

Dear Mr. Baker:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

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Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

Copy Furnished (w/enclosure):
Mr. Marcos Guerrero, Cultural Resources Specialist, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 11 2012

Ms. Eileen Moon, Vice Chairperson
760 South Auburn Street, Suite 2-C
Grass Valley, California 95945

Dear Ms. Moon:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 11 2012

Ms. Cathy Bishop, Chairperson
Strawberry Valley Rancheria
P.O. Box 667
Marysville, California 95901

Dear Ms. Bishop:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

Additionally, 12 of the locations will include a second boring using the air rotary cased hammer method to collect undisturbed samples. Trenching will consist of excavating an area 15 feet deep and 150 feet long to perform a visual verification of the soil patterns. The maximum depth for borings will not exceed 80 feet and all borings and trenches will be backfilled upon completion. Enclosed is a map of the proposed locations for the geotechnical borings (shown as blue and white dots) and trenching (outlined in red) testing locations.

A comparison between the records search and the map of the boring/testing locations indicates that there are no known sites at any of these locations. An archaeological field investigation of the specific geotechnical exploration locations will be completed prior to any ground disturbing activities. In the event that cultural resources are identified during the archeological field investigation, we will relocate those explorations to avoid possible sites. Although there are no known prehistoric resources located within the areas identified for borings and testing locations, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil at every testing location.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 11 2012

Mr. Daniel Fonseca
Cultural Resources Director
Shingle Springs Band of Miwok Indians
Shingle Springs Rancheria
P.O. Box 1340
Shingle Springs, California 95682

Dear Mr. Fonseca:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

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A comparison between the records search and the map of the boring/testing locations indicates that there are no known sites at any of these locations. An archaeological field investigation of the specific geotechnical exploration locations will be completed prior to any ground disturbing activities. In the event that cultural resources are identified during the archeological field investigation, we will relocate those explorations to avoid possible sites. Although there are no known prehistoric resources located within the areas identified for borings and testing locations, a qualified archeological monitor will be present during ground disturbing activities for the first 20 feet of previously undisturbed soil at every testing location.

For all the geotechnical explorations located on the American River, as well as for all future geotechnical explorations for the Common Features Project, in the event of an unanticipated discovery during the explorations all activity within the vicinity of the find would cease and a qualified archeologist would examine the find to determine treatment.

We are sensitive to traditional cultural properties and sacred sites, and make every effort to avoid them. Please let us know if you have knowledge of locations of archeological sites, or areas of traditional cultural interest or concern within the locations identified for the borings and testing. If you are interested in further communication regarding exploratory efforts or our continuing efforts to comply with Section 106 of the National Historic Preservation Act of 1966, as amended, we ask that you notify us. Correspondence may be sent to: Ms. Melissa Montag (CESPK-PD-RC), U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

Copy Furnished (w/enclosure):
Ms. Crystal Dilworth, Cultural Resources Office Manager , Shingle Springs Band of Miwok Indians, Shingle Springs, P.O. Box 1340, Shingle Springs, California 95682

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

MAY 11 2012

Mr. Cosme Valdez
Interim Chief Executive Officer
Nashville-El Dorado Miwok
P.O. Box 580986
Elk Grove, California 95758

Dear Mr. Valdez:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

Additionally, 12 of the locations will include a second boring using the air rotary cased hammer method to collect undisturbed samples. Trenching will consist of excavating an area 15 feet deep and 150 feet long to perform a visual verification of the soil patterns. The maximum depth for borings will not exceed 80 feet and all borings and trenches will be backfilled upon completion. Enclosed is a map of the proposed locations for the geotechnical borings (shown as blue and white dots) and trenching (outlined in red) testing locations.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ione Band of Miwok Indians
P.O. Box 699
Plymouth, California 95669

MAY 11 2012

Dear Ione Band of Miwok Indians:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Glenda Nelson, Chairperson
Enterprise Rancheria of Maidu Indians
2133 Monta Vista Avenue
Oroville, California 95966

MAY 11 2012

Dear Ms. Nelson:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

El Dorado Miwok Tribe
P.O. Box 711
El Dorado, California 95623

MAY 11 2012

Dear El Dorado Miwok Tribe:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued geotechnical exploration work for the American River Common Features Project (Common Features) following our initial consultation with you in a letter dated May 4, 2011. The overall Common Features Project is located in Sacramento and Sutter Counties along the Sacramento River, the American River, the Natomas Cross Canal, the Pleasant Grove Cross Canal, and the Natomas East Main Drain Canal, Arcade Creek, and Dry/Robla Creeks.

As part of the U.S. Army Corps of Engineers' (Corps) exploratory phase for the Common Features Project, we are completing a series of geotechnical explorations. The work will consist of soil testing to depths of 80 feet, soil surface testing of erodibility, in-channel borings, trenching, and various geophysical surveys. The geotechnical borings will occur at 23 locations along the American River between river miles 0.0 and 22.4 while the trenching will occur at five locations between river miles 5 and 14. The borings will be taken in various locations along the toe and bench within the American River Parkway. The sonic drilling method will be used to collect continuous samples for geologic and engineering characteristics at all sites.

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June 21, 2012

Ms Melissa Montag (CESPK-PD-RC)
U.S Army Corps of Engineers,
1325 J Street, Sacramento CA 95814-2922

Dear Ms Melissa Montag,

We are in receipt of a letter dated May 11, 2012 from Alicia E. Kirchner, Chief, Planning Division informing us of the continued geotechnical exploration work for the American River Common Features Project.

As per your request, Buena Vista Rancheria is interested in continued consultation with U.S Army Corps of Engineers pursuant to Section106 of the National Historic Preservation Act of 1966. In order for us to better understand the project we would like to request additional information on the full range of proposed project activities for which the drilling and trenching is being proposed, including detail project descriptions with maps and photographs. We also request the schedule for the proposed borings and trenching, and a site visit. Buried archeological deposits and other cultural resources could be present at some drilling and trenching sites that could potentially be impacted by proposed project activities.

In addition, Buena Vista Rancheria would like to review the results of your records search concerning cultural resources including archeological sites and other resources of interest and concern to American Indians. The Tribe requests to be involved in developing the scope of work, sampling strategy and research design, as well as field investigations, laboratory analysis, and report writing for the proposed archeological investigations Please provide a schedule for your proposed cultural resources studies. A site visit to the proposed study area is requested, as well.

Buena Vista Rancheria is pleased that the Department of the Army plans to have a qualified archaeologist on site during geotechnical exploration excavations. We request that you consider having the Tribe's Cultural Monitors present during the borings and trenching and all related activities involving substantial ground disturbing actions, in addition to the field investigations mentioned above.

We look forward to receiving additional project information from you to review prior to a site visit, as well as working with you to develop the studies to investigate cultural resources of interest and concern to the American Indian people in the project area of potential effect.

If you have any questions regarding this letter feel free to call me at telephone number (916) 491-0011.

Respectfully,

Roselynn Lwenya, PhD
Tribal Historic Preservation Officer and
Environmental Resources Director

P.O. BOX 162283 Sacramento, CA 95816
TEL: 916.491.0011 FAX: 916.491.0012
www.buenavistatribe.com

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Roselynn Lwenya, THPO
Buena Vista Rancheria Me-Wuk Indians
P.O. Box 162283
Sacramento, California 95816

JUL 12 2012

Dear Ms. Lwenya:

In response to your letter dated June 21, 2012 and in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to keep you informed of our continued work for the American River Common Features General Reevaluation (Common Features) Project. The area of potential effects for the Common Features Project is shown on Enclosure 1. The geotechnical borings, for which we originally consulted with you back in May, will no longer be occurring as planned. However, we are still moving forward with the Section 106 consultation process for the overall Common Features Project and we would like to keep you informed of our upcoming efforts on the project.

A draft programmatic agreement will be available soon. In accordance with 36 CFR Part 800.14(b)(2)(i), you will be invited to review this document as a concurring party. Additionally, in accordance with 36 CFR Part 800.2, we would like to propose the prospect of setting up a meeting with you to discuss our current and future Section 106 compliance efforts for the Common Features Project. We will be contacting you soon to schedule a consultation meeting.

We are sensitive to traditional cultural properties and sacred sites, and make every effort to avoid them. If you have any questions or concerns, please feel free to contact us. Correspondence may be sent to: Ms. Melissa Montag (CESPK-PD-RC), U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922. For specific project questions please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

Ms. Rhonda Morningstar Pope, Chairperson
Buena Vista Rancheria
P.O. Box 162283
Sacramento, California 95816

Dear Ms. Pope:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

In the Sacramento area the Sacramento and American rivers form a flood plain covering roughly 110,000 acres in their confluence. The flood plain includes most of the developed portions of the city of Sacramento. The ARCF Project area of potential effects (APE) includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; the Sacramento Bypass and Sacramento Weir; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal (Enclosure 1).

The ARCF Project is a single purpose flood risk management project with the measures described in Enclosure 2 proposed for implementation. The ARCF Project APE is within an area known to be sensitive for prehistoric and historic cultural resources. The Corps has determined that ARCF Project will be a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties. As a result, pursuant to 36 CFR § 800.14(b), we have drafted a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project. The draft PA is enclosed for your review and comment (Enclosure 3).

Included as attachments to the draft PA are a map of the APE (Enclosure 3, Attachment 1) and a draft project description for the ARCF Project (Enclosure 3, Attachment 3). We have contacted the Advisory Council on Historic Preservation and the State Historic Preservation Officer to ask for their comments on the proposed ARCF Project. They have also received the draft PA for their review and comment.

Pursuant to 36 CFR § 800.14(b)(2)(i), we request your involvement in the development of the PA for the ARCF Project. We ask that you review the enclosed draft PA and provide us with comments within 45 days. Additionally, if you would like to meet with us so that we may answer any questions you may have about ARCF Project, our proposed Section 106 compliance efforts, or the draft PA, we ask that you contact us to schedule a meeting.

Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information about the Section 106 compliance and consultation for the ARCF Project, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

Mr. Ambar Mohammed
Cachil DeHe Band of Wintun Indians of the
Colusa Indian Community of the Colusa Rancheria
3730 State Highway 45 # B
Colusa, California 95932

Dear Mr. Mohammed:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

In the Sacramento area the Sacramento and American rivers form a flood plain covering roughly 110,000 acres in their confluence. The flood plain includes most of the developed portions of the city of Sacramento. The ARCF Project area of potential effects (APE) includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; the Sacramento Bypass and Sacramento Weir; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal (Enclosure 1).

The ARCF Project is a single purpose flood risk management project with the measures described in Enclosure 2 proposed for implementation. The ARCF Project APE is within an area known to be sensitive for prehistoric and historic cultural resources. The Corps has determined that ARCF Project will be a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties. As a result, pursuant to 36 CFR § 800.14(b), we have drafted a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project. The draft PA is enclosed for your review and comment (Enclosure 3).

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

Mr. Guy Taylor, Representative
Mooretown Rancheria of Maidu Indians
31 Alverde Drive
Oroville, California 95966

Dear Mr. Taylor:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

In the Sacramento area the Sacramento and American rivers form a flood plain covering roughly 110,000 acres in their confluence. The flood plain includes most of the developed portions of the city of Sacramento. The ARCF Project area of potential effects (APE) includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; the Sacramento Bypass and Sacramento Weir; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal (Enclosure 1).

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

Mr. Michael D. DeSpain, Director of OEPP
Mechoopda Indian Tribe of Chico Rancheria
125 Mission Ranch Boulevard
Chico, California 95926

Dear Mr. DeSpain:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

Mr. Dennis Ramirez, Chairperson
Mechoopda Indian Tribe of Chico Rancheria
125 Mission Ranch Boulevard
Chico, California 95926

Dear Mr. Ramirez:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

In the Sacramento area the Sacramento and American rivers form a flood plain covering roughly 110,000 acres in their confluence. The flood plain includes most of the developed portions of the city of Sacramento. The ARCF Project area of potential effects (APE) includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; the Sacramento Bypass and Sacramento Weir; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal (Enclosure 1).

The ARCF Project is a single purpose flood risk management project with the measures described in Enclosure 2 proposed for implementation. The ARCF Project APE is within an area known to be sensitive for prehistoric and historic cultural resources. The Corps has determined that ARCF Project will be a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties. As a result, pursuant to 36 CFR § 800.14(b), we have drafted a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project. The draft PA is enclosed for your review and comment (Enclosure 3).

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REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Mary Daniels-Tarango, Chairperson
Wilton Rancheria
7916 Farnell Way
Sacramento, California 95823

APR 05 2013

Dear Ms. Daniels-Tarango:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Danny Rey, Tribal Historic Preservation Officer
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

APR 05 2013

Dear Mr. Rey:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Marcos Guerrero, Cultural Resources Specialist
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

APR 05 2013

Dear Mr. Guerrero:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

Ms. Eileen Moon, Vice Chairperson
760 South Auburn Street, Suite 2-C
Grass Valley, California 95945

Dear Ms. Moon:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Cathy Bishop, Chairperson
Strawberry Valley Rancheria
P.O. Box 667
Marysville, California 95901

APR 05 2013

Dear Ms. Bishop:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

Ms. Angela Rivera
Shingle Springs Band of Miwok Indians
P.O. Box 1340
Shingle Springs, California 95682

Dear Ms. Rivera:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Daniel Fonseca, Cultural Resources Director
Shingle Springs Band of Miwok Indians
P.O. Box 1340
Shingle Springs, California 95682

APR 05 2013

Dear Mr. Fonseca:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Cosme Valdez, Interim Chief Executive Officer
Nashville-El Dorado Miwok
P.O. Box 580986
Elk Grove, California 95758

APR 05 2013

Dear Mr. Valdez:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Yvonne Miller, Chairperson
Ione Band of Miwok Indians
P.O. Box 699
Plymouth, California 95669

APR 05 2013

Dear Ms. Miller:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Glenda Nelson, Chairperson
Enterprise Rancheria of Maidu Indians
2133 Monta Vista Avenue
Oroville, California 95966

APR 05 2013

Dear Ms. Nelson:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

El Dorado Miwok Tribe
P.O. Box 711
El Dorado, California 95623

Dear El Dorado Miwok Tribe:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 05 2013

Ms. Roselynn Lwenya
Tribal Historic Preservation Officer
Buena Vista Rancheria
P.O. Box 162283
Sacramento, California 95816

Dear Ms. Lwenya:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

In the Sacramento area the Sacramento and American rivers form a flood plain covering roughly 110,000 acres in their confluence. The flood plain includes most of the developed portions of the city of Sacramento. The ARCF Project area of potential effects (APE) includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; the Sacramento Bypass and Sacramento Weir; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal (Enclosure 1).

The ARCF Project is a single purpose flood risk management project with the measures described in Enclosure 2 proposed for implementation. The ARCF Project APE is within an area known to be sensitive for prehistoric and historic cultural resources. The Corps has determined that ARCF Project will be a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties. As a result, pursuant to 36 CFR § 800.14(b), we have drafted a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project. The draft PA is enclosed for your review and comment (Enclosure 3).

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Art Angle
Enterprise Rancheria of Maidu Indians
2133 Monta Vista Avenue
Oroville, California 95966

JUN 0 6 2013

Dear Mr. Angle:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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Included as attachments to the draft PA are a map of the APE (Enclosure 3, Attachment 1) and a draft project description for the ARCF Project (Enclosure 3, Attachment 3). We have contacted the Advisory Council on Historic Preservation and the State Historic Preservation Officer to ask for their comments on the proposed ARCF Project. They have also received the draft PA for their review and comment.

Pursuant to 36 CFR § 800.14(b)(2)(i), we request your involvement in the development of the PA for the ARCF Project. We ask that you review the enclosed draft PA and provide us with comments within 45 days. Additionally, if you would like to meet with us so that we may answer any questions you may have about ARCF Project, our proposed Section 106 compliance efforts, or the draft PA, we ask that you contact us to schedule a meeting.

Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information about the Section 106 compliance and consultation for the ARCF Project, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Steven Hutchason
Wilton Rancheria
9300 W. Stockton, Suite 200
Elk Grove, California 95758

JUN 06 2013

Dear Mr. Hutchason:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Cathy Bishop, Chairperson
Strawberry Valley Rancheria
1540 Strader Avenue
Sacramento, California 95815

JUN 06 2013

Dear Ms. Bishop:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Kesner Flores
P.O. Box 1047
Wheatland, California 95692

JUN 06 2013

Dear Mr. Flores:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Cortina Wintun Environmental Protection Agency
P.O. Box 1630
Williams, California 95987

JUN 06 2013

To Whom It May Concern:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Marshall McKay
Yocha Dehe Wintun Nation
P.O. Box 18
Brooks, California 95606

JUN 06 2013

Dear Mr. McKay:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Leland Kinter
Yocha Dehe Wintun Nation
P.O. Box 18
Brooks, California 95606

JUN 06 2013

Dear Mr. Kinter:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Cynthia Clarke
Yocha Dehe Wintun Nation
P.O. Box 18
Brooks, California 95606

JUN 06 2013

Dear Ms. Clarke:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Rose Enos
15310 Bancroft Road
Auburn, California 95603

JUN 06 2013

Dear Ms. Enos:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Randy Yonemura
4305 39th Avenue
Sacramento, California 95824

JUN 06 2013

Dear Mr. Yonemura:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. April Wallace Moore
19630 Placer Hills Road
Colfax, California 95713

JUN 06 2013

Dear Ms. Moore:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Judith Marks
Colfax-Todds Valley Consolidated Tribe
1068 Silverton Circle
Lincoln, California 95648

JUN 06 2013

Dear Ms. Marks:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

In the Sacramento area, the Sacramento and American rivers form a flood plain covering roughly 110,000 acres. The flood plain includes most of the developed portions of the city of Sacramento. The ARCF Project area of potential effects (APE) includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; the Sacramento Bypass and Sacramento Weir; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal (Enclosure 1).

The ARCF Project is a single purpose flood risk management project with the measures described in Enclosure 2 proposed for implementation. The ARCF Project APE is within an area known to be sensitive for prehistoric and historic cultural resources. The Corps has determined that ARCF Project will be a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties. As a result, pursuant to 36 CFR § 800.14(b), we have drafted a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project. The draft PA is enclosed for your review and comment (Enclosure 3).

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Pamela Cubbler
Colfax-Todds Valley Consolidated Tribe
P.O. Box 734
Foresthill, California 95631

JUN 06 2013

Dear Ms. Cubbler:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

In the Sacramento area, the Sacramento and American rivers form a flood plain covering roughly 110,000 acres. The flood plain includes most of the developed portions of the city of Sacramento. The ARCF Project area of potential effects (APE) includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; the Sacramento Bypass and Sacramento Weir; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal (Enclosure 1).

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Anthony Burris
Ione Band of Miwok Indians
P.O. Box 699
Plymouth, California 95699

JUN 06 2013

Dear Mr. Burris:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

In the Sacramento area, the Sacramento and American rivers form a flood plain covering roughly 110,000 acres. The flood plain includes most of the developed portions of the city of Sacramento. The ARCF Project area of potential effects (APE) includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; intermittent sites along the east bank of the Sacramento River downstream of the Natomas Cross Canal (NCC) down to the confluence with the American River; intermittent sites on the south bank of the NCC immediately upstream of the confluence with the Sacramento River; approximately 4 miles of the Pleasant Grove Creek Canal; the Sacramento Bypass and Sacramento Weir; approximately 8 miles of the Natomas East Main Drainage Canal (NEMDC); approximately 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek; approximately ½ mile of the south bank of Dry/Robla Creeks; approximately 2 miles of the north and south banks of Arcade Creek; and approximately ½ mile of the Magpie Creek Diversion Canal (Enclosure 1).

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Sam Daniels
Shingle Springs Band of Miwok Indians
P.O. Box 1340
Shingle Springs, California 95682

JUN 06 2013

Dear Mr. Daniels:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Grayson Coney
Tsi-Akim Maidu
P.O. Box 1316
Colfax, California 95713

JUN 06 2013

Dear Mr. Coney:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA, 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Andrew Franklin
Wilton Rancheria
9300 W. Stockton, Suite 200
Elk Grove, California 95758

JUN 06 2013

Dear Mr. Franklin:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to inform you of the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to provide flood risk reduction to the City of Sacramento and the Natomas Basin pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

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June 13, 2013

Melissa Montag, Senior Environmental Manager/Historian
U.S. Army Corps of Engineers
Cultural, Recreation & Social Assessment Section (CESPK-PD-RC)
1325 J Street
Sacramento, CA 95814-2922

Re: American River Common Features Project - Draft Programmatic Agreement

Dear Ms. Montag:

I am writing on behalf of the Buena Vista Rancheria of Me-Wuk Indians (BVR) to express concerns and share comments about the enclosed American River Common Features Project Draft Programmatic Agreement (PA).

This draft PA requests tribal governments to concur with procedural documents that have not yet been prepared, such as the Historic Properties Management Plan (HPMP) and the Historic Properties Treatment Plans (HPTPs). This is problematic for a couple reasons. First, tribes were not involved in determining the area of potential effect (APE), the presence of historic properties, the effect of the undertaking on historic properties, or the identification of resources having spiritual and cultural significance to American Indians. Further, despite requests, BVR has been denied adequate information and documentation on known historic properties within the APE.

BVR believes that the draft PA was prepared with inadequate tribal government to government consultation, as required under Section 106 of the National Historic Preservation Act and Executive Order 13175. BVR has only received copies of letters sent to other agencies and letters of invitation to initiate consultation. Substantive government to government consultation at the earliest possible stage is crucial in order for consultation to be meaningful.

The meeting between representatives of the Army Corps and BVR, on May 29, 2013, is an example of how the process should work, and BVR looks forward to many more opportunities to consult with the U.S. Army Corps of Engineers on local projects.

If you have any questions regarding our comments please feel free to contact Roselynn Lwenya, Ph.D., Environmental Resources Director, at (916) 491-0011.

Respectfully,

Rhonda L. Morningstar Pope, Chairwoman
Buena Vista Rancheria of Me-Wuk Indians

P.O. BOX 162283 Sacramento, CA 95816
TEL: 916.491.0011 FAX: 916.491.0012
www.buenavistatribe.com

Tribal Council

Marshall McKay
Chairman

James Kinter
Secretary

Anthony Roberts
Treasurer

Mia Durham
Member

Matthew Lowell, Jr.
Member

July 9th, 2013

Melissa Montag
US Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, CA 95814-2922

RE: ARCF Project

Dear Ms. Montag:

Thank you for your project notification letter and programmatic agreement (PA) dated, June 6th, 2013, regarding cultural information on or near the proposed ARCF project, Sacramento area, CA. We appreciate your effort to contact us.

The Cultural Resources Department has reviewed the project and concluded that it is not within the aboriginal territories of the Yocha Dehe Wintun Nation. Therefore, we respectively decline any comment on this project or the PA.

Should you have any questions, please feel free to contact the following individual:

Mr. James Sarmento
Cultural Resources Manager
Yocha Dehe Wintun Nation
Office: (530) 723-0452, Email: jsarmento@yochadehe-nsn.gov

Please refer to identification number YD-06202013-01 in any correspondences concerning this project.

Thank you for providing us with this notice and the opportunity to comment.

Sincerely,

Marshall McKay
Tribal Chairman

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ms. Cathy Bishop
Chairperson
Strawberry Valley Rancheria
1540 Strader Avenue
Sacramento, California 95815

Dear Ms. Bishop:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated June 6, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

c. Provided the Corps' determination, pursuant to 36 CFR § 800.14(b), that a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project would be the means for the Corps to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

We are providing the most recent final draft of the PA for the ARCF Project for your final review and comment before we plan to execute the PA. The final draft of the PA is included in Enclosure 1. We have prepared a short summary document describing the authorizations for the projects in the region, what has been constructed, what agency or partner completed the construction, previous compliance with the National Historic Preservation Act of 1966, as amended, and the National Environmental Policy Act of 1969, and the planned future activities within the watersheds (Enclosure 1, Attachment 4). The APE for the ARCF Project is further described and shown in Enclosure 1, Attachment 3.

Because the APE for the ARCF Project covers a large geographic area and is mostly located along rivers, which have been shown to be sensitive for buried resources, we have developed two predictive models to extrapolate archaeological sensitivity over un-surveyed portions of the APE. The first model is a general model of site locations that anticipates the likelihood that any one or more spots in the study area will be in an archaeological site. The second model highlights portions of the APE where we would be more or less likely to find buried archaeological materials. Ultimately we plan to use the predictive models to assist with planning and evaluating alternatives to avoid adverse effects to cultural resources whenever and wherever possible. The models and detailed information on the archaeological sensitivity assessment are included in Enclosure 2. We request any comments you may have on the archaeological sensitivity assessment.

The PA has been provided to the State Historic Preservation Officer (SHPO), the Advisory Council on Historic Preservation (ACHP), CVFPP, Department of Water Resources (DWR), SAFCA, and potentially interested American Indian Tribes and interested American Indian individuals for review and comment. In a letter dated August 7, 2012, the ACHP declined to participate in consultation for the ARCF Project (Enclosure 1, Attachment 2). Comments were received from the CVFPP, DWR, SAFCA, and American Indian Tribes and have been considered in this current final draft of the PA. A consultation log of communications with American Indian tribes and American Indian individuals for the ARCF Project is included as Enclosure 3.

In April 2013, letters to 100 historical societies, museums, state historic parks, associations with historic interests, local city and county groups, and groups of various prehistoric and historic interests were sent providing a description and map of the project and requesting information on cultural resources within the APE. One response, from the Center for Sacramento History, was received, noting they would keep our letter on file. In accordance with 36 CFR § 800.14(b)(2)(ii), we will also provide potentially interested American Indian Tribes and interested American Indian individuals and the groups and agencies listed above the final draft PA with the forthcoming Environmental

Impact Statement/Environmental Impact Report which will be released for public review this summer.

Pursuant to 36 CFR § 800.14(b)(2)(i), we have requested your involvement in the development of the PA for the ARCF Project. As a potential Concurring Party to the PA, we ask that you review the enclosed final draft PA and archaeological sensitivity assessment and provide us with comments within 30 days. Any comments on the draft final PA received during the review period will be considered for the final PA. If you would like to meet with us so that we may answer any questions you may have about ARCF Project, our proposed Section 106 compliance efforts, or the draft PA, we ask that you contact us to schedule a meeting. Additionally, we request that you inform us if you are interested in signing the PA as a Concurring Party and if there are any required alterations to your signature page of the PA.

Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information about the Section 106 compliance and consultation for the ARCF Project, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

For Alicia E. Kirchner
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Anthony Burris
Ione Band of Miwok Indians
P.O. Box 699
Plymouth, California 95699

Dear Mr. Burris:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated June 6, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

c. Provided the Corps' determination, pursuant to 36 CFR § 800.14(b), that a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project would be the means for the Corps to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Jason Camp
Tribal Historic Preservation Officer
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

Dear Mr. Camp:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted the United Auburn Indian Community of the Auburn Rancheria via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Grayson Coney
Tsi-Akim Maidu
P.O. Box 1316
Colfax, California 95713

Dear Mr. Coney:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ms. Pamela Cubbler
Colfax-Todds Valley Consolidated Tribe
P.O. Box 734
Foresthill, California 95631

Dear Ms. Cubbler:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
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1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Sam Daniels
Shingle Springs Band of Miwok Indians
P.O. Box 1340
Shingle Springs, California 95682

Dear Mr. Daniels:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated June 6, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

c. Provided the Corps' determination, pursuant to 36 CFR § 800.14(b), that a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project would be the means for the Corps to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ms. Mary Daniels-Tarango
Chairperson
Wilton Rancheria
7916 Farnell Way
Sacramento, California 95823

Dear Ms. Daniels-Tarango:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Michael D. DeSpain
Director of OEPP
Mechoopda Indian Tribe of Chico Rancheria
125 Mission Ranch Boulevard
Chico, California 95926

Dear Mr. DeSpain:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

El Dorado Miwok Tribe
P.O. Box 711
El Dorado, California 95623

To Whom It May Concern:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ms. Rose Enos
15310 Bancroft Road
Auburn, California 95603

Dear Ms. Enos:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated June 6, 2013 wherein we:

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Kesner Flores
P.O. Box 1047
Wheatland, California 95692

Dear Mr. Flores:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Daniel Fonseca
Cultural Resources Director
Shingle Springs Band of Miwok Indians
P.O. Box 1340
Shingle Springs, California 95682

Dear Mr. Fonseca:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Nicholas Fonseca
Chairperson
Shingle Springs Band of Miwok Indians
P.O. Box 1340
Shingle Springs, California 95682

Dear Mr. Fonseca:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted the Shingle Springs Band of Miwok Indians via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Andrew Franklin
Wilton Rancheria
9300 W. Stockton, Suite 200
Elk Grove, California 95758

Dear Mr. Franklin:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Reno Franklin
Tribal Historic Preservation Officer
The Enterprise Rancheria of Maidu Indians
2213 Monte Vista Avenue
Oroville, California 95966

Dear Mr. Franklin:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Marcos Guerrero
Cultural Resources Specialist
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

Dear Mr. Guerrero:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Steven Hutchason
Wilton Rancheria
9300 W. Stockton, Suite 200
Elk Grove, California 95758

Dear Mr. Hutchason:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ms. Judith Marks
Colfax-Todds Valley Consolidated Tribe
1068 Silverton Circle
Lincoln, California 95648

Dear Ms. Marks:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Ms. Yvonne Miller
Chairperson
Ione Band of Miwok Indians
P.O. Box 699
Plymouth, California 95669

Dear Ms. Miller:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ambar Mohammed
Cachil DeHe Band of Wintun Indians of the
Colusa Indian Community of the Colusa Rancheria
3730 State Highway 45 # B
Colusa, California 95932

Dear Mr. Mohammed:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ms. Eileen Moon
Vice Chairperson
Tsi-Akim Maidu
760 South Auburn Street, Suite 2-C
Grass Valley, California 95945

Dear Ms. Moon:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

c. Provided the Corps' determination, pursuant to 36 CFR § 800.14(b), that a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project would be the means for the Corps to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ms. April Wallace Moore
19630 Placer Hills Road
Colfax, California 95713

Dear Ms. Moore:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated June 6, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

c. Provided the Corps' determination, pursuant to 36 CFR § 800.14(b), that a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project would be the means for the Corps to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Ms. Glenda Nelson
Chairperson
Enterprise Rancheria of Maidu Indians
2133 Monte Vista Avenue
Oroville, California 95966

Dear Ms. Nelson:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 1 2 2014

Mr. Dennis Ramirez
Chairperson
Mechoopda Indian Tribe of Chico Rancheria
125 Mission Ranch Boulevard
Chico, California 95926

Dear Mr. Ramirez:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Guy Taylor
Representative
Mooretown Rancheria of Maidu Indians
31 Alverde Drive
Oroville, California 95966

Dear Mr. Taylor:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

c. Provided the Corps' determination, pursuant to 36 CFR § 800.14(b), that a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project would be the means for the Corps to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Cosme Valdez
Interim Chief Executive Officer
Nashville-El Dorado Miwok
P.O. Box 580986
Elk Grove, California 95758

Dear Mr. Valdez:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Gene Whitehouse
Chairperson
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

Dear Mr. Whitehouse:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted the United Auburn Indian Community of the Auburn Rancheria via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

c. Provided the Corps' determination, pursuant to 36 CFR § 800.14(b), that a programmatic agreement (PA) to establish a framework for the resolution of potential adverse effects that may result from implementation of the ARCF Project would be the means for the Corps to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Charlie Wright
Chairperson
Cortina Band Wintun of Indians
P.O. Box 1630
Williams, California 95987

Dear Mr. Wright:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted the Cortina Band Wintun of Indians via a letter dated June 6, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

b. Provided the Corps' determination that the ARCF Project is a complex undertaking that may be constructed in multiple phases, that the effects on historic properties cannot be fully determined prior to the approval of the undertaking, and that the ARCF Project may result in adverse effects to historic properties.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 12 2014

Mr. Randy Yonemura
4305 39th Avenue
Sacramento, California 95824

Dear Mr. Yonemura:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Ms. Rhonda Morningstar Pope
Chairperson
Buena Vista Rancheria
1418 20th Street, Suite 200
Sacramento, CA 95811

JUN 25 2014

Dear Ms. Pope:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

We most recently contacted you via a letter dated April 5, 2013 wherein we:

a. Provided the ARCF Project area of potential effects (APE) and project description.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

JUN 2 5 2014

Roselynn Lwenya, Ph.D
Tribal Historic Preservation Officer
Buena Vista Rancheria
1418 20th Street, Suite 200
Sacramento, CA 95811

Dear Dr. Lwenya:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin and areas along the north and south banks of the American River as well as the east bank of the Sacramento River pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999. The ARCF Project is a part of the Common Features General Reevaluation Report. The State of California Central Valley Flood Protection Board (CVFPP), in cooperation with the Sacramento Area Flood Control Agency (SAFCA), is the non-Federal sponsor for the ARCF Project.

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d. Requested your involvement in the development of the PA for the ARCF Project.

e. Enclosed the ARCF Project draft PA for your review and comment.

MIWOK MAIDU United Auburn Indian Community of the Auburn Rancheria

Gene Whitehouse, Chairman | John L. Williams, Vice Chairman | Danny Rey, Secretary | Brenda Adams, Treasurer | Calvin Moman, Council Member

August 19, 2014

Ms. Melissa Montag
U.S. Army Corp of Engineers
Sacramento District
1325 J Street
Sacramento California 95814-29922

Subject: American River Commons Features (ARCF) Project

Dear Melissa Montag,

Thank you for requesting information regarding the above referenced project. The United Auburn Indian Community (UAIC) of the Auburn Rancheria is comprised of Miwok and Southern Maidu (Nisenan) people whose tribal lands are within Placer County and whose service area includes El Dorado, Nevada, Placer, Sacramento, Sutter, and Yuba counties. The UAIC is concerned about development within its aboriginal territory that has potential to impact the lifeways, cultural sites, and landscapes that may be of sacred or ceremonial significance. We appreciate the opportunity to comment on this and other projects in your jurisdiction.

In order to ascertain whether or not the project could affect cultural resources that may be of importance to the UAIC, we would like to receive copies of any archaeological reports that have been, or will be, completed for the project. We also request copies of future environmental documents for the proposed project so that we have the opportunity to comment on potential impacts and proposed mitigation measures related to cultural resources. Finally, we would like the opportunity to have our tribal monitors accompany you during the field survey. The information gathered will provide us with a better understanding of the project and cultural resources on site and is invaluable for consultation purposes.

Our preservation committee has identified many cultural resources within your project area and in close proximity, and would like to request a site visit to confirm their locations and meet with you regarding this project. In addition, we have several specific requests that arose out of your meeting with our committee members and staff on August 5, 2014. We ask that the USACE and DWR provide the UAIC with:

- A confidentiality and/or data sharing agreement;
- A burial plan;
- A Historic Properties Treatment Plan that is approved before ground disturbing activities begin;
- A confederacy agreement between the tribes that wish to consult on the project;
- Signatory status on the Programmatic Agreement.

Each of these is crucial to ensuring that the many cultural resources within your project area are protected and that any disturbance to the resources is minimized.

We will begin preparing comments to the PA and look forward to meeting with you again so that we can maintain an open dialogue. Thank you again for taking these matters into consideration, and for involving the UAIC early in the planning process. We look forward to reviewing the documents we requested. Please contact Marcos Guerrero, Cultural Resources Manager, at (530) 883-2364 or by email at mguerrero@auburnrancheria.com if you have any questions.

Sincerely,

Gene Whitehouse,
Chairman

CC: Marcos Guerrero, CRM

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Charlie Wright
Chairperson
Cortina Wintun Environmental Protection Agency
P.O. Box 1630
Williams, California 95987

Dear Mr. Wright:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

The geotechnical study consists of drilling thirty eight (38) soil borings within the levee prism, levee toe, waterside berm, or adjacent field along the American River and NEMDC. The borings will be performed by a truck mounted drill rig or hand auger. There will be a total of eleven (11) borings using a truck or track mounted drill rig and twenty-seven (27) hand augers taking place. The borings will be up to 8 inches in diameter and up to 80 feet deep, and the augers will be up to 8 inches in diameter and up to 15 feet deep. The main access and travel paths to the boring and auger locations would be from the existing levee roads, levee access ramps, bike paths, and adjacent streets. After boring and augering is complete all holes/excavations will be backfilled and the surface returned to pre-work conditions. Enclosed is a map of the proposed boring and augering locations and a table describing the activities (Enclosures 1 and 2).

A records search and archeological survey completed on October 14, 2014 revealed that the locations for the geotechnical study have been previously subjected to cultural resources inventory twice and that there are no known prehistoric resources located

within or adjacent to the locations for the geotechnical study. Although there are three previously recorded historic-era features (NEMDC west levee, Del Paso Road, and Northgate Boulevard) within the area, none will be affected by the geotechnical study. A recent archeological field verification of the boring and augering locations did not result in the identification of previously unknown prehistoric resources. A single, isolated, potentially historic-era feature was identified in the NEMDC channel just north of San Juan Road, but it is located outside the area planned for the geotechnical study. However, in the event of an unanticipated discovery during the borings or augering, all work at the location of the discovery would stop and both the State Historic Preservation Officer and tribes would be notified.

Previous consultation with Native American tribes on other Corps projects in the vicinity of the geotechnical study locations has noted the area is potentially sensitive for cultural resources. As a result, an archeological monitor meeting 36 CFR § 61 and the Secretary of the Interior's Professional Qualifications Standards for Archeology will inspect the available soil for the presence of cultural resources and will collect samples of organic matter from a variety of subsurface sediments for radiocarbon dating in order to better understand the age of alluvial deposits and inform the Corps' assessments of the probability of encountering buried archaeological sites.

We are sensitive toward the protection of traditional cultural properties and sacred sites, and make every effort to avoid them. Please let us know if you have knowledge of locations of archeological sites, sacred sites, or areas of traditional cultural value or concern in or near the locations identified for the borings and augering. Correspondence may be sent to: Ms. Melissa Montag (CESPK-PD-RC), U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814. If you have any questions or would like additional information, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Kesner Flores
P.O. Box 1047
Wheatland, California 95692

Dear Mr. Flores:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

The geotechnical study consists of drilling thirty eight (38) soil borings within the levee prism, levee toe, waterside berm, or adjacent field along the American River and NEMDC. The borings will be performed by a truck mounted drill rig or hand auger. There will be a total of eleven (11) borings using a truck or track mounted drill rig and twenty-seven (27) hand augers taking place. The borings will be up to 8 inches in diameter and up to 80 feet deep, and the augers will be up to 8 inches in diameter and up to 15 feet deep. The main access and travel paths to the boring and auger locations would be from the existing levee roads, levee access ramps, bike paths, and adjacent streets. After boring and augering is complete all holes/excavations will be backfilled and the surface returned to pre-work conditions. Enclosed is a map of the proposed boring and augering locations and a table describing the activities (Enclosures 1 and 2).

A records search and archeological survey completed on October 14, 2014 revealed that the locations for the geotechnical study have been previously subjected to cultural resources inventory twice and that there are no known prehistoric resources located within or adjacent to the locations for the geotechnical study. Although there are three previously recorded historic-era features (NEMDC west levee, Del Paso Road, and

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Ms. Rose Enos
15310 Bancroft Road
Auburn, California 95603

Dear Ms. Enos:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

El Dorado Miwok Tribe
P.O. Box 711
El Dorado, California 95623

To Whom It May Concern:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Ms. Cathy Bishop
Chairperson
Strawberry Valley Rancheria
1540 Strader Avenue
Sacramento, California 95815

Dear Ms. Bishop:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Andrew Franklin
Chairperson
Wilton Rancheria
9728 Kent Street
Elk Grove, California 95624

Dear Mr. Franklin:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 20 2014

Mr. Ambar Mohammed
Cachil DeHe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria
3730 State Highway 45 # B
Colusa, California 95932

Dear Mr. Mohammed:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Ms. Yvonne Miller
Chairperson
Ione Band of Miwok Indians
P.O. Box 699
Plymouth, California 95669

Dear Ms. Miller:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Ms. Judith Marks
Colfax-Todds Valley Consolidated Tribe
1068 Silverton Circle
Lincoln, California 95648

Dear Ms. Marks:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Ms. April Wallace Moore
19630 Placer Hills Road
Colfax, California 95713

Dear Ms. Moore:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch NOV 2 0 2014

Ms. Glenda Nelson
Chairperson
Enterprise Rancheria of Maidu Indians
2133 Monte Vista Avenue
Oroville, California 95966

Dear Ms. Nelson:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Ms. Rhonda Morningstar Pope
Chairperson
Buena Vista Rancheria
1418 20th Street, Suite 200
Sacramento, California 95811

Dear Ms. Pope:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Dennis Ramirez
Chairperson
Mechoopda Indian Tribe of Chico Rancheria
125 Mission Ranch Boulevard
Chico, California 95926

Dear Mr. Ramirez:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Randy Yonemura
4305 39th Avenue
Sacramento, California 95824

Dear Mr. Yonemura:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Gene Whitehouse
Chairperson
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

Dear Mr. Whitehouse:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

The geotechnical study consists of drilling thirty eight (38) soil borings within the levee prism, levee toe, waterside berm, or adjacent field along the American River and NEMDC. The borings will be performed by a truck mounted drill rig or hand auger. There will be a total of eleven (11) borings using a truck or track mounted drill rig and twenty-seven (27) hand augers taking place. The borings will be up to 8 inches in diameter and up to 80 feet deep, and the augers will be up to 8 inches in diameter and up to 15 feet deep. The main access and travel paths to the boring and auger locations would be from the existing levee roads, levee access ramps, bike paths, and adjacent streets. After boring and augering is complete all holes/excavations will be backfilled and the surface returned to pre-work conditions. Enclosed is a map of the proposed boring and augering locations and a table describing the activities (Enclosures 1 and 2).

A records search and archeological survey completed on October 14, 2014 revealed that the locations for the geotechnical study have been previously subjected to cultural resources inventory twice and that there are no known prehistoric resources located

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Cosme Valdez
Interim Chief Executive Officer
Nashville-El Dorado Miwok
P.O. Box 580986
Elk Grove, California 95758

Dear Mr. Valdez:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Guy Taylor
Representative
Mooretown Rancheria of Maidu Indians
31 Alverde Drive
Oroville, California 95966

Dear Mr. Taylor:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

NOV 2 0 2014

Mr. Don Ryberg
Chairman
Tsi-Akim Maidu
1239 East Main Street
Grass Valley, California 95945

Dear Mr. Ryberg:

The U.S. Army Corps of Engineers (Corps), along with its non-Federal sponsors, the Central Valley Flood Protection Board (CVFPB) and Sacramento Area Flood Control Agency (SAFCA), are conducting geotechnical study as a part of the American River Watershed Common Features Project Natomas Basin, specifically Reach H, which extends from Northgate Boulevard to the Natomas East Main Drainage Canal (NEMDC) Stormwater Pump Station. Authorization for the Common Features project is provided by Section 7002 of Water Resources Reform and Development Act (WRRDA) (PL 113-121) of 2014. As part of these studies, soil borings will be performed to collect, classify, and test soil samples along the American River and NEMDC near Sacramento, California. Additionally, in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36 CFR § 800.4, and as part of efforts to identify historic properties, the Corps will collect samples of organic matter (e.g. charcoal, wood) encountered during the studies for radiocarbon dating. This work is expected to occur between December 2014 and February of 2015.

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MIWOK MAIDU United Auburn Indian Community of the Auburn Rancheria

Gene Whitehouse, Chairman | John L. Williams, Vice Chairman | Danny Rey, Secretary | Brenda Adams, Treasurer | Calvin Moman, Council Member

May 18, 2015

Colonel Michael Farrell, District Commander
U.S. Army Corps of Engineers
Sacramento District
1325 J Street, Room 1513
Sacramento, California 95814

RE: Formal Request for Government-to-Government Consultation, American River Watershed Common Features General Reevaluation Report, Draft Environmental Impact Statement/Environmental Impact Report, March 2015

Dear Colonel Farrell,

The United Auburn Indian Community (UAIC) is sending this letter to the U.S. Army Corps of Engineers (USACE) requesting formal Government-to-Government Consultation for the American River Common Features (ARCF) Project, located in Sacramento County. The primary purpose of government-to-government consultation as described in Federal Executive Order 13175 "Consultation and Coordination with Indian Tribal Governments" is to ensure that the UAIC is given the opportunity to provide meaningful and timely input regarding proposed USACE actions that uniquely or significantly affect our burial and sacred sites and places.

With this letter, the UAIC is notifying the USACE that unique or significant historic properties will be adversely affected by your project-related planned and proposed levee improvements. Early identification of Tribal concerns will allow the USACE to consider alternatives to avoid and minimize potential impacts to our burial sites and cultural resources. The UAIC would like to be a signatory party to the Programmatic Agreement and be involved early and often as the project planning, alternatives, and documentation are developed and refined.

The UAIC understands and has concerns regarding the confidentiality of information on areas or resources of religious, traditional and cultural importance to the Tribe. We would be happy to discuss these concerns and develop procedures to ensure the confidentiality of such information is strictly maintained.

Your timely response will greatly assist us in being able to have our concerns incorporated into project planning and the Final EIR/EIS. Please contact Marcos Guerrero, Cultural Resources Manager, at (530) 883-2364 or email at mguerrero@auburnrancheria.com if you have any questions.

Sincerely,

Gene Whitehouse,
Chairman

CC:
Mark A. Gilfillan, USACE

Melissa L. Montag, USACE
Jason Camp, THPO
Danny Rey, Secretary

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO, CA 95814-2922

REPLY TO
ATTENTION OF

JUL 07 2015

Environmental Resources Branch

Mr. Gene Whitehouse
Chairperson
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

Dear Mr. Whitehouse:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), we are writing to continue our consultation with you regarding the proposed American River Common Features (ARCF) Project. The U.S. Army Corps of Engineers (Corps) is authorized to reduce flood risk to the City of Sacramento and the Natomas Basin, and areas along the north and south banks of the American River, as well as the east bank of the Sacramento River, pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999 and the Water Resources Reform and Development Act of 2014. In addition to the work contained in these authorizations, a General Reevaluation Report is being prepared to identify the extent of Federal interest in additional levee improvements in the greater Sacramento area. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

As a result of your stated interest in the ARCF Project, and in compliance with Section 106 of the NHPA, we have been meeting with the United Auburn Indian Community of the Auburn Rancheria (UAIC) quarterly with the most recent meeting occurring on May 19, 2015. We also received your email dated April 16, 2015, wherein you provided several comments on the ARCF Draft Environmental Impact Statement/Draft Environmental Impact Report. Based on several of your comments we request any specific information the UAIC may be able to provide in order to ensure that the Corps completely and accurately understands the UAIC's issues and concerns with the ARCF Project:

a. Comment 1: What specific design features would the UAIC prefer be incorporated to reduce the potential for direct cultural impacts?

b. Comment 2: Please provide specific information on the tribal values the UAIC would like considered under construction timing, project and alternatives screening criteria, environmental commitments for cultural resources, social effects, and environmental justice.

c. Comment 2: Please provide specific information on how the UAIC should be identified as a viewer group for visual impacts.

d. Comment 5: Please provide specific information on tribal cultural values, sanctified cemeteries, and/or cultural landscapes that the Corps should consider.

e. Comment 7: Please provide specific information on how the UAIC believes there will be cumulative effects or effects to cultural resources and/or cultural landscapes across several phases or projects over wide geography.

f. Comment 11: Please provide information on how the UAIC believes vibration or compression effects on cultural resources should be considered.

g. Comment 11: Please provide specific information on the vegetation the UAIC considers to be native or cultural plants, their relationships to burial mounds or tribal cultural landscapes, and the impacts the UAIC believes should be considered.

h. Comment 11: Please provide information on traditional cultural properties and cultural landscapes and the importance of place, setting, and landscape to the UAIC.

We welcome your input on any of the subjects above, or any other information the UAIC would be willing to provide that the Corps may take into consideration while preparing the Final Environmental Impact Statement/Final Environmental Impact Report (FEIS/FEIR). If there is information you would like us to consider but not include in the FEIS/FEIR we welcome the opportunity to discuss accommodating those kinds of requests as well. In order to allow time to consider this information, please provide any responses within 15 calendar days of receipt of this letter.

Correspondence may be sent to Ms. Melissa Montag, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922.

If you have any questions or would like additional information about the Section 106 compliance and consultation for the ARCF Project, please contact Ms. Montag at (916) 557-7907 or by email at: Melissa.L.Montag@usace.army.mil. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

FOR Alicia E. Kirchner
Chief, Planning Division

CF:
Jason Camp, Tribal Historic Preservation Officer, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603
Marcos Guerrero, Cultural Resources Manager, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

AUG 24 2015

Mr. Gene Whitehouse
Chairperson
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

Dear Mr. Whitehouse:

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA) and the U.S. Army Corps of Engineers, Sacramento District (Corps), Tribal Consultation Policy (Nov. 1, 2012), we are writing to continue consultation with you regarding the proposed American River Common Features (ARCF) Project. The Corps is authorized to reduce flood risk to the City of Sacramento, the Natomas Basin, areas along the north and south banks of the American River, and the east bank of the Sacramento River, pursuant to the Water Resources Development Act (WRDA) of 1996 with additional authority provided in WRDA 1999 and the Water Resources Reform and Development Act of 2014. We are further pursuing additional authorization of levee and flow conveyance improvements. The State of California Central Valley Flood Protection Board, in cooperation with the Sacramento Area Flood Control Agency, is the non-Federal sponsor for the ARCF Project.

We received your letter dated May 18, 2015 in which you requested formal Government-to-Government Consultation, notified the Corps that historic properties will be adversely affected by the ARCF Project, and requested that the Corps invite the UAIC to sign the ARCF Project Programmatic Agreement (PA) as a signatory party. The Corps' Tribal Liaison, Mark Gilfillan, has been in contact with your staff to initiate formal Government-to-Government Consultation and to reiterate our commitment to working closely and openly with the UAIC to provide meaningful and timely input regarding the Corps' ARCF Project.

I have given your request careful consideration and would like to invite the tribe to join our PA as a concurring party. With the role as a concurring party, along with my staff working closely and cooperatively with yours, it is my sincere hope and intent to address our mutual concerns regarding any adverse effects to historic properties. As a concurring party, the tribe reserves the ability to object to the manner in which the PA is implemented, if at any point you believe that your voice is not being heard. My goal is that your ideas and concerns are addressed as part of implementation of the PA throughout this project. I share your concerns regarding potential adverse

effects to historic properties, and I am committed to ensuring that our project avoids or minimizes to the maximum extent any adverse effects through implementation of the PA and throughout construction of the project.

We look forward to continuing consultation with the UAIC on the ARCF Project. Correspondence may be sent to Mr. Dan Tibbitts, Project Manager, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. I am looking forward to meeting with you to further engage in Government-to-Government Consultation for the ARCF Project. Please contact Mark Gilfillan, Corps Tribal Liaison, at (970) 243-1199 x15, or by email at: Mark.A.Gilfillan@usace.army.mil to further coordinate a Government-to-Government Consultation meeting. Please contact Mr. Dan Tibbitts, Project Manager, at (916) 557-7372 with any specific project questions.

Sincerely,

Michael J. Farrell
Colonel, U.S. Army
District Commander

cc:
Jason Camp, Tribal Historic Preservation Officer, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603
Marcos Guerrero, Cultural Resources Manager, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Ms. Rhonda Morningstar Pope
Chairperson
Buena Vista Rancheria
1418 20th Street, Suite 200
Sacramento, California 95811

Dear Ms. Morningstar Pope:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

Please return an original signed copy of the appropriate signature page if you wish to participate in this agreement as a concurring party. The signed page and/or any questions or comments may be directed to Ms. Melissa Montag, CESPK-PD-RC, U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814; email at Melissa.L.Montag@usace.army.mil; or telephone at (916) 557-7907.

Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

Cc: (w/enclosure)
Ms. Roselynn Lwenya, Tribal Historic Preservation Officer, Buena Vista Rancheria,
1418 20th Street, Suite 200, Sacramento, California 95811

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Ambar Mohammed
Cachil DeHe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria
3730 State Highway 45 # B
Colusa, California 95932

Dear Mr. Mohammed:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Ms. Judith Marks
Colfax-Todds Valley Consolidated Tribe
1068 Silverton Circle
Lincoln, California 95648

Dear Ms. Marks:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Ms. Pamela Cubbler
Colfax-Todds Valley Consolidated Tribe
P.O. Box 734
Foresthill, California 95631

Dear Ms. Cubbler:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Charlie Wright
Chairperson
Cortina Wintun Environmental Protection Agency
P.O. Box 1630
Williams, California 95987

Dear Mr. Wright:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

El Dorado Miwok Tribe
P.O. Box 711
El Dorado, California 95623

Dear Sir or Madam:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Ms. Rose Enos
15310 Bancroft Road
Auburn, California 95603

Dear Ms. Enos:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Ms. Glenda Nelson
Chairperson
Enterprise Rancheria of Maidu Indians
2133 Monte Vista Avenue
Oroville, California 95966

Dear Ms. Nelson:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

Cc: (w/enclosure)
Mr. Reno Franklin, Tribal Historic Preservation Officer, Enterprise Rancheria of Maidu Indians, 2133 Monte Vista Avenue, Oroville, California 95669

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Kesner Flores
P.O. Box 1047
Wheatland, California 95692

Dear Mr. Flores:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Dr. Crystal Martinez
Chairperson
Ione Band of Miwok Indians
P.O. Box 699
Plymouth, California 95669

Dear Dr. Martinez:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

Cc: (w/enclosure)
Cultural Committee, Ione Band of Miwok Indians, PO Box 699, Plymouth, California 95669

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC

Mr. Dennis Ramirez
Chairperson
Mechoopda Indian Tribe of Chico Rancheria
125 Mission Ranch Boulevard
Chico, California 95926

DEC 07 2015

Dear Mr. Ramirez:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

Cc: (w/enclosure)
Mr. Michael D. DeSpain, Director of OEPP, Mechoopda Indian Tribe of Chico Rancheria, 125 Mission Ranch Boulevard, Chico, California 95926

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Guy Taylor
Representative
Mooretown Rancheria of Maidu Indians
31 Alverde Drive
Oroville, California 95966

Dear Mr. Taylor:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Cosme Valdez
Interim Chief Executive Officer
Nashville-El Dorado Miwok
P.O. Box 580986
Elk Grove, California 95758

Dear Mr. Valdez:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Nicholas Fonseca
Chairperson
Shingle Springs Band of Miwok Indians
P.O. Box 1340
Shingle Springs, California 95682

Dear Mr. Fonseca:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

Cc: (w/enclosure)
Mr. Daniel Fonseca, Cultural Resources Director, Shingle Springs Band of Miwok Indians, PO Box 1340, Shingle Springs, California 95682
Mr. Hermo Olanio, Vice Chairperson, Shingle Springs Band of Miwok Indians, PO Box 1340, Shingle Springs, California 95682
Ms. Kara Perry, Administrative Assistant, Cultural Resources Department, Shingle Springs Band of Miwok Indians, PO Box 1340, Shingle Springs, California 95682

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Ms. Cathy Bishop
Chairperson
Strawberry Valley Rancheria
1540 Strader Avenue
Sacramento, California 95815

Dear Ms. Bishop:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Don Ryberg
Chairman
Tsi-Akim Maidu
1239 East Main Street
Grass Valley, California 95945

Dear Mr. Ryberg:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

Cc: (w/enclosure)
Ms. Eileen Moon, Vice Chairperson, Tsi-Akim Maidu, 1239 East Main Street, Grass Valley, California 95945
Mr. Grayson Coney, Tsi-Akim Maidu, P.O. Box 1316, Colfax, California 95713

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

DEC 07 2015

Environmental Resources Branch

Mr. Gene Whitehouse
Chairperson
United Auburn Indian Community of the Auburn Rancheria
10720 Indian Hill Road
Auburn, California 95603

Dear Mr. Whitehouse:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

Cc: (w/enclosure)
Mr. Marcos Guerrero, Cultural Resources Specialist, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603
Mr. Jason Camp, Tribal Historic Preservation Officer, United Auburn Indian Community of the Auburn Rancheria, 10720 Indian Hill Road, Auburn, California 95603

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Raymond Hitchcock
Chairperson
Wilton Rancheria
9728 Kent Street
Elk Grove, California 95642

Dear Mr. Hitchcock:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

Cc: (w/enclosure)
Mr. Steven Hutchason, Wilton Rancheria, 9728 Kent Street, Elk Grove, California 95642

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Mr. Randy Yonemura
4305 39th Avenue
Sacramento, California 95824

Dear Mr. Yonemura:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

American River Common Features GRR

EIS Cultural Resources Appendix

Enclosure 6

Letters to the Interested Public

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

State of California Central Valley Flood Protection Board
Andrea Buckley
3310 El Camino Avenue, Room 151
Sacramento, California 95821

Dear Ms. Buckley:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Fair Oaks Historical Society
P.O. Box 2044
Fair Oaks, California 95628

Dear Sir or Madam:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Golden Gate State Museum
1020 O Street
Sacramento, California 95814

Dear Sir or Madam:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Sacramento County Historical Society
P.O. Box 160065
Sacramento, California 95816

Dear Sir or Madam:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Society for California Archaeology
1692 Mangrove Avenue, #153
Chico, California 95926

Dear Sir or Madam:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Sutter County Historical Society
P.O. Box 1004
Yuba City, California 95992

Dear Sir or Madam:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

West Sacramento Historical Society
P.O. Box 1202
West Sacramento, California 95691

Dear Sir or Madam:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT
1325 J STREET
SACRAMENTO CA 95814-2922

Environmental Resources Branch

DEC 07 2015

Yolo County Historical Society
P.O. Box 1447
Woodland, California 95776

Dear Sir or Madam:

We thank you for your interest in the American River Common Features Project (Project). The U.S. Army Corps of Engineers, Sacramento District (Corps), is proceeding to implement aspects of the Project as authorized in the Water Resources Development Act (WRDA) of 1996, as amended by the WRDA 1999 and the Energy and Water Development and Related Agencies Appropriations Act of 2008, and as authorized by Section 7002 of the Water Resources Reform and Development Act of 2014. At this time, we are submitting the signed Programmatic Agreement for your records and to invite you to sign the document as a concurring party.

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Sincerely,

for Alicia E. Kirchner
Chief, Planning Division

Enclosure

Air Quality Technical Appendix

AIR QUALITY

The air quality emissions analysis for the ARCF GRR was developed based on several interrelated assumptions and constraints:

- The project will require 14 separate years to construct the required features;
- Project funding will be limited to $100 million per construction year;
- The project will receive $100 million per construction year;
- In any given year, approximately 85% of the funding will be applied toward construction;
- A construction season is six months (April 15 to October 15);
- Construction will begin in 2015;
- All required administrative, legal, real estate and environmental clearances/approvals will be acquired prior to initiation of construction.
- All project plans and specifications will require that construction contractors use only off-road equipment that implements the Sacramento Metropolitan Air Quality Management Districts' (SMAQMD) Enhanced Exhaust Control Practices and only use on-road hauling equipment that was manufactured in 2010, or later.
- If the off-road equipment and on-road hauling specifications stated above are not met, it cannot be assured that the project air emissions can meet the Federal *de minimis* standards.

It was determined through internal discussions, as well as discussions with staff from the SMAQMD, that the most reasonable approach to determine if the project was to be in compliance with Federal and local standards was to base the evaluation on a "worst case scenario" construction year.

The project team determined that construction in the second year within Reach F of the American River South basin would be the construction season that would result in the most combined air emissions. Reach F was chosen because it is the single longest reach (5 miles) in the entire Common Features Project, and due to design, constructability and funding constraints, will take 3 1/3 years to construct. This would allow for 1.5 miles of construction in years 1 through 3, with the last 0.5 miles to be completed in the fourth year. The following construction activities are scheduled for this reach: clearing of trees and vegetation, degrading and excavation of the levee, construction of two types of seepage control slurry cutoff walls (conventional slot-trench and deep soil mixing), construction of a retaining wall to allow corrections to the levee height and width, reconstruction of the levee, relocation of utilities, and delivery and installation of rip-rap on the waterside slope. The second year of construction in Reach F was chosen because the slurry cutoff walls must be allowed to cure until the following construction season before the rip-rap is placed. Under this scenario, the rip-rap would be placed on the slopes of the segment completed in the first year of construction, while all other construction activities are

being conducted in the second year segment. The staggering of construction years for the placement of rip-rap would continue until Reach F would be completed.

In close coordination with SMAQMD, the Corps uses their Road Construction Emissions Model (RCEM), as it was designed to calculate air emissions for linear projects. The construction activities listed above were broken out into 19 individual sub-tasks based on information developed by Corps engineering and cost-estimating staff. Using the RCEM, a model run was conducted for each sub-task, with one exception: the barging of rip-rap material to the project site. In this case, information for barging material was developed, in close coordination with SMAQMD staff, for similar activities being conducted for the Joint Federal Project (JFP). It was agreed that it is reasonable to use this information for the purposes of a feasibility-level study. Although calculations for the JFP involved smaller harbor craft than that assumed for the Common Features project, SMAQMD staff determined that it was reasonable to extrapolate the air emissions data by increasing the horsepower, daily hours and number of days in the JFP model to calculate specific emissions data (ROG, CO, NOx, PM and CO_2) for the Common Features project.

In order to provide a means of comparison for future decision-making purposes, the delivery and placement task was also calculated using the assumption that same amount of material to be barged to the project site, would be trucked to the site in the same period of time. Those results are shown in Tables 1a and 2a (calculated in pounds per day under local standards) and 1b and 2b (calculated in tons per construction project under Federal standards). Note that neither version of this scenario (barging or trucking rip-rap) would be able to perform consistently under the local standard for NOx (Tables 1a and 2a), however, the trucking alternative would require a lower overall mitigation fee cost. In the case of the Federal *de minimis* standards (Tables 1b and 2b) the alternative that involves trucking the rip-rap is within the Federal de minimis standard, even without mitigation, while the barging alternative would likely meet the standard using the mitigation provided by the implementation of Enhance Exhaust Control Practices for off-road equipment and only using on-road hauling equipment that was manufactured in 2010, or later.

Table 1a. Estimated Air Emissions for the American River Common Features Project (South) – Reach F (Year 2)
(with Truck Rip-Rap Delivery)
Maximum Pounds per Day

Project Tasks	ROG	CO	NO_x	NO_x (*mitigated)	Mitigation Fee **	Total PM_{10}	Exhaust PM_{10}	Fugitive Dust PM_{10}	Total $PM_{2.5}$	Exhaust $PM_{2.5}$	Fugitive Dust $PM_{2.5}$	CO_2
1. Clear Vegetation (3 days)	4.5	22.7	194.3	159.1	$1,993.36	71.2	4.2	67.0	16.6	2.7	13.9	38,068
2. Tree Removal (11 days)	1.4	9.0	33.4	N/A		1.0	1.0	-	0.8	0.8	-	5,303
3. Strip to Stockpile (3 days)	10.5	51.7	129.2	104.3	$519.19	72.4	5.4	67.0	18.8	4.9	13.9	12,179
4. Strip to Spoils (1 day)	13.7	66.8	272.4	245.5	$1,439.20	75.4	8.4	67.0	20.7	6.8	13.9	40,202
5. Excavation to Stockpile (31 days)	11.2	55.5	139.6	112.7	$7,699.96	72.7	5.7	67.0	19.1	5.2	13.9	13,162
6. Excavation to Spoils (1 day)	18.3	89.6	335.9	298.5	$1,914.45	77.8	10.8	67.0	22.9	9.0	13.9	47,018
7. Import Sand (8 days)	6.2	27.7	167.0	158.6	$5,279.80	71.7	4.7	67.0	17.4	3.5	13.9	29,264
8. Import Cohesive Fill (5 days)	8.5	41.5	196.0	182.3	$4,362.45	72.8	5.8	67.0	18.4	4.5	13.9	32,565
9. Cutoff Wall SCB (34 days)	4.8	30.0	50.1	N/A		69.6	2.6	67.0	16.3	2.4	13.9	6,182
10. Cutoff Wall DSM (110 days)	16.9	100.5	155.6	124.5	$38,961.62	75.4	8.4	67.0	21.6	7.7	13.9	18,598
11a. Retaining Wall (Concrete) (2 days)	4.0	19.6	146.3	142.6	$1,033.00	70.6	3.6	67.0	16.3	2.4	13.9	28,259
11b. Retaining Wall (Forms/Steel) (32 days)	1.1	5.2	13.1	N/A		67.7	0.7	67.0	14.6	0.6	13.9	1,560
12. Fill from Stockpile (30 days)	4.5	24.0	56.3	N/A		69.4	2.4	67.0	16.1	2.2	13.9	6,281
13. Import Random Fill (7 days)	6.7	34.2	176.2	166.0	$5,084.29	71.8	4.8	67.0	17.5	3.6	13.9	30,691
14. Import Topsoil Fill (6 days)	5.9	29.9	148.9	139.7	$2,942.97	71.2	4.2	67.0	17.1	3.1	13.9	25,646
15. Surfacing (1 day)	14.5	64.3	331.0	309.7	$2,014.88	77.5	10.5	67.0	22.1	8.2	13.9	55,317
16. Import Rip-Rap (Truck) (80 days)	4.9	25.9	160.9	154.9	$50,143.46	71.0	4.0	67.0	16.8	2.8	13.9	30,116
17. Utilities #1 (3 days)	2.1	11.3	24.7	N/A		101.7	1.2	100.5	22.0	1.1	20.9	2,400
18. Utilities #2 (52 days)	1.1	5.1	11.7	N/A		101.2	0.7	100.5	21.5	0.6	20.9	1,264
Maximum (lbs/day)	**18.3**	**100.5**	**335.9**	**309.7**		**101.7**	**10.8**	**100.5**	**22.9**	**9.0**	**20.9**	**55,317**
SMAQMD thresholds (lbs/day)	**N/A**	**N/A**	**85**	**85**		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Total Estimated Mitigation Fee					**$123,388.63**							

Notes:
***** Values based on a 20% mitigation for off-road equipment
** Calculation of Mitigation Fee: (any mitigated value over the 85 lbs/day threshold) X (number of days the task is performed) X ($8.54/lb) X (5% Administrative Fee) (As of 12/18/2012)

Table 1b. Estimated Air Emissions for the American River Common Features Project (South) – Reach F (Year 2)
(with Barge Rip-Rap Delivery)
Maximum Pounds per Day

Project Tasks	ROG	CO	NO_x	NO_x (*mitigated)	Mitigation Fee **	Total PM_{10}	Exhaust PM_{10}	Fugitive Dust PM_{10}	Total $PM_{2.5}$	Exhaust $PM_{2.5}$	Fugitive Dust $PM_{2.5}$	CO_2
1. Clear Vegetation (3 days)	4.5	22.7	194.3	159.1	$1,993.36	71.2	4.2	67.0	16.6	2.7	13.9	38,068
2. Tree Removal (11 days)	1.4	9.0	33.4	N/A		1.0	1.0	-	0.8	0.8	-	5,303
3. Strip to Stockpile (3 days)	10.5	51.7	129.2	104.3	$519.19	72.4	5.4	67.0	18.8	4.9	13.9	12,179
4. Strip to Spoils (1 day)	13.7	66.8	272.4	245.5	$1,439.20	75.4	8.4	67.0	20.7	6.8	13.9	40,202
5. Excavation to Stockpile (31 days)	11.2	55.5	139.6	112.7	$7,699.96	72.7	5.7	67.0	19.1	5.2	13.9	13,162
6. Excavation to Spoils (1 day)	18.3	89.6	335.9	298.5	$1,914.45	77.8	10.8	67.0	22.9	9.0	13.9	47,018
7. Import Sand (8 days)	6.2	27.7	167.0	158.6	$5,279.80	71.7	4.7	67.0	17.4	3.5	13.9	29,264
8. Import Cohesive Fill (5 days)	8.5	41.5	196.0	182.3	$4,362.45	72.8	5.8	67.0	18.4	4.5	13.9	32,565
9. Cutoff Wall SCB (34 days)	4.8	30.0	50.1	N/A		69.6	2.6	67.0	16.3	2.4	13.9	6,182
10. Cutoff Wall DSM (110 days)	16.9	100.5	155.6	124.5	$38,961.62	75.4	8.4	67.0	21.6	7.7	13.9	18,598
11a. Retaining Wall (Concrete) (2 days)	4.0	19.6	146.3	142.6	$1,033.00	70.6	3.6	67.0	16.3	2.4	13.9	28,259
11b. Retaining Wall (Forms/Steel) (32 days)	1.1	5.2	13.1	N/A		67.7	0.7	67.0	14.6	0.6	13.9	1,560
12. Fill from Stockpile (30 days)	4.5	24.0	56.3	N/A		69.4	2.4	67.0	16.1	2.2	13.9	6,281
13. Import Random Fill (7 days)	6.7	34.2	176.2	166.0	$5,084.29	71.8	4.8	67.0	17.5	3.6	13.9	30,691
14. Import Topsoil Fill (6 days)	5.9	29.9	148.9	139.7	$2,942.97	71.2	4.2	67.0	17.1	3.1	13.9	25,646
15. Surfacing (1 day)	14.5	64.3	331.0	309.7	$2,014.88	77.5	10.5	67.0	22.1	8.2	13.9	55,317
16. Import Rip-Rap (Barge) (80 days)	27.6	106.5	256.8	222.4	$98,565.26	10.0	1.0	67.0	4.5	1.2	13.9	9,726
17. Utilities #1 (3 days)	2.1	11.3	24.7	N/A		101.7	1.2	100.5	22.0	1.1	20.9	2,400
18. Utilities #2 (52 days)	1.1	5.1	11.7	N/A		101.2	0.7	100.5	21.5	0.6	20.9	1,264
Maximum (lbs/day)	**18.3**	**100.5**	**335.9**	**309.7**		**101.7**	**10.8**	**100.5**	**22.9**	**9.0**	**20.9**	**55,317**
SMAQMD thresholds (lbs/day)	**N/A**	**N/A**	**85**	**85**		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Total Estimated Mitigation Fee					**$171,810.43**							

Notes:
***** Values based on a 20% mitigation for off-road equipment
** Calculation of Mitigation Fee: (any mitigated value over the 85 lbs/day threshold) X (number of days the task is performed) X ($8.54/lb) X (5% Administrative Fee) (As of 12/18/2012)

Table 2a. Estimated Air Emissions for the American River Common Features Project (South) – Reach F (Year 2) (with Truck Rip-Rap Delivery)
Total Tons Per Construction Project

Project Tasks	ROG	CO	NO_x	Total PM_{10}	Exhaust PM_{10}	Fugitive Dust PM_{10}	Total $PM_{2.5}$	Exhaust $PM_{2.5}$	Fugitive Dust $PM_{2.5}$	CO_2
1. Clear Vegetation	0.0	0.0	0.3	0.1	0.0	0.1	0.0	0.0	0.0	62.8
2. Tree Removal	0.0	0.0	0.2	0.0	0.0	-	0.0	0.0	-	29.2
3. Strip to Stockpile	0.0	0.1	0.2	0.1	0.0	0.1	0.0	0.0	0.0	20.1
4. Strip to Spoils	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	22.1
5. Excavation to Stockpile	0.2	0.9	2.1	0.6	0.1	0.5	0.2	0.1	0.1	202.7
6. Excavation to Spoils	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	25.9
7. Import Sand	0.0	0.1	0.7	0.1	0.0	0.1	0.0	0.0	0.0	128.8
8. Import Fill	0.0	0.1	0.5	0.1	0.0	0.1	0.0	0.0	0.0	89.6
9. Cutoff Wall SCB	0.1	0.5	0.8	0.5	0.0	0.5	0.1	0.0	0.1	102.0
10. Cutoff Wall DSM	0.9	5.5	8.6	2.1	0.5	1.7	0.8	0.4	0.3	1,022.9
11a. Retaining Wall (Concrete)	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	31.1
11b. Retaining Wall (Forms/Steel)	0.0	0.1	0.2	0.5	0.0	0.5	0.1	0.0	0.1	25.7
12. Fill from Stockpile	0.1	0.4	0.9	0.5	0.0	0.5	0.1	0.0	0.1	96.7
13. Import Random Fill	0.0	0.1	0.6	0.1	0.0	0.1	0.0	0.0	0.0	101.3
14. Import Topsoil Fill	0.0	0.1	0.5	0.1	0.0	0.1	0.0	0.0	0.0	84.6
15. Surfacing	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	30.4
16. Import Rip-Rap (Truck)	0.2	1.0	6.4	1.4	0.2	1.2	0.4	0.1	0.2	1,192.6
17. Utilities #1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	4.0
18. Utilities #2	0.0	0.1	0.3	1.2	0.0	1.2	0.3	0.0	0.2	33.4
Total (tons/construction project)	**1.5**	**9.0**	**23.0**	**7.5**	**0.8**	**6.8**	**2.0**	**0.6**	**1.1**	**3,305.9**
Federal standards (tons/year)	**25**	**100**	**25**	**100**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

Table 2b. Estimated Air Emissions for the American River Common Features Project (South) – Reach F (Year 2) (with Barge Rip-Rap Delivery)
Total Tons Per Construction Project

Project Tasks	ROG	CO	NO_x	Total PM_{10}	Exhaust PM_{10}	Fugitive Dust PM_{10}	Total $PM_{2.5}$	Exhaust $PM_{2.5}$	Fugitive Dust $PM_{2.5}$	CO_2
1. Clear Vegetation	0.0	0.0	0.3	0.1	0.0	0.1	0.0	0.0	0.0	62.8
2. Tree Removal	0.0	0.0	0.2	0.0	0.0	-	0.0	0.0	-	29.2
3. Strip to Stockpile	0.0	0.1	0.2	0.1	0.0	0.1	0.0	0.0	0.0	20.1
4. Strip to Spoils	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	22.1
5. Excavation to Stockpile	0.2	0.9	2.1	0.6	0.1	0.5	0.2	0.1	0.1	202.7
6. Excavation to Spoils	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	25.9
7. Import Sand	0.0	0.1	0.7	0.1	0.0	0.1	0.0	0.0	0.0	128.8
8. Import Fill	0.0	0.1	0.5	0.1	0.0	0.1	0.0	0.0	0.0	89.6
9. Cutoff Wall SCB	0.1	0.5	0.8	0.5	0.0	0.5	0.1	0.0	0.1	102.0
10. Cutoff Wall DSM	0.9	5.5	8.6	2.1	0.5	1.7	0.8	0.4	0.3	1,022.9
11a. Retaining Wall (Concrete)	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	31.1
11b. Retaining Wall (Forms/Steel)	0.0	0.1	0.2	0.5	0.0	0.5	0.1	0.0	0.1	25.7
12. Fill from Stockpile	0.1	0.4	0.9	0.5	0.0	0.5	0.1	0.0	0.1	96.7
13. Import Random Fill	0.0	0.1	0.6	0.1	0.0	0.1	0.0	0.0	0.0	101.3
14. Import Topsoil Fill	0.0	0.1	0.5	0.1	0.0	0.1	0.0	0.0	0.0	84.6
15. Surfacing	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	30.4
16. Import Rip-Rap (Barge)	1.1	4.5	10.6	0.4	0.0	0.4	0.0	0.0	0.1	401.6
17. Utilities #1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	4.0
18. Utilities #2	0.0	0.1	0.3	1.2	0.0	1.2	0.3	0.0	0.2	33.4
Total (tons/construction project)	**2.4**	**12.5**	**27.2**	**6.5**	**0.6**	**6.0**	**1.6**	**0.5**	**1.0**	**2,514.9**
Federal standards (tons/year)	**25**	**100**	**25**	**100**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

Harbor Craft Model Emission Factors

Hp	Year	NO_x	PM	ROG	CO	SO_x	CO_2
40	2013	0.30	0.03	0.10	0.19	0.000	10.15
	2014	0.30	0.03	0.10	0.19	0.000	10.15
	2015	0.30	0.03	0.10	0.19	0.000	10.15
	2016	0.30	0.03	0.10	0.19	0.000	10.15
	2017	0.30	0.03	0.10	0.19	0.000	10.15
200	2013	2.09	0.08	0.21	0.74	0.001	56.38
	2014	1.99	0.08	0.20	0.73	0.001	56.38
	2015	1.94	0.07	0.20	0.73	0.001	56.38
	2016	1.91	0.07	0.20	0.73	0.001	56.38
	2017	1.88	0.07	0.20	0.74	0.001	56.38
250	2013	2.70	0.11	0.26	0.87	0.001	78.31
	2014	2.58	0.10	0.26	0.91	0.001	78.31
	2015	2.46	0.10	0.26	0.94	0.001	78.31
	2016	2.34	0.09	0.26	0.98	0.001	78.31
	2017	2.27	0.09	0.25	0.99	0.001	78.31
400	2013	4.31	0.18	0.42	1.40	0.001	125.29
	2014	4.13	0.17	0.42	1.45	0.001	125.29
	2015	3.94	0.16	0.41	1.51	0.001	125.29
	2016	3.75	0.15	0.41	1.57	0.001	125.29
	2017	3.63	0.14	0.41	1.58	0.001	125.29
450	2013	4.85	0.20	0.48	1.57	0.001	140.95
	2014	4.64	0.19	0.47	1.63	0.001	140.95
	2015	4.43	0.18	0.47	1.70	0.001	140.95
	2016	4.22	0.16	0.46	1.76	0.001	140.95
	2017	4.08	0.16	0.46	1.77	0.001	140.95
500	2013	5.39	0.22	0.53	1.75	0.002	156.61
	2014	5.16	0.21	0.52	1.82	0.002	156.61
	2015	4.93	0.20	0.52	1.89	0.002	156.61
	2016	4.69	0.18	0.51	1.96	0.002	156.61
	2017	4.54	0.18	0.51	1.97	0.002	156.61

15	ppm sulfur diesel
0.000015	
64.066	Mol Wt. SO2
32.065	Mol Wt. S

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (C&G Clear Vegetation) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	4.5	22.7	194.3	71.2	4.2	67.0	16.6	2.7	13.9	38,067.8
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	4.5	22.7	194.3	71.2	4.2	67.0	16.6	2.7	13.9	38,067.8
Total (tons/construction project)	0.0	0.0	0.3	0.1	0.0	0.1	0.0	0.0	0.0	62.8

Notes:		
	Project Start Year ->	2016
	Project Length (months) ->	0
	Total Project Area (acres) ->	28
	Maximum Area Disturbed/Day (acres) ->	7
	Total Soil Imported/Exported (yd^3/day)->	3910

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (C&G Clear Vegetation) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.0	10.3	88.3	32.4	1.9	30.5	7.6	1.2	6.3	17,303.6
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	2.0	10.3	88.3	32.4	1.9	30.5	7.6	1.2	6.3	17,303.6
Total (megagrams/construction project)	0.0	0.0	0.3	0.1	0.0	0.1	0.0	0.0	0.0	57.0

Notes:		
	Project Start Year ->	2016
	Project Length (months) ->	0
	Total Project Area (hectares) ->	11
	Maximum Area Disturbed/Day (hectares) ->	3
	Total Soil Imported/Exported ($meters^3$/day)->	2989

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (C&G Clear Vegetation)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.2	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported	3910.0	yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.02
Grading/Excavation	0.15	0.09
Drainage/Utilities/Sub-Grade	0.00	0.06
Paving	0.00	0.03
Totals	0.15	0.20

Please note: You have entered a different number of months than the project length shown in cell C13.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	50.00	30
Round trips/day		196
Vehicle miles traveled/day (calculated)		9775

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	3.4	177.7	15.1	3.6	2.1	36168.7
Tons per contruction period	0.01	0.29	0.02	0.01	0.00	59.68

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.98		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.1	13.9	0.0		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Skid Steer Loaders	0.15	1.77	1.86	0.10	0.10	275.98
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	1.1	7.4	13.8	0.6	0.5	1307.1
	Grading	tons per phase	0.0	0.0	0.0	0.0	0.0	2.2

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.0	0.0	0.0	0.0	2.2

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	10.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172		8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81		8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65	10.00	8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98		8				
Trenchers		81		8				
Welders		45		8				
20								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (C&G Strip to Spoils) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	13.7	66.8	272.4	75.4	8.4	67.0	20.7	6.8	13.9	40,202.0
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	13.7	66.8	272.4	75.4	8.4	67.0	20.7	6.8	13.9	40,202.0
Total (tons/construction project)	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	22.1

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	3040

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (C&G Strip to Spoils) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	6.2	30.4	123.8	34.3	3.8	30.5	9.4	3.1	6.3	18,273.6
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	6.2	30.4	123.8	34.3	3.8	30.5	9.4	3.1	6.3	18,273.6
Total (megagrams/construction project)	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	20.1

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	2324

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (C&G Strip to Spoils)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.1	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported	3040.0	yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.01
Grading/Excavation	0.05	0.05
Drainage/Utilities/Sub-Grade	0.00	0.03
Paving	0.00	0.02
Totals	0.05	0.10

Please note: You have entered a different number of months than the project length shown in cell C13.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	50.00	30
Round trips/day		152
Vehicle miles traveled/day (calculated)		7600

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	2.6	138.1	11.7	2.8	1.7	28120.9
Tons per contruction period	0.00	0.08	0.01	0.00	0.00	15.47

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.33		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.0	13.9	0.0		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Crawler Tractors	1.85	11.17	23.79	0.92	0.84	2062.23
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
4.00	1	Scrapers	7.28	36.27	88.48	3.57	3.28	8040.11
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	11.0	54.8	131.4	5.5	5.1	11489.0
	Grading	tons per phase	0.0	0.0	0.1	0.0	0.0	6.3

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.0	0.1	0.0	0.0	6.3

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.

	Default Values		Default Values
Equipment	Horsepower		Hours/day
Aerial Lifts	63		8
Air Compressors	106		8
Bore/Drill Rigs	206		8
Cement and Mortar Mixers	10		8
Concrete/Industrial Saws	64		8
Cranes	226		8
Crawler Tractors	208	10.00	8
Crushing/Proc. Equipment	142		8
Excavators	163		8
Forklifts	89		8
Generator Sets	66		8
Graders	175	10.00	8
Off-Highway Tractors	123		8
Off-Highway Trucks	400		8
Other Construction Equipment	172	10.00	8
Other General Industrial Equipment	88		8
Other Material Handling Equipment	167		8
Pavers	126		8
Paving Equipment	131		8
Plate Compactors	8		8
Pressure Washers	26		8
Pumps	53		8
Rollers	81		8
Rough Terrain Forklifts	100		8
Rubber Tired Dozers	255		8
Rubber Tired Loaders	200		8
Scrapers	362	10.00	8
Signal Boards	20		8
Skid Steer Loaders	65		8
Surfacing Equipment	254		8
Sweepers/Scrubbers	64		8
Tractors/Loaders/Backhoes	98		8
Trenchers	81		8
Welders	45		8
40			
END OF DATA ENTRY SHEET			

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (C&G Strip to Stockpile) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	10.5	51.7	129.2	72.4	5.4	67.0	18.8	4.9	13.9	12,179.0
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	10.5	51.7	129.2	72.4	5.4	67.0	18.8	4.9	13.9	12,179.0
Total (tons/construction project)	0.0	0.1	0.2	0.1	0.0	0.1	0.0	0.0	0.0	20.1

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	2520

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (C&G Strip to Stockpile) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	4.8	23.5	58.7	32.9	2.4	30.5	8.6	2.2	6.3	5,535.9
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	4.8	23.5	58.7	32.9	2.4	30.5	8.6	2.2	6.3	5,535.9
Total (megagrams/construction project)	0.0	0.1	0.2	0.1	0.0	0.1	0.0	0.0	0.0	18.2

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	1927

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (C&G Strip to Stockpile)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.2	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported	2520.0	yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.02
Grading/Excavation	0.15	0.09
Drainage/Utilities/Sub-Grade	0.00	0.06
Paving	0.00	0.03
Totals	0.15	0.20

Please note: You have entered a different number of months than the project length shown in cell C13.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	2.00	30
Round trips/day		126
Vehicle miles traveled/day (calculated)		252

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.1	4.6	0.4	0.1	0.1	932.4
Tons per contruction period	0.00	0.01	0.00	0.00	0.00	1.54

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.98		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.1	13.9	0.0		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Crawler Tractors	1.66	10.06	21.41	0.83	0.76	1856.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.20	3.92	11.68	0.66	0.60	754.90
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.52	2.71	5.51	0.29	0.27	493.10
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.39	1.70	3.48	0.26	0.24	314.47
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
4.00	1	Scrapers	6.55	32.65	79.63	3.21	2.95	7236.10
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	10.3	51.0	121.7	5.2	4.8	10654.6
	Grading	tons per phase	0.0	0.1	0.2	0.0	0.0	17.6

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.1	0.2	0.0	0.0	17.6

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	9.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175	9.00	8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	9.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81	9.00	8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362	9.00	8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98		8				
Trenchers		81		8				
Welders		45		8				
45								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (C&G Tree Removal) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.4	9.0	33.4	1.0	1.0	-	0.8	0.8	-	5,303.2
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	1.4	9.0	33.4	1.0	1.0	-	0.8	0.8	-	5,303.2
Total (tons/construction project)	0.0	0.0	0.2	0.0	0.0	-	0.0	0.0	-	29.2

Notes:		
	Project Start Year ->	2016
	Project Length (months) ->	1
	Total Project Area (acres) ->	28
	Maximum Area Disturbed/Day (acres) ->	7
	Total Soil Imported/Exported (yd^3/day)->	1505

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (C&G Tree Removal) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	0.7	4.1	15.2	0.4	0.4	-	0.3	0.3	-	2,410.6
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	0.7	4.1	15.2	0.4	0.4	-	0.3	0.3	-	2,410.6
Total (megagrams/construction project)	0.0	0.0	0.2	0.0	0.0	-	0.0	0.0	-	26.5

Notes:		
	Project Start Year ->	2016
	Project Length (months) ->	1
	Total Project Area (hectares) ->	11
	Maximum Area Disturbed/Day (hectares) ->	3
	Total Soil Imported/Exported ($meters^3$/day)->	1151

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (C&G Tree Removal)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.5	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported	1505.0	yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.05
Grading/Excavation	0.50	0.23
Drainage/Utilities/Sub-Grade	0.00	0.15
Paving	0.00	0.08
Totals	0.50	0.50

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	40.00	30
Round trips/day	25.00	75
Vehicle miles traveled/day (calculated)		1000

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.3	18.2	1.5	0.4	0.2	3700.1
Tons per contruction period	0.00	0.10	0.01	0.00	0.00	20.35

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust	1.00	2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.03	1.45	0.12	0.03	0.02	296.01		
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	1.63		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation	0.00	6.7	0.0	0.0	0.0	0.0		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Skid Steer Loaders	0.15	1.77	1.86	0.10	0.10	275.98
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	1.1	7.4	13.8	0.6	0.5	1307.1
	Grading	tons per phase	0.0	0.0	0.1	0.0	0.0	7.2

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.0	0.1	0.0	0.0	7.2

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	10.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172		8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81		8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65	10.00	8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98		8				
Trenchers		81		8				
Welders		45		8				
20								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Cutoff Wall DSM) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	16.9	100.5	155.6	75.4	8.4	67.0	21.6	7.7	13.9	18,598.4
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	16.9	100.5	155.6	75.4	8.4	67.0	21.6	7.7	13.9	18,598.4
Total (tons/construction project)	0.9	5.5	8.6	2.1	0.5	1.7	0.8	0.4	0.3	1,022.9

Notes:

Project Start Year ->	2016
Project Length (months) ->	5
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Cutoff Wall DSM) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	7.7	45.7	70.7	34.3	3.8	30.5	9.8	3.5	6.3	8,453.8
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	7.7	45.7	70.7	34.3	3.8	30.5	9.8	3.5	6.3	8,453.8
Total (megagrams/construction project)	0.8	5.0	7.8	1.9	0.4	1.5	0.7	0.4	0.3	927.8

Notes:

Project Start Year ->	2016
Project Length (months) ->	5
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model — Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Cutoff Wall DSM)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	5.0	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.50
Grading/Excavation	5.00	2.25
Drainage/Utilities/Sub-Grade	0.00	1.50
Paving	0.00	0.75
Totals	5.00	5.00

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip		30
Round trips/day		0
Vehicle miles traveled/day (calculated)		0

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
Tons per contruction period	0.00	0.00	0.00	0.00	0.00	0.00

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.16	0.01	0.00	0.00	32.56		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	1.7	13.9	0.3		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
2.00		Aerial Lifts	0.15	2.16	2.32	0.10	0.09	446.54
2.00		Air Compressors	1.71	8.55	10.96	0.92	0.84	1269.86
2.00		Bore/Drill Rigs	0.92	9.50	13.22	0.39	0.36	2364.04
4.00		Cement and Mortar Mixers	0.34	1.77	2.11	0.09	0.08	289.41
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Crawler Tractors	1.85	11.17	23.79	0.92	0.84	2062.23
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
2.00	3	Excavators	1.02	6.97	11.17	0.55	0.51	1432.16
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
4.00		Generator Sets	2.57	14.92	19.32	1.37	1.26	2435.33
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
2.00	1	Other Construction Equipment	1.72	8.99	18.27	0.96	0.88	1635.48
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
6.00		Pumps	3.28	18.49	23.94	1.75	1.61	2971.06
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Rough Terrain Forklifts	0.56	5.07	6.83	0.38	0.35	931.86
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
	2	Rubber Tired Loaders	1.31	7.79	16.28	0.56	0.51	1656.55
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Welders	1.42	4.93	4.51	0.36	0.33	511.86
	Grading/Excavation	pounds per day	16.8	100.3	152.7	8.3	7.7	18006.4
	Grading	tons per phase	0.9	5.5	8.4	0.5	0.4	990.3

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.9	5.5	8.4	0.5	0.4	990.3

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63	10.00	8				
Air Compressors		106	10.00	8				
Bore/Drill Rigs		206	10.00	8				
Cement and Mortar Mixers		10	10.00	8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	10.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163	10.00	8				
Forklifts		89		8				
Generator Sets		66	10.00	8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53	10.00	8				
Rollers		81		8				
Rough Terrain Forklifts		100	10.00	8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200	10.00	8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98		8				
Trenchers		81		8				
Welders		45	10.00	8				
120								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Cutoff Wall SCB) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	4.8	30.0	50.1	69.6	2.6	67.0	16.3	2.4	13.9	6,181.5
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	4.8	30.0	50.1	69.6	2.6	67.0	16.3	2.4	13.9	6,181.5
Total (tons/construction project)	0.1	0.5	0.8	0.5	0.0	0.5	0.1	0.0	0.1	102.0

Notes:

Project Start Year ->	2016
Project Length (months) ->	2
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Cutoff Wall SCB) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.2	13.7	22.8	31.6	1.2	30.5	7.4	1.1	6.3	2,809.8
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	2.2	13.7	22.8	31.6	1.2	30.5	7.4	1.1	6.3	2,809.8
Total (megagrams/construction project)	0.1	0.4	0.8	0.5	0.0	0.5	0.1	0.0	0.1	92.5

Notes:

Project Start Year ->	2016
Project Length (months) ->	2
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Cutoff Wall SCB)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	1.5	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.15
Grading/Excavation	1.50	0.68
Drainage/Utilities/Sub-Grade	0.00	0.45
Paving	0.00	0.23
Totals	1.50	1.50

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip		30
Round trips/day		0
Vehicle miles traveled/day (calculated)		0

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
Tons per contruction period	0.00	0.00	0.00	0.00	0.00	0.00

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust		2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade		1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.05	0.00	0.00	0.00	9.77		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.5	13.9	0.1		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	3	Excavators	1.54	10.46	16.75	0.82	0.76	2148.24
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Generator Sets	0.64	3.73	4.83	0.34	0.32	608.83
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Pumps	1.09	6.16	7.98	0.58	0.54	990.35
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rough Terrain Forklifts	0.28	2.53	3.42	0.19	0.17	465.93
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Rubber Tired Loaders	0.66	3.89	8.14	0.28	0.26	828.28
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	4.8	29.8	47.2	2.5	2.3	5589.5
	Grading	tons per phase	0.1	0.5	0.8	0.0	0.0	92.2

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.1	0.5	0.8	0.0	0.0	92.2

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208		8				
Crushing/Proc. Equipment		142		8				
Excavators		163	10.00	8				
Forklifts		89		8				
Generator Sets		66	10.00	8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53	10.00	8				
Rollers		81		8				
Rough Terrain Forklifts		100	10.00	8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200	10.00	8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98		8				
Trenchers		81		8				
Welders		45		8				
60								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Fill from Stockpile) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	4.5	24.0	56.3	69.4	2.4	67.0	16.1	2.2	13.9	6,281.3
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	4.5	24.0	56.3	69.4	2.4	67.0	16.1	2.2	13.9	6,281.3
Total (tons/construction project)	0.1	0.4	0.9	0.5	0.0	0.5	0.1	0.0	0.1	96.7

Notes:

Project Start Year ->	2016
Project Length (months) ->	1
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	3030

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Fill from Stockpile) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.0	10.9	25.6	31.6	1.1	30.5	7.3	1.0	6.3	2,855.1
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	2.0	10.9	25.6	31.6	1.1	30.5	7.3	1.0	6.3	2,855.1
Total (megagrams/construction project)	0.1	0.3	0.8	0.5	0.0	0.4	0.1	0.0	0.1	87.7

Notes:

Project Start Year ->	2016
Project Length (months) ->	1
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	2317

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Fill from Stockpile)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	1.4	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported	3030.0	yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.14
Grading/Excavation	1.40	0.63
Drainage/Utilities/Sub-Grade	0.00	0.42
Paving	0.00	0.21
Totals	1.40	1.40

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	2.00	30
Round trips/day		152
Vehicle miles traveled/day (calculated)		303

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.1	5.5	0.5	0.1	0.1	1121.1
Tons per contruction period	0.00	0.08	0.01	0.00	0.00	17.27

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.04	0.00	0.00	0.00	9.12		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.5	13.9	0.1		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.44	1.89	3.86	0.28	0.26	349.42
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	1.02	8.43	13.06	0.45	0.42	1800.91
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	4.3	23.3	47.9	2.2	2.1	4568.1
	Grading	tons per phase	0.1	0.4	0.7	0.0	0.0	70.3

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.1	0.4	0.7	0.0	0.0	70.3

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	10.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175	10.00	8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81	10.00	8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes	425.00	98	10.00	8				
Trenchers		81		8				
Welders		45		8				
475								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Cohesive Fill) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	8.5	41.5	196.0	72.8	5.8	67.0	18.4	4.5	13.9	32,565.1
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	8.5	41.5	196.0	72.8	5.8	67.0	18.4	4.5	13.9	32,565.1
Total (tons/construction project)	0.0	0.1	0.5	0.1	0.0	0.1	0.0	0.0	0.0	89.6

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	2810

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Cohesive Fill) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	3.9	18.9	89.1	33.1	2.7	30.5	8.4	2.0	6.3	14,802.3
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	3.9	18.9	89.1	33.1	2.7	30.5	8.4	2.0	6.3	14,802.3
Total (megagrams/construction project)	0.0	0.1	0.5	0.1	0.0	0.1	0.0	0.0	0.0	81.2

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	2148

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Import Cohesive Fill)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.3	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	2810.0	yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.03
Grading/Excavation	0.25	0.11
Drainage/Utilities/Sub-Grade	0.00	0.08
Paving	0.00	0.04
Totals	0.25	0.25

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	50.00	30
Round trips/day		141
Vehicle miles traveled/day (calculated)		7025

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	2.4	127.7	10.8	2.6	1.5	25993.4
Tons per contruction period	0.01	0.35	0.03	0.01	0.00	71.48

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	1.63		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.1	13.9	0.0		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00	3	Excavators	0.41	2.79	4.47	0.22	0.20	572.86
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
	2	Graders	2.67	8.70	25.95	1.46	1.34	1677.56
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.44	1.89	3.86	0.28	0.26	349.42
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	1.02	8.43	13.06	0.45	0.42	1800.91
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	6.0	30.4	65.4	3.2	2.9	5979.8
	Grading	tons per phase	0.0	0.1	0.2	0.0	0.0	16.4

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.1	0.2	0.0	0.0	16.4

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	10.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175	10.00	8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81	10.00	8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes	425.00	98	10.00	8				
Trenchers		81		8				
Welders		45		8				
475								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Random Fill)				Total	Exhaust	Fugitive Dust	Total	Exhaust	Fugitive Dust	
Project Phases (English Units)	**ROG (lbs/day)**	**CO (lbs/day)**	**NOx (lbs/day)**	**PM10 (lbs/day)**	**PM10 (lbs/day)**	**PM10 (lbs/day)**	**PM2.5 (lbs/day)**	**PM2.5 (lbs/day)**	**PM2.5 (lbs/day)**	**CO2 (lbs/day)**
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	6.7	34.2	176.2	71.8	4.8	67.0	17.5	3.6	13.9	30,691.0
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	6.7	34.2	176.2	71.8	4.8	67.0	17.5	3.6	13.9	30,691.0
Total (tons/construction project)	0.0	0.1	0.6	0.1	0.0	0.1	0.0	0.0	0.0	101.3

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	2760

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Random Fill)				Total	Exhaust	Fugitive Dust	Total	Exhaust	Fugitive Dust	
Project Phases (Metric Units)	**ROG (kgs/day)**	**CO (kgs/day)**	**NOx (kgs/day)**	**PM10 (kgs/day)**	**PM10 (kgs/day)**	**PM10 (kgs/day)**	**PM2.5 (kgs/day)**	**PM2.5 (kgs/day)**	**PM2.5 (kgs/day)**	**CO2 (kgs/day)**
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	3.1	15.5	80.1	32.7	2.2	30.5	8.0	1.6	6.3	13,950.4
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	3.1	15.5	80.1	32.7	2.2	30.5	8.0	1.6	6.3	13,950.4
Total (megagrams/construction project)	0.0	0.1	0.5	0.1	0.0	0.1	0.0	0.0	0.0	91.9

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	2110

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Import Random Fill)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.3	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	2760.0	yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.03
Grading/Excavation	0.30	0.11
Drainage/Utilities/Sub-Grade	0.00	0.08
Paving	0.00	0.04
Totals	0.30	0.25

Please note: You have entered a different number of months than the project length shown in cell C13.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions	User Override of							
User Input	Soil Hauling Defaults	Default Values						
Miles/round trip	50.00	30						
Round trips/day		138						
Vehicle miles traveled/day (calculated)			6900					
Hauling Emissions	**ROG**	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day	2.4	125.4	10.7	2.5	1.5	25530.9		
Tons per contruction period	0.01	0.41	0.04	0.01	0.00	84.25		

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions	User Override of Worker Commute Default Values	Default Values						
Miles/ one-way trip		20						
One-way trips/day		2						
No. of employees: Grubbing/Land Clearing	0.00	10						
No. of employees: Grading/Excavation		15						
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11						
No. of employees: Paving	0.00	13						
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000		
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000		
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000		
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000		
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592		
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000		
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000		
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000		
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000		
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000		
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000		
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000		
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000		
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000		
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000		
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000		

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day
Grubbing/Land Clearing - Exhaust	0.00	2		80
Grading/Excavation - Exhaust		2		80
Drainage/Utilities/Subgrade	0.00	1		40

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	1.95
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0
Fugitive Dust - Grading/Excavation		6.7	67.0	0.1	13.9	0.0
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.44	1.89	3.86	0.28	0.26	349.42
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	1.02	8.43	13.06	0.45	0.42	1800.91
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	4.3	23.3	47.9	2.2	2.1	4568.1
	Grading	tons per phase	0.0	0.1	0.2	0.0	0.0	15.1

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.1	0.2	0.0	0.0	15.1

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	10.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175	10.00	8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81	10.00	8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes	425.00	98	10.00	8				
Trenchers		81		8				
Welders		45		8				
475								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Rip Rap - Barge+) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.2	9.3	17.5	67.6	0.6	67.0	14.5	0.5	13.9	2,377.0
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	1.2	9.3	17.5	67.6	0.6	67.0	14.5	0.5	13.9	2,377.0
Total (tons/construction project)	0.0	0.4	0.7	1.2	0.0	1.2	0.3	0.0	0.2	94.1

Notes:

Project Start Year ->	2016
Project Length (months) ->	4
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Rip Rap - Barge+) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	0.5	4.2	8.0	30.7	0.3	30.5	6.6	0.2	6.3	1,080.5
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	0.5	4.2	8.0	30.7	0.3	30.5	6.6	0.2	6.3	1,080.5
Total (megagrams/construction project)	0.0	0.3	0.6	1.1	0.0	1.1	0.2	0.0	0.2	85.4

Notes:

Project Start Year ->	2016
Project Length (months) ->	4
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model — Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Import Rip Rap - Barge+)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	3.6	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	0.0	yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.36
Grading/Excavation	3.60	1.62
Drainage/Utilities/Sub-Grade	0.00	1.08
Paving	0.00	0.54
Totals	3.60	3.60

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip		30
Round trips/day		0
Vehicle miles traveled/day (calculated)		0

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
Tons per contruction period	0.00	0.00	0.00	0.00	0.00	0.00

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.12	0.01	0.00	0.00	23.44		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	1.2	13.9	0.2		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0	Cranes	0.97	8.27	13.69	0.48	0.45	1655.80
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
3.00		Plate Compactors	0.15	0.79	0.94	0.04	0.03	129.18
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	1.1	9.1	14.6	0.5	0.5	1785.0
	Grading	tons per phase	0.0	0.4	0.6	0.0	0.0	70.7

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.4	0.6	0.0	0.0	70.7

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes	500.00	226	10.00	8				
Crawler Tractors		208		8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172		8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8	10.00	8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81		8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98	10.00	8				
Trenchers		81		8				
Welders		45		8				
530								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Rip Rap - Truck) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	4.9	25.9	160.9	71.0	4.0	67.0	16.8	2.8	13.9	30,116.1
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	4.9	25.9	160.9	71.0	4.0	67.0	16.8	2.8	13.9	30,116.1
Total (tons/construction project)	0.2	1.0	6.4	1.4	0.2	1.2	0.4	0.1	0.2	1,192.6

Notes:

Project Start Year ->	2016
Project Length (months) ->	4
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	3200

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Rip Rap - Truck) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.2	11.8	73.1	32.3	1.8	30.5	7.6	1.3	6.3	13,689.1
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	2.2	11.8	73.1	32.3	1.8	30.5	7.6	1.3	6.3	13,689.1
Total (megagrams/construction project)	0.2	0.9	5.8	1.2	0.1	1.1	0.3	0.1	0.2	1,081.7

Notes:

Project Start Year ->	2016
Project Length (months) ->	4
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported (meters^3/day)->	2446

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Import Rip Rap - Truck)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	3.6	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	3200.0	yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	40.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.36
Grading/Excavation	3.60	1.62
Drainage/Utilities/Sub-Grade	0.00	1.08
Paving	0.00	0.54
Totals	3.60	3.60

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	90.00	30
Round trips/day		80
Vehicle miles traveled/day (calculated)		7200

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	2.5	130.9	11.1	2.6	1.6	26640.9
Tons per contruction period	0.10	5.18	0.44	0.10	0.06	1054.98

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.12	0.01	0.00	0.00	23.44		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	1.2	13.9	0.2		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
2.00	3	Excavators	1.02	6.97	11.17	0.55	0.51	1432.16
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	2.4	14.5	27.2	1.3	1.2	2883.2
	Grading	tons per phase	0.1	0.6	1.1	0.1	0.0	114.2

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.1	0.6	1.1	0.1	0.0	114.2

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	10.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163	10.00	8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172		8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81		8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98	10.00	8				
Trenchers		81		8				
Welders		45		8				
30								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Sand) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	6.2	27.7	167.0	71.7	4.7	67.0	17.4	3.5	13.9	29,263.7
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	6.2	27.7	167.0	71.7	4.7	67.0	17.4	3.5	13.9	29,263.7
Total (tons/construction project)	0.0	0.1	0.7	0.1	0.0	0.1	0.0	0.0	0.0	128.8

Notes:		
	Project Start Year ->	2016
	Project Length (months) ->	0
	Total Project Area (acres) ->	28
	Maximum Area Disturbed/Day (acres) ->	7
	Total Soil Imported/Exported (yd^3/day)->	2755

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Sand) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.8	12.6	75.9	32.6	2.1	30.5	7.9	1.6	6.3	13,301.7
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	2.8	12.6	75.9	32.6	2.1	30.5	7.9	1.6	6.3	13,301.7
Total (megagrams/construction project)	0.0	0.1	0.7	0.1	0.0	0.1	0.0	0.0	0.0	116.8

Notes:		
	Project Start Year ->	2016
	Project Length (months) ->	0
	Total Project Area (hectares) ->	11
	Maximum Area Disturbed/Day (hectares) ->	3
	Total Soil Imported/Exported ($meters^3$/day)->	2106

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Import Sand)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.4	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	2755.0	yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.04
Grading/Excavation	0.40	0.16
Drainage/Utilities/Sub-Grade	0.00	0.11
Paving	0.00	0.05
Totals	0.40	0.36

Please note: You have entered a different number of months than the project length shown in cell C13.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	50.00	30
Round trips/day		138
Vehicle miles traveled/day (calculated)		6887.5

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	2.4	125.2	10.6	2.5	1.5	25484.6
Tons per contruction period	0.01	0.55	0.05	0.01	0.01	112.13

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day
Grubbing/Land Clearing - Exhaust	0.00	2		80
Grading/Excavation - Exhaust		2		80
Drainage/Utilities/Subgrade	0.00	1		40

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	2.60
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0
Fugitive Dust - Grading/Excavation		6.7	67.0	0.1	13.9	0.0
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.44	1.89	3.86	0.28	0.26	349.42
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	3.7	16.8	38.9	2.1	1.9	3187.1
	Grading	tons per phase	0.0	0.1	0.2	0.0	0.0	14.0

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.1	0.2	0.0	0.0	14.0

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.

	Default Values		Default Values
Equipment	Horsepower		Hours/day
Aerial Lifts	63		8
Air Compressors	106		8
Bore/Drill Rigs	206		8
Cement and Mortar Mixers	10		8
Concrete/Industrial Saws	64		8
Cranes	226		8
Crawler Tractors	208	10.00	8
Crushing/Proc. Equipment	142		8
Excavators	163		8
Forklifts	89		8
Generator Sets	66		8
Graders	175	10.00	8
Off-Highway Tractors	123		8
Off-Highway Trucks	400		8
Other Construction Equipment	172	10.00	8
Other General Industrial Equipment	88		8
Other Material Handling Equipment	167		8
Pavers	126		8
Paving Equipment	131		8
Plate Compactors	8		8
Pressure Washers	26		8
Pumps	53		8
Rollers	81	10.00	8
Rough Terrain Forklifts	100		8
Rubber Tired Dozers	255		8
Rubber Tired Loaders	200		8
Scrapers	362		8
Signal Boards	20		8
Skid Steer Loaders	65		8
Surfacing Equipment	254		8
Sweepers/Scrubbers	64		8
Tractors/Loaders/Backhoes	98	10.00	8
Trenchers	81		8
Welders	45		8
50			
END OF DATA ENTRY SHEET			

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Topsoil Fill) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	5.9	29.9	148.9	71.2	4.2	67.0	17.1	3.1	13.9	25,646.0
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	5.9	29.9	148.9	71.2	4.2	67.0	17.1	3.1	13.9	25,646.0
Total (tons/construction project)	0.0	0.1	0.5	0.1	0.0	0.1	0.0	0.0	0.0	84.6

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	2830

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Import Topsoil Fill) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.7	13.6	67.7	32.3	1.9	30.5	7.8	1.4	6.3	11,657.3
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	2.7	13.6	67.7	32.3	1.9	30.5	7.8	1.4	6.3	11,657.3
Total (megagrams/construction project)	0.0	0.1	0.4	0.1	0.0	0.1	0.0	0.0	0.0	76.8

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	2164

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model — Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Import Topsoil Fill)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.3	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	2830.0	yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.03
Grading/Excavation	0.30	0.11
Drainage/Utilities/Sub-Grade	0.00	0.08
Paving	0.00	0.04
Totals	0.30	0.25

Please note: You have entered a different number of months than the project length shown in cell C13.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	40.00	30
Round trips/day		142
Vehicle miles traveled/day (calculated)		5660

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	2.0	102.9	8.7	2.1	1.2	20942.7
Tons per contruction period	0.01	0.34	0.03	0.01	0.00	69.11

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day
Grubbing/Land Clearing - Exhaust	0.00	2		80
Grading/Excavation - Exhaust		2		80
Drainage/Utilities/Subgrade	0.00	1		40

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	1.95
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0
Fugitive Dust - Grading/Excavation		6.7	67.0	0.1	13.9	0.0
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.83	5.03	10.71	0.41	0.38	928.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.20	3.92	11.68	0.66	0.60	754.90
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.52	2.71	5.51	0.29	0.27	493.10
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.39	1.70	3.48	0.26	0.24	314.47
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.92	7.59	11.76	0.41	0.37	1620.82
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	3.9	20.9	43.1	2.0	1.9	4111.3
	Grading	tons per phase	0.0	0.1	0.1	0.0	0.0	13.6

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.1	0.1	0.0	0.0	13.6

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	9.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175	9.00	8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	9.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81	9.00	8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes	425.00	98	9.00	8				
Trenchers		81		8				
Welders		45		8				
470								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (Retaining Wall - Concrete) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	4.0	19.6	146.3	70.6	3.6	67.0	16.3	2.4	13.9	28,259.0
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	4.0	19.6	146.3	70.6	3.6	67.0	16.3	2.4	13.9	28,259.0
Total (tons/construction project)	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	31.1

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	1580

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (Retaining Wall - Concrete) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.8	8.9	66.5	32.1	1.6	30.5	7.4	1.1	6.3	12,845.0
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	1.8	8.9	66.5	32.1	1.6	30.5	7.4	1.1	6.3	12,845.0
Total (megagrams/construction project)	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	28.2

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	1208

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (Retaining Wall - Concrete)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.1	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	1580.0	yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	9.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.01
Grading/Excavation	0.10	0.05
Drainage/Utilities/Sub-Grade	0.00	0.03
Paving	0.00	0.02
Totals	0.10	0.10

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	40.00	30
Round trips/day		176
Vehicle miles traveled/day (calculated)		7022.222222

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	2.4	127.6	10.8	2.6	1.5	25983.1
Tons per contruction period	0.00	0.14	0.01	0.00	0.00	28.58

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.65		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.0	13.9	0.0		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00	3	Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	1.5	8.5	15.8	0.9	0.8	1683.9
	Grading	tons per phase	0.0	0.0	0.0	0.0	0.0	1.9

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.0	0.0	0.0	0.0	1.9

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208		8				
Crushing/Proc. Equipment		142		8				
Excavators		163	10.00	8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81		8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98	10.00	8				
Trenchers		81		8				
Welders		45		8				
30								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Retaining Wall - Form & S Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.1	5.2	13.1	67.7	0.7	67.0	14.6	0.6	13.9	1,559.8
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	1.1	5.2	13.1	67.7	0.7	67.0	14.6	0.6	13.9	1,559.8
Total (tons/construction project)	0.0	0.1	0.2	0.5	0.0	0.5	0.1	0.0	0.1	25.7

Notes:

Project Start Year ->	2016
Project Length (months) ->	2
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Retaining Wall - Form & S Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	0.5	2.4	6.0	30.8	0.3	30.5	6.6	0.3	6.3	709.0
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	0.5	2.4	6.0	30.8	0.3	30.5	6.6	0.3	6.3	709.0
Total (megagrams/construction project)	0.0	0.1	0.2	0.5	0.0	0.5	0.1	0.0	0.1	23.3

Notes:

Project Start Year ->	2016
Project Length (months) ->	2
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Retaining Wall - Form & Steel)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	1.5	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.15
Grading/Excavation	1.50	0.68
Drainage/Utilities/Sub-Grade	0.00	0.45
Paving	0.00	0.23
Totals	1.50	1.50

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	40.00	30
Round trips/day		0
Vehicle miles traveled/day (calculated)		0

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
Tons per contruction period	0.00	0.00	0.00	0.00	0.00	0.00

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.05	0.00	0.00	0.00	9.77		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.5	13.9	0.1		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	1.0	5.0	10.2	0.6	0.6	967.8
	Grading	tons per phase	0.0	0.1	0.2	0.0	0.0	16.0

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.1	0.2	0.0	0.0	16.0

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208		8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81		8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98	10.00	8				
Trenchers		81		8				
Welders		45		8				
20								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E to Spoils) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	18.3	89.6	335.9	77.8	10.8	67.0	22.9	9.0	13.9	47,017.6
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	18.3	89.6	335.9	77.8	10.8	67.0	22.9	9.0	13.9	47,017.6
Total (tons/construction project)	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	25.9

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	4090

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E to Spoils) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	8.3	40.7	152.7	35.4	4.9	30.5	10.4	4.1	6.3	21,371.7
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	8.3	40.7	152.7	35.4	4.9	30.5	10.4	4.1	6.3	21,371.7
Total (megagrams/construction project)	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	23.5

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	3127

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E to Spoils)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.1	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported	4090.0	yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.01
Grading/Excavation	0.05	0.02
Drainage/Utilities/Sub-Grade	0.00	0.02
Paving	0.00	0.01
Totals	0.05	0.05

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	40.00	30
Round trips/day	205.00	205
Vehicle miles traveled/day (calculated)		8200

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	2.8	149.0	12.7	3.0	1.8	30341.0
Tons per contruction period	0.00	0.08	0.01	0.00	0.00	16.69

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.33		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.0	13.9	0.0		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Crawler Tractors	2.59	15.64	33.31	1.28	1.18	2887.12
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.87	6.09	18.17	1.02	0.94	1174.29
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.81	4.22	8.57	0.45	0.41	767.04
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
4.00	1	Scrapers	10.19	50.78	123.87	4.99	4.59	11256.15
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	15.4	76.7	183.9	7.7	7.1	16084.6
	Grading	tons per phase	0.0	0.0	0.1	0.0	0.0	8.8

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.0	0.1	0.0	0.0	8.8

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	14.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175	14.00	8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	14.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81		8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362	14.00	8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98		8				
Trenchers		81		8				
Welders		45		8				
56								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E to Stockpile) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	11.2	55.5	139.6	72.7	5.7	67.0	19.1	5.2	13.9	13,161.5
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	11.2	55.5	139.6	72.7	5.7	67.0	19.1	5.2	13.9	13,161.5
Total (tons/construction project)	0.2	0.9	2.1	0.6	0.1	0.5	0.2	0.1	0.1	202.7

Notes:

Project Start Year ->	2016
Project Length (months) ->	1
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	2920

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E to Stockpile) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	5.1	25.2	63.4	33.0	2.6	30.5	8.7	2.4	6.3	5,982.5
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	5.1	25.2	63.4	33.0	2.6	30.5	8.7	2.4	6.3	5,982.5
Total (megagrams/construction project)	0.2	0.8	1.9	0.5	0.1	0.4	0.2	0.1	0.1	183.8

Notes:

Project Start Year ->	2016
Project Length (months) ->	1
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported (meters^3/day)->	2232

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E to Stockpile)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	1.4	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported	2920.0	yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.14
Grading/Excavation	1.40	0.63
Drainage/Utilities/Sub-Grade	0.00	0.42
Paving	0.00	0.21
Totals	1.40	1.40

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	2.00	30
Round trips/day	146.00	146
Vehicle miles traveled/day (calculated)		292

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.1	5.3	0.5	0.1	0.1	1080.4
Tons per contruction period	0.00	0.08	0.01	0.00	0.00	16.64

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust		2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02		
Tons per const. Period - Grading/Excavation	0.00	0.04	0.00	0.00	0.00	9.12		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	67.0	0.5	13.9	0.1		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Crawler Tractors	1.85	11.17	23.79	0.92	0.84	2062.23
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
4.00	1	Scrapers	7.28	36.27	88.48	3.57	3.28	8040.11
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	11.0	54.8	131.4	5.5	5.1	11489.0
	Grading	tons per phase	0.2	0.8	2.0	0.1	0.1	176.9

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.2	0.8	2.0	0.1	0.1	176.9

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.

	Default Values		Default Values
Equipment	Horsepower		Hours/day
Aerial Lifts	63		8
Air Compressors	106		8
Bore/Drill Rigs	206		8
Cement and Mortar Mixers	10		8
Concrete/Industrial Saws	64		8
Cranes	226		8
Crawler Tractors	208	10.00	8
Crushing/Proc. Equipment	142		8
Excavators	163		8
Forklifts	89		8
Generator Sets	66		8
Graders	175	10.00	8
Off-Highway Tractors	123		8
Off-Highway Trucks	400		8
Other Construction Equipment	172	10.00	8
Other General Industrial Equipment	88		8
Other Material Handling Equipment	167		8
Pavers	126		8
Paving Equipment	131		8
Plate Compactors	8		8
Pressure Washers	26		8
Pumps	53		8
Rollers	81		8
Rough Terrain Forklifts	100		8
Rubber Tired Dozers	255		8
Rubber Tired Loaders	200		8
Scrapers	362	10.00	8
Signal Boards	20		8
Skid Steer Loaders	65		8
Surfacing Equipment	254		8
Sweepers/Scrubbers	64		8
Tractors/Loaders/Backhoes	98		8
Trenchers	81		8
Welders	45		8
40			
END OF DATA ENTRY SHEET			

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Surfacing) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	14.5	64.3	331.0	77.5	10.5	67.0	22.1	8.2	13.9	55,317.2
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	14.5	64.3	331.0	77.5	10.5	67.0	22.1	8.2	13.9	55,317.2
Total (tons/construction project)	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	30.4

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	8228

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (G&E Surfacing) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	6.6	29.2	150.4	35.2	4.8	30.5	10.1	3.7	6.3	25,144.2
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	6.6	29.2	150.4	35.2	4.8	30.5	10.1	3.7	6.3	25,144.2
Total (megagrams/construction project)	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	27.6

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	6291

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (G&E Surfacing)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.1	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	8228.0	yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.01
Grading/Excavation	0.05	0.05
Drainage/Utilities/Sub-Grade	0.00	0.03
Paving	0.00	0.02
Totals	0.05	0.10

Please note: You have entered a different number of months than the project length shown in cell C13.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip		30
Round trips/day		411
Vehicle miles traveled/day (calculated)		12342

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	4.3	224.3	19.1	4.5	2.7	45666.9
Tons per contruction period	0.00	0.12	0.01	0.00	0.00	25.12

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day
Grubbing/Land Clearing - Exhaust	0.00	2		80
Grading/Excavation - Exhaust	3.00	2		80
Drainage/Utilities/Subgrade	0.00	1		40

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00
Pound per day - Grading/Excavation	0.08	4.36	0.37	0.09	0.05	888.03
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.49
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0
Fugitive Dust - Grading/Excavation		6.7	67.0	0.0	13.9	0.0
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	1.02	6.15	13.08	0.50	0.46	1134.22
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	3	Excavators	1.23	8.37	13.40	0.66	0.61	1718.59
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
3.00	2	Graders	4.40	14.36	42.82	2.41	2.21	2767.98
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.64	3.31	6.73	0.35	0.33	602.67
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
3.00		Rollers	1.44	6.23	12.75	0.94	0.86	1153.07
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
3.00		Tractors/Loaders/Backhoes	1.48	6.49	13.49	1.04	0.96	1385.69
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	10.2	44.9	102.3	5.9	5.4	8762.2
	Grading	tons per phase	0.0	0.0	0.1	0.0	0.0	4.8

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.0	0.1	0.0	0.0	4.8

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	11.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175	11.00	8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	11.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81	11.00	8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98	11.00	8				
Trenchers		81		8				
Welders		45		8				
55								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (Utilities #1) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.1	11.3	24.7	101.7	1.2	100.5	22.0	1.1	20.9	2,399.7
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	2.1	11.3	24.7	101.7	1.2	100.5	22.0	1.1	20.9	2,399.7
Total (tons/construction project)	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	4.0

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (Utilities #1) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.0	5.1	11.2	46.2	0.6	45.7	10.0	0.5	9.5	1,090.8
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	1.0	5.1	11.2	46.2	0.6	45.7	10.0	0.5	9.5	1,090.8
Total (megagrams/construction project)	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	3.6

Notes:

Project Start Year ->	2016
Project Length (months) ->	0
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (Utilities #1)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.2	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.02
Grading/Excavation	0.15	0.09
Drainage/Utilities/Sub-Grade	0.00	0.06
Paving	0.00	0.03
Totals	0.15	0.20

Please note: You have entered a different number of months than the project length shown in cell C13.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip		30
Round trips/day		0
Vehicle miles traveled/day (calculated)		0

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
Tons per contruction period	0.00	0.00	0.00	0.00	0.00	0.00

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust	1.00	2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.03	1.45	0.12	0.03	0.02	296.01		
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.49		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	100.5	0.1	20.9	0.0		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.13	0.57	1.16	0.09	0.08	104.82
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	2.1	11.1	23.3	1.2	1.1	2103.7
	Grading	tons per phase	0.0	0.0	0.0	0.0	0.0	3.5

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.0	0.0	0.0	0.0	3.5

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208	10.00	8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81	3.00	8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98	10.00	8				
Trenchers		81		8				
Welders		45		8				
33								
END OF DATA ENTRY SHEET								

Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> ARCF ARS Reach F-Year 2 (Utilities #2) Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.1	5.1	11.7	101.2	0.7	100.5	21.5	0.6	20.9	1,263.8
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	1.1	5.1	11.7	101.2	0.7	100.5	21.5	0.6	20.9	1,263.8
Total (tons/construction project)	0.0	0.1	0.3	1.2	0.0	1.2	0.3	0.0	0.2	33.4

Notes:

Project Start Year ->	2016
Project Length (months) ->	2
Total Project Area (acres) ->	28
Maximum Area Disturbed/Day (acres) ->	7
Total Soil Imported/Exported (yd^3/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> ARCF ARS Reach F-Year 2 (Utilities #2) Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	0.5	2.3	5.3	46.0	0.3	45.7	9.8	0.3	9.5	574.5
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	0.5	2.3	5.3	46.0	0.3	45.7	9.8	0.3	9.5	574.5
Total (megagrams/construction project)	0.0	0.1	0.3	1.1	0.0	1.1	0.2	0.0	0.2	30.3

Notes:

Project Start Year ->	2016
Project Length (months) ->	2
Total Project Area (hectares) ->	11
Maximum Area Disturbed/Day (hectares) ->	3
Total Soil Imported/Exported ($meters^3$/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.2

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type		
Project Name	ARCF ARS Reach F-Year 2 (Utilities #2)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	2.4	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd^3/day
Soil Exported		yd^3/day
Average Truck Capacity	20.0	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.00	0.24
Grading/Excavation	2.40	1.08
Drainage/Utilities/Sub-Grade	0.00	0.72
Paving	0.00	0.36
Totals	2.40	2.40

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip		30
Round trips/day		0
Vehicle miles traveled/day (calculated)		0

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
Tons per contruction period	0.00	0.00	0.00	0.00	0.00	0.00

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing	0.00	10
No. of employees: Grading/Excavation		15
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11
No. of employees: Paving	0.00	13

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day				
Grubbing/Land Clearing - Exhaust	0.00	2		80				
Grading/Excavation - Exhaust	1.00	2		80				
Drainage/Utilities/Subgrade	0.00	1		40				
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**		
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86		
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00		
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00		
Pound per day - Grading/Excavation	0.03	1.45	0.12	0.03	0.02	296.01		
Tons per const. Period - Grading/Excavation	0.00	0.04	0.00	0.00	0.00	7.81		
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00		

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period		
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0		
Fugitive Dust - Grading/Excavation		6.7	100.5	1.2	20.9	0.2		
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0		

Off-Road Equipment Emissions

	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.58	3.01	6.12	0.32	0.30	547.89
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	1.0	5.0	10.2	0.6	0.6	967.8
	Grading	tons per phase	0.0	0.1	0.3	0.0	0.0	25.5

	Default							
Drainage/Utilities/Subgrade	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
	2	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Drainage	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Drainage	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0

	Default							
Paving	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			0.0	0.1	0.3	0.0	0.0	25.5

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.								
		Default Values		Default Values				
Equipment		Horsepower		Hours/day				
Aerial Lifts		63		8				
Air Compressors		106		8				
Bore/Drill Rigs		206		8				
Cement and Mortar Mixers		10		8				
Concrete/Industrial Saws		64		8				
Cranes		226		8				
Crawler Tractors		208		8				
Crushing/Proc. Equipment		142		8				
Excavators		163		8				
Forklifts		89		8				
Generator Sets		66		8				
Graders		175		8				
Off-Highway Tractors		123		8				
Off-Highway Trucks		400		8				
Other Construction Equipment		172	10.00	8				
Other General Industrial Equipment		88		8				
Other Material Handling Equipment		167		8				
Pavers		126		8				
Paving Equipment		131		8				
Plate Compactors		8		8				
Pressure Washers		26		8				
Pumps		53		8				
Rollers		81		8				
Rough Terrain Forklifts		100		8				
Rubber Tired Dozers		255		8				
Rubber Tired Loaders		200		8				
Scrapers		362		8				
Signal Boards		20		8				
Skid Steer Loaders		65		8				
Surfacing Equipment		254		8				
Sweepers/Scrubbers		64		8				
Tractors/Loaders/Backhoes		98	10.00	8				
Trenchers		81		8				
Welders		45		8				
20								
END OF DATA ENTRY SHEET								

Additional air quality analysis for the proposed Sacramento Weir and Bypass Widening is performed separately due to the spatial separation between the Sacramento Weir and the additional portion of the project in Alternatives 1 and 2. It should be noted that the Sacramento Weir and Bypass Widening portion of the project is only proposed under Alternative 2.

The air quality emissions analysis for the Sacramento Weir and Bypass Widening was developed based on the following assumptions:

- The Sacramento Weir and Bypass Widening would be constructed as three phases over three years: the Weir, the new levee, and the deconstruction of the old levee;
- The Sacramento Weir would be constructed on dry land on the portion of land between the railroad property and the Old River Road;
- The Old River Road and the railroad would be realigned onto the new weir crown under a separate construction agreement;
- The existing weir would remain in place, and a small transitional island would remain between the new weir and the existing weir;
- The new levee would be constructed using soil existing in the Sacramento Bypass, and no new soil would be imported from other borrow sites.

Sacramento Weir Widening

The construction and design for the proposed widening of the Sacramento Weir has not yet been determined. For the purpose of air quality analysis, it is assumed that the new portion of the weir would be constructed with cement formed on site, requiring haul trucks of both cement and treated wood for the forms. At the peak of construction, as many as 20 trucks could deliver cement or other materials in a day; however, for the purposes of air quality analysis it is anticipated that an average of 5 haul trucks per day would deliver materials to the site over a six month period. Waste materials would be exported on as as-needed basis. The construction of the weir would also include a new section of railroad tracks and a new segment of road in order to connect the existing Yolo Shortline Railroad and the existing Old River Road across the weir. It is currently assumed that the Yolo Shortline Railroad and the Old River Road would remain active during construction, and the only closures and detours would occur when the old section is connected with the new; however, it is possible that the Yolo Shortline Railroad would be closed during construction due to the proximity of the railroad to the footprint of the new weir section. If the railroad requires closure during construction, the goods normally transported by rail could be rerouted onto large cargo trucks; however, the potential emissions from rerouting rail goods onto trucks are outside the scope of this analysis. Construction design, additional traffic analysis, and additional air quality analysis would be conducted during the PED phase.

Construction of the Sacramento Weir and Bypass portion of Alternative 2 is assumed to take place over three years in three different phases: construction of the new levee, construction of the

new weir, and demolition of the old levee. For the purposes of air quality analysis, several assumptions associated with each of these phases have been made.

It is assumed that the construction of the new levee segment would utilize soil available either from the existing bypass area or from the area that will be integrated into the new, larger bypass. This nearby borrow source would eliminate the use of haul trucks; therefore, the model analysis included in Appendix D reflects no haul trucks for this portion of construction. Large construction equipment such as scrapers would be needed in order to take the soil from the source to the site of the new levee. Upon completion of the new levee, a new road to take the place of County Road 126 would be constructed on the levee crown. Although construction is assumed to take place over a single construction season (approximately 6 months), the complete design may determine that additional time is needed to construct this portion of the project. Additional analysis may be needed at that time.

Table 3. Estimated Air Emissions for the Sacramento Bypass New Levee Construction.

	Annual Emissions in Tons					**Maximum Daily Emissions in Pounds**				
Construction Year	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**
Emissions generated in YSAQMD										
Construction of levee	0.7	7.3	6.5	2.5	0.8	18.5	184.7	157.9	47.9	15.6
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	No							No	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					

It is assumed that the construction of the new portion of the weir would be of similar design and materials of the existing weir and would therefore consist mostly of concrete formed on site. It is currently unknown how many cement trucks would be needed for the actual construction of the weir; however, for the purposes of air quality analysis it is assumed that approximately five loads of cement would be delivered to the site daily for the duration of the six month construction project. Additional analysis would be performed once the design of the new weir is completed. Upon completion of the new weir, a new segment of road and railroad would be constructed on the top of the weir and connected to the existing Old River Road and Yolo Shortline Railroad.

Table 4. Estimated Air Emissions for the Sacramento Bypass Weir Construction.

Construction Year	Annual Emissions in Tons					Maximum Daily Emissions in Pounds				
	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$
Emissions generated in YSAQMD										
Construction of weir	0.8	7.5	5.9	2.6	0.8	15.2	148.6	114.6	47.0	6.3
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	No							No	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					

Upon completion of the new levee and the new weir, the existing levee would be deconstructed and the soil from the degraded levee would be redistributed across the entire bypass area in order to encourage positive drainage toward the Yolo Bypass. Additionally, the segment of land that is currently between the existing Yolo Shortline Railroad and the Sacramento River would be lowered in order to connect the new section of the widened Sacramento Bypass to the Sacramento River. Soil removed from this segment of land would also be redistributed across the entire bypass area in order to meet elevation requirements as determined by future design. It is assumed that the majority of the existing river bank would remain in place; however, some vegetation and large trees could be removed. Full analysis of these potential impacts would be performed once the design is completed. Due to the large amount of soil that would be displaced and redistributed in this phase of work, as many as 20 scrapers could be in use at one time during the peak of construction; however, it is not anticipated that any soil would be brought in or removed from the site using haul trucks. The model analysis included in Appendix D reflects no haul trucks for this portion of construction.

Table 5. Estimated Air Emissions for the Sacramento Bypass Existing Levee Removal and Soil Redistribution.

Construction Year	Annual Emissions in Tons					Maximum Daily Emissions in Pounds				
	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$
Emissions generated in YSAQMD										
Levee Removal	1.5	14.2	13.1	3.0	1.1	30.3	297.2	281.8	52.4	19.7
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	Yes							No	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					

Maximum daily emissions are estimated for ROG, NO_X, PM_{10}, and $PM_{2.5}$ to evaluate emissions against YSAQMD thresholds. Those results are shown in Table 6. Construction-related emissions from the Sacramento Weir and Bypass Widening portion of the project would exceed the YSAQMD's emission threshold for NO_X. The actual emissions may be reduced by reducing the number and type of large construction vehicles utilized on site at one time and by following the mitigation measures as recommended by SMAQMD; however, the overall construction emissions under the alternative would likely exceed the thresholds and would therefore result in a significant effect. The Corps would be required to pay an off-site mitigation fee for NO_X emissions in the SVAB in order to reduce the effect to a less-than-significant level.

Table 6. Estimated Air Emissions for Alternative 2, Sacramento Bypass and Weir Widening Construction.

Construction Year	**Annual Emissions in Tons**					**Maximum Daily Emissions in Pounds**				
	ROG	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**
Emissions generated in YSAQMD										
Construction of New Levee	0.7	7.3	6.5	2.5	0.8	18.5	184.7	157.9	47.9	15.6
Construction of New Weir	0.8	7.5	5.9	2.8	0.8	1532	148.6	114.6	47.0	6.3
Demolition of Old Levee	1.5	14.2	13.1	3.0	1.1	30.3	297.2	281.8	52.4	19.7
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	Yes							No	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					

Although Alternative 2 would reduce the number of levee raises along the Sacramento River compared to Alternative 1, for the purposes of air quality analysis the emissions estimates are assumed to be the same as Alternative 1. Alternative 1 summarizes the maximum daily emissions estimated for ROG, NO_X, PM_{10}, and $PM_{2.5}$ under the construction emissions that would result in the most combined air emission. As shown in Table 6, the greatest potential emissions impacts would occur during the demolition of the old levee due to the large number of scrapers and other large construction equipment to displace and redistribute soil. These emissions are combined with the previously analyzed emissions from Alternative 1 in Tables 7 and 8, below.

Table 7. Estimated Air Emissions for the Truck Delivery Scenario With Bypass Widening.

Construction Year	Annual Emissions in Tons					Maximum Daily Emissions in Pounds				
	ROG	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**
Emissions generated in SMAQMD										
Year 2 Onsite Construction	1.5	22.3	8.9	7.4	2.0	11.6	159.7	66.8	29.9	5.4
Year 2 Off-Site Soil Borrow	0	0.7	0.1	0.1	0	6.7	176.2	34.2	71.8	17.5
Year 2 Total	1.5	23.0	9.0	7.5	2.0	18.3	335.9	101	101.7	22.9
CEQA Threshold							85			
Exceed Threshold?							Yes			
General Conformity *de minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					
Emissions generated in YSAQMD										
Year 2 Off-Site Soil Borrow	0	0.6	0.1	.01	0	6.03	158.8	30.78	65.67	15.75
Bypass Widening: Levee Demolition	1.5	14.2	13.1	3.0	1.1	30.3	297.2	281.8	52.4	19.7
Total	1.5	14.8	13.2	3.01	1.1	36.6	456.0	312.58	118.07	35.45
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	Yes							No	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					

Maximum daily emissions are estimated for ROG, NO_X, PM_{10}, and $PM_{2.5}$ to evaluate emissions against SMAQMD, YSAQMD, and BAAQMD thresholds under the barge delivery scenario. Those results are shown in Table 8. Construction-related emissions under Alternative 1 would exceed the SMAQMD's and BAAQMD's emission thresholds for NO_X. Therefore, construction of the alternative with barge delivery would result in a significant effect and the Corps would be required to pay an off-site mitigation fee for NO_X emissions in the SVAB. Payment of these mitigation fees would reduce the impacts to a less-than-significant level. Borrow activities and barge delivery emissions would not exceed YSAQMD thresholds; however, the addition of the Sacramento Weir and Bypass Widening portion of Alternative 2 would exceed the YSAQMD's emission threshold for NO_X. The actual emissions may be reduced by reducing the number and type of large construction vehicles utilized on site at one time and by following the mitigation measures as recommended by SMAQMD; however, the overall construction emissions under the alternative would likely exceed the thresholds and would therefore result in a significant effect. The Corps would be required to pay an off-site mitigation fee for NO_X emissions in the SVAB in

order to reduce the effect to a less-than-significant level. Since less than 50 percent of borrow activities emissions could occur in FRAQMD, it was assumed FRAQMD thresholds would not be exceeded. Borrow activities emissions associated with potential borrow site located north of the project site were captured in the SMAQMD off-site soil estimations.

Table 8. Estimated Air Emissions for the Barge Delivery Scenario With Bypass Widening.

	Annual Emissions in Tons					**Maximum Daily Emissions in Pounds**				
Construction Year	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**
Emissions generated in SMAQMD										
Year 2 Onsite Construction	2.0	22.6	10.7	6.25	1.6	11.6	159.7	66.8	29.9	5.4
Year 2 Off-Site Soil Borrow	0	0.7	0.1	0.1	0	6.7	176.2	34.2	71.8	17.5
Year 2 Barge Delivery	0.41	3.92	1.67	0.15	0	10.2	95.0	39.4	3.7	1.7
Year 2 Total	2.4	27.2	12.5	6.5	1.6	28.5	430.9	140.4	105.4	24.6
CEQA Threshold	NA	NA	NA	NA	NA	NA	85	NA	NA	NA
Exceed Threshold?							Yes			
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	Yes	No	No	No					
Emissions generated in YSAQMD										
Year 2 Off-Site Soil Borrow	0	0.6	0.1	.01	0	6.03	158.8	30.78	65.67	15.75
Year 2 Barge Delivery	0.24	2.33	1	.01	0	6.07	56.5	23.43	2.2	1
Bypass Widening Levee Demolition	1.5	14.2	13.1	3.0	1.1	30.3	297.2	281.80	52.4	19.7
Year 2 Total	1.74	17.13	14.2	3.02	1.1	42.4	512.5	336.01	120.27	36.45
CEQA Threshold	10	10	NA	NA	NA				80	
Exceed Threshold?	No	Yes							Yes	
General Conformity *de Minimis* Threshold	25	25	100	100	100					
Exceed Threshold?	No	No	No	No	No					
Emissions generated in BAAQMD **										
Year 2 Barge Delivery	0.45	4.35	1.85	.16	0	11.32	105.3	91.2	4.1	1.84
CEQA Threshold						54	54		82	54
Exceed Threshold?						No	Yes		No	No
General Conformity *de Minimis* Threshold	50	100	100	NA	100					
Exceed Threshold?	No	No	No		No					

Notes: **Only on-water exhaust emissions generated from towboats are expected to occur within the BAAQMD.

Road Construction Emissions Model, Version 7.1.5.1

Emission Estimates for -> Sac Bypass Widening: NEW LEVEE Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	6.1	49.3	62.2	42.9	2.9	40.0	11.0	2.7	8.3	10,244.4
Grading/Excavation	20.8	157.9	217.0	49.3	9.3	40.0	16.9	8.5	8.3	34,015.3
Drainage/Utilities/Sub-Grade	4.9	38.1	42.8	42.4	2.4	40.0	10.5	2.2	8.3	7,262.2
Paving	3.6	35.3	32.6	1.8	1.8	-	1.7	1.7	-	6,747.9
Maximum (pounds/day)	20.8	157.9	217.0	49.3	9.3	40.0	16.9	8.5	8.3	34,015.3
Total (tons/construction project)	0.8	6.5	8.5	2.6	0.4	2.2	0.8	0.3	0.5	1,370.1

Notes:	
Project Start Year ->	2021
Project Length (months) ->	6
Total Project Area (acres) ->	20
Maximum Area Disturbed/Day (acres) ->	4
Total Soil Imported/Exported (yd^3/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> Sac Bypass Widening: NEW LEVEE Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	2.8	22.4	28.3	19.5	1.3	18.2	5.0	1.2	3.8	4,656.5
Grading/Excavation	9.4	71.8	98.6	22.4	4.2	18.2	7.7	3.9	3.8	15,461.5
Drainage/Utilities/Sub-Grade	2.2	17.3	19.4	19.3	1.1	18.2	4.8	1.0	3.8	3,301.0
Paving	1.6	16.0	14.8	0.8	0.8	-	0.8	0.8	-	3,067.2
Maximum (kilograms/day)	9.4	71.8	98.6	22.4	4.2	18.2	7.7	3.9	3.8	15,461.5
Total (megagrams/construction project)	0.8	5.9	7.7	2.3	0.3	2.0	0.7	0.3	0.4	1,242.7

Notes:	
Project Start Year ->	2021
Project Length (months) ->	6
Total Project Area (hectares) ->	8
Maximum Area Disturbed/Day (hectares) ->	2
Total Soil Imported/Exported (meters ^{3}/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Data Entry Worksheet

Version 7.1.5.1

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a
yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Input Type

Project Name	Sac Bypass Widening: NEW LEVEE	
Construction Start Year	2021	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	6.00	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	2.00	miles
Total Project Area	20.00	acres
Maximum Area Disturbed/Day	4.00	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	0.00	yd^3/day
Soil Exported	0.00	yd^3/day
Average Truck Capacity	20	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months	2005	%	2006	%	2007	%
Grubbing/Land Clearing	0.50	0.60	0.00	0.00	0.00	0.00	0.00	0.00
Grading/Excavation	3.00	2.70	0.00	0.00	0.00	0.00	0.00	0.00
Drainage/Utilities/Sub-Grade	1.00	1.80	0.00	0.00	0.00	0.00	0.00	0.00
Paving	1.50	0.90	0.00	0.00	0.00	0.00	0.00	0.00
Totals	6.00	6.00						

NOTE: soil hauling emissions are included in the Grading/Excavation Construction Period Phase, therefore the Construction Period for Grading/Excavation cannot be zero if hauling is part of the project.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions	User Override of Soil Hauling Defaults	Default Values
User Input		
Miles/round trip		30
Round trips/day		0
Vehicle miles traveled/day (calculated)		0

Hauling Emissions	**ROG**	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**

Emission rate (grams/mile)	0.17	2.87	0.77	0.15	0.09	1551.98
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.00	0.00	0.00	0.00	0.00	0.00
Tons per contruction period	0.00	0.00	0.00	0.00	0.00	0.00

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing		8
No. of employees: Grading/Excavation		20
No. of employees: Drainage/Utilities/Sub-Grade		18
No. of employees: Paving		14

	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**
Emission rate - Grubbing/Land Clearing (grams/mile)	0.101	0.120	1.122	0.047	0.020	441.814
Emission rate - Grading/Excavation (grams/mile)	0.101	0.120	1.122	0.047	0.020	441.814
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.101	0.120	1.122	0.047	0.020	441.814
Emission rate - Paving (grams/mile)	0.101	0.120	1.122	0.047	0.020	441.814
Emission rate - Grubbing/Land Clearing (grams/trip)	0.330	0.185	2.592	0.004	0.004	96.043
Emission rate - Grading/Excavation (grams/trip)	0.330	0.185	2.592	0.004	0.004	96.043
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.330	0.185	2.592	0.004	0.004	96.043
Emission rate - Paving (grams/trip)	0.330	0.185	2.592	0.004	0.004	96.043
Pounds per day - Grubbing/Land Clearing	0.077	0.085	0.827	0.031	0.013	295.121
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.005	0.000	0.000	1.623
Pounds per day - Grading/Excavation	0.207	0.227	2.205	0.083	0.035	786.989
Tons per const. Period - Grading/Excavation	0.007	0.007	0.073	0.003	0.001	25.971
Pounds per day - Drainage/Utilities/Sub-Grade	0.181	0.199	1.929	0.072	0.030	688.616
Tons per const. Period - Drain/Util/Sub-Grade	0.002	0.002	0.021	0.001	0.000	7.575
Pounds per day - Paving	0.142	0.156	1.516	0.057	0.024	541.055
Tons per const. Period - Paving	0.002	0.003	0.025	0.001	0.000	8.927
tons per construction period	0.012	0.013	0.124	0.005	0.002	44.096

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day
Grubbing/Land Clearing - Exhaust	2.00	1		40
Grading/Excavation - Exhaust	2.00	1		40
Drainage/Utilities/Subgrade	1.00	1		40

	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**
Emission rate - Grubbing/Land Clearing (grams/mile)	0.17	2.87	0.77	0.15	0.09	1551.98
Emission rate - Grading/Excavation (grams/mile)	0.17	2.87	0.77	0.15	0.09	1551.98
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.17	2.87	0.77	0.15	0.09	1551.98
Pounds per day - Grubbing/Land Clearing	0.03	0.51	0.14	0.03	0.02	273.48
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	1.50
Pound per day - Grading/Excavation	0.03	0.51	0.14	0.03	0.02	273.48
Tons per const. Period - Grading/Excavation	0.00	0.02	0.00	0.00	0.00	9.02

Pound per day - Drainage/Utilities/Subgrade	0.01	0.25	0.07	0.01	0.01	136.74	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	1.50	

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period
Fugitive Dust - Grubbing/Land Clearing		4	40.0	0.2	8.3	0.0
Fugitive Dust - Grading/Excavation		4	40.0	1.2	8.3	0.2
Fugitive Dust - Drainage/Utilities/Subgrade		4	40.0	0.8	8.3	0.2

Off-Road Equipment Emissions

Grubbing/Land Clearing Override of Default Number of Vehicles	Default Number of Vehicles *Program-estimate*	Type	ROG pounds/day	CO pounds/day	NOx pounds/day	PM10 pounds/day	PM2.5 pounds/day	CO2 pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
	1	Crawler Tractors	0.71	5.58	8.52	0.32	0.30	1030.55
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	1	Excavators	0.31	3.49	2.78	0.13	0.12	716.05
1.00		Forklifts	0.14	0.90	1.19	0.08	0.08	165.47
2.00		Generator Sets	0.72	7.21	6.36	0.35	0.32	1217.66
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Off-Highway Tractors	0.25	2.54	2.50	0.12	0.11	493.07
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Construction Equipment	0.54	4.49	5.40	0.28	0.26	817.30
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Scrapers	2.41	18.15	26.47	1.03	0.95	4021.92
0.00	4	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.49	3.92	4.76	0.28	0.26	837.10
1.00		Trenchers	0.42	2.10	3.65	0.27	0.24	376.64

		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	6.0	48.4	61.6	2.9	2.6	9675.8
	Grubbing/Land Clearing	tons per phase	0.0	0.3	0.3	0.0	0.0	53.2

Grading/Excavation	Default Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
	1	Crawler Tractors	0.71	5.58	8.52	0.32	0.30	1030.55
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	3	Excavators	0.93	10.46	8.35	0.40	0.37	2148.15
1.00		Forklifts	0.14	0.90	1.19	0.08	0.08	165.47
2.00		Generator Sets	0.72	7.21	6.36	0.35	0.32	1217.66
	1	Graders	0.83	4.33	7.61	0.42	0.39	833.84
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Construction Equipment	0.54	4.49	5.40	0.28	0.26	817.30
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Plate Compactors	0.04	0.21	0.25	0.01	0.01	34.45
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
3.00	2	Rollers	0.74	5.66	7.16	0.44	0.40	1048.10
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Rubber Tired Dozers	1.83	8.83	18.08	0.83	0.76	1888.37
3.00	1	Rubber Tired Loaders	1.06	9.34	11.45	0.38	0.35	1987.16
10.00	2	Scrapers	12.03	90.73	132.35	5.15	4.74	20109.62
0.00	4	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
4.00	2	Tractors/Loaders/Backhoes	0.98	7.84	9.52	0.56	0.52	1674.19
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	20.6	155.6	216.3	9.2	8.5	32954.9
	Grading	tons per phase	0.7	5.1	7.1	0.3	0.3	1087.5

Drainage/Utilities/Subgrade	Default Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
	1	Air Compressors	0.41	3.28	2.83	0.18	0.16	507.95
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00

		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Concrete/Industrial Saws	0.30	2.90	2.40	0.14	0.13	467.14
1.00		Cranes	0.42	3.00	4.71	0.19	0.18	601.63
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Forklifts	0.14	0.90	1.19	0.08	0.08	165.47
2.00	1	Generator Sets	0.72	7.21	6.36	0.35	0.32	1217.66
	1	Graders	0.83	4.33	7.61	0.42	0.39	833.84
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Construction Equipment	0.54	4.49	5.40	0.28	0.26	817.30
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	1	Plate Compactors	0.04	0.21	0.25	0.01	0.01	34.45
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
	1	Rough Terrain Forklifts	0.13	2.03	1.63	0.06	0.06	372.90
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	4	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00	2	Tractors/Loaders/Backhoes	0.49	3.92	4.76	0.28	0.26	837.10
1.00		Trenchers	0.42	2.10	3.65	0.27	0.24	376.64
1.00		Welders	0.31	1.70	1.51	0.08	0.07	204.74
	Drainage	pounds per day	4.7	36.1	42.3	2.3	2.2	6436.8
	Drainage	tons per phase	0.1	0.4	0.5	0.0	0.0	70.8

Paving	Default Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Cement and Mortar Mixers	0.07	0.35	0.42	0.02	0.02	57.88
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Generator Sets	0.72	7.21	6.36	0.35	0.32	1217.66
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00

		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Material Handling Equipment	0.38	3.97	3.27	0.17	0.15	760.75
	1	Pavers	0.31	3.55	3.10	0.15	0.14	602.27
	1	Paving Equipment	0.24	3.37	2.37	0.12	0.11	532.69
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
	3	Rollers	0.74	5.66	7.16	0.44	0.40	1048.10
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	4	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Surfacing Equipment	0.25	4.18	2.95	0.11	0.10	880.33
1.00		Sweepers/Scrubbers	0.24	1.57	2.04	0.15	0.14	270.09
	2	Tractors/Loaders/Backhoes	0.49	3.92	4.76	0.28	0.26	837.10
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	3.4	33.8	32.4	1.8	1.6	6206.9
	Paving	tons per phase	0.1	0.6	0.5	0.0	0.0	102.4
Total Emissions all Phases (tons per construction period) =>			0.8	6.4	8.5	0.4	0.3	1313.9

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.

Equipment		Default Values Horsepower		Default Values Hours/day
Aerial Lifts		63		8
Air Compressors		106		8
Bore/Drill Rigs		206		8
Cement and Mortar Mixers		10		8
Concrete/Industrial Saws		64		8
Cranes		226		8
Crawler Tractors		208	10.00	8
Crushing/Proc. Equipment		142		8
Excavators		163	10.00	8
Forklifts		89		8
Generator Sets		66	10.00	8
Graders		175	10.00	8
Off-Highway Tractors		123		8
Off-Highway Trucks		400		8
Other Construction Equipment		172	10.00	8
Other General Industrial Equipment		88	10.00	8
Other Material Handling Equipment		167	10.00	8
Pavers		126	10.00	8
Paving Equipment		131	10.00	8
Plate Compactors		8		8
Pressure Washers		26		8

Pumps		53		8
Rollers		81	10.00	8
Rough Terrain Forklifts		100		8
Rubber Tired Dozers		255		8
Rubber Tired Loaders		200		8
Scrapers		362	10.00	8
Signal Boards		20		8
Skid Steer Loaders		65		8
Surfacing Equipment		254	10.00	8
Sweepers/Scrubbers		64		8
Tractors/Loaders/Backhoes		98	10.00	8
Trenchers		81		8
Welders		45		8

END OF DATA ENTRY SHEET

Road Construction Emissions Model, Version 7.1.5.1

Emission Estimates for -> Sac Bypass Widening: WEIR ONLY Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	7.0	55.3	66.7	43.2	3.2	40.0	11.2	2.9	8.3	11,096.6
Grading/Excavation	13.8	114.4	129.7	46.1	6.1	40.0	13.8	5.5	8.3	23,724.5
Drainage/Utilities/Sub-Grade	3.3	27.5	26.6	41.5	1.5	40.0	9.6	1.3	8.3	5,330.0
Paving	3.9	39.7	34.1	1.7	1.7	-	1.6	1.6	-	7,332.4
Maximum (pounds/day)	13.8	114.4	129.7	46.1	6.1	40.0	13.8	5.5	8.3	23,724.5
Total (tons/construction project)	0.7	5.9	6.6	2.5	0.3	2.2	0.7	0.3	0.5	1,214.9

Notes:	
Project Start Year ->	2022
Project Length (months) ->	6
Total Project Area (acres) ->	10
Maximum Area Disturbed/Day (acres) ->	4
Total Soil Imported/Exported (yd^3/day)->	120

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> Sac Bypass Widening: WEIR ONLY Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	3.2	25.1	30.3	19.6	1.5	18.2	5.1	1.3	3.8	5,043.9
Grading/Excavation	6.3	52.0	59.0	20.9	2.8	18.2	6.3	2.5	3.8	10,783.9
Drainage/Utilities/Sub-Grade	1.5	12.5	12.1	18.8	0.7	18.2	4.4	0.6	3.8	2,422.7
Paving	1.8	18.1	15.5	0.8	0.8	-	0.7	0.7	-	3,332.9
Maximum (kilograms/day)	6.3	52.0	59.0	20.9	2.8	18.2	6.3	2.5	3.8	10,783.9
Total (megagrams/construction project)	0.6	5.4	6.0	2.3	0.3	2.0	0.7	0.3	0.4	1,101.9

Notes:	
Project Start Year ->	2022
Project Length (months) ->	6
Total Project Area (hectares) ->	4
Maximum Area Disturbed/Day (hectares) ->	2
Total Soil Imported/Exported (meters ^{3}/day)->	92

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Version 7.1.5.1

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a
yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

Input Type

Project Name	Sac Bypass Widening: WEIR ONLY	
Construction Start Year	2022	Enter a Year between 2009 and 2025 (inclusive)
Project Type	3	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	6.00	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	0.30	miles
Total Project Area	10.00	acres
Maximum Area Disturbed/Day	4.00	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	100.00	yd^3/day
Soil Exported	20.00	yd^3/day
Average Truck Capacity	20	yd^3 (assume 20 if unknown)

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months
Grubbing/Land Clearing	0.50	0.60
Grading/Excavation	4.00	2.70
Drainage/Utilities/Sub-Grade	0.50	1.80
Paving	1.00	0.90
Totals	6.00	6.00

2005	%	2006	%	2007	%
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00

NOTE: soil hauling emissions are included in the Grading/Excavation Construction Period Phase, therefore the Construction Period for Grading/Excavation cannot be zero if hauling is part of the project.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions

User Input	User Override of Soil Hauling Defaults	Default Values
Miles/round trip	30.00	30
Round trips/day		6
Vehicle miles traveled/day (calculated)		180

Hauling Emissions	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate (grams/mile)	0.18	1.77	0.83	0.15	0.08	1546.69
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.07	0.70	0.33	0.06	0.03	613.23
Tons per contruction period	0.00	0.03	0.01	0.00	0.00	26.98

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions

	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing		5
No. of employees: Grading/Excavation		28
No. of employees: Drainage/Utilities/Sub-Grade		18
No. of employees: Paving		8

	ROG	NOx	CO	PM10	PM2.5	CO2
Emission rate - Grubbing/Land Clearing (grams/mile)	0.097	0.112	1.056	0.047	0.020	441.772
Emission rate - Grading/Excavation (grams/mile)	0.097	0.112	1.056	0.047	0.020	441.772
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.097	0.112	1.056	0.047	0.020	441.772
Emission rate - Paving (grams/mile)	0.097	0.112	1.056	0.047	0.020	441.772
Emission rate - Grubbing/Land Clearing (grams/trip)	0.310	0.168	2.386	0.004	0.004	96.127
Emission rate - Grading/Excavation (grams/trip)	0.310	0.168	2.386	0.004	0.004	96.127
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.310	0.168	2.386	0.004	0.004	96.127
Emission rate - Paving (grams/trip)	0.310	0.168	2.386	0.004	0.004	96.127
Pounds per day - Grubbing/Land Clearing	0.049	0.053	0.518	0.021	0.009	196.730
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.003	0.000	0.000	1.082
Pounds per day - Grading/Excavation	0.272	0.291	2.848	0.114	0.048	1082.017
Tons per const. Period - Grading/Excavation	0.012	0.013	0.125	0.005	0.002	47.609
Pounds per day - Drainage/Utilities/Sub-Grade	0.173	0.185	1.813	0.072	0.030	688.556
Tons per const. Period - Drain/Util/Sub-Grade	0.001	0.001	0.010	0.000	0.000	3.787
Pounds per day - Paving	0.074	0.079	0.777	0.031	0.013	295.096
Tons per const. Period - Paving	0.001	0.001	0.009	0.000	0.000	3.246
tons per construction period	0.014	0.015	0.147	0.006	0.002	55.724

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	1.00	1		40			
Grading/Excavation - Exhaust	1.00	1		40			
Drainage/Utilities/Subgrade	1.00	1		40			
	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.18	1.77	0.83	0.15	0.08	1546.69	
Emission rate - Grading/Excavation (grams/mile)	0.18	1.77	0.83	0.15	0.08	1546.69	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.18	1.77	0.83	0.15	0.08	1546.69	
Pounds per day - Grubbing/Land Clearing	0.02	0.16	0.07	0.01	0.01	136.27	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.75	
Pound per day - Grading/Excavation	0.02	0.16	0.07	0.01	0.01	136.27	
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	6.00	
Pound per day - Drainage/Utilities/Subgrade	0.02	0.16	0.07	0.01	0.01	136.27	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.75	

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period
Fugitive Dust - Grubbing/Land Clearing		4	40.0	0.2	8.3	0.0
Fugitive Dust - Grading/Excavation		4	40.0	1.2	8.3	0.2
Fugitive Dust - Drainage/Utilities/Subgrade		4	40.0	0.8	8.3	0.2

Off-Road Equipment Emissions

Grubbing/Land Clearing Override of Default Number of Vehicles	Default Number of Vehicles *Program-estimate*	Type	ROG pounds/day	CO pounds/day	NOx pounds/day	PM10 pounds/day	PM2.5 pounds/day	CO2 pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Concrete/Industrial Saws	0.28	2.89	2.21	0.12	0.11	467.14
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
	1	Crawler Tractors	0.63	5.57	7.35	0.28	0.26	1028.75
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Excavators	0.27	3.48	2.30	0.11	0.10	715.80
1.00		Forklifts	0.12	0.90	1.06	0.07	0.06	165.47
2.00		Generator Sets	0.67	7.20	5.90	0.31	0.28	1217.66
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Construction Equipment	0.49	4.49	4.70	0.25	0.23	817.03
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Material Handling Equipment	0.34	3.97	2.75	0.15	0.14	760.75
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Rubber Tired Dozers	2.21	11.05	21.39	0.98	0.90	2362.06
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Scrapers	1.06	9.09	11.06	0.43	0.40	2014.23
0.00	1	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.43	3.92	4.21	0.23	0.21	838.04
1.00		Trenchers	0.40	2.10	3.51	0.25	0.23	376.67
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	6.9	54.7	66.4	3.2	2.9	10763.6
	Grubbing/Land Clearing	tons per phase	0.0	0.3	0.4	0.0	0.0	59.2

Grading/Excavation	Default Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
5.00		Cement and Mortar Mixers	0.42	2.21	2.64	0.10	0.09	361.76
1.00		Concrete/Industrial Saws	0.28	2.89	2.21	0.12	0.11	467.14
	1	Cranes	0.38	3.00	4.07	0.17	0.16	601.73
	2	Crawler Tractors	1.26	11.15	14.70	0.55	0.51	2057.50
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	4	Excavators	1.10	13.94	9.18	0.44	0.41	2863.19
1.00		Forklifts	0.12	0.90	1.06	0.07	0.06	165.47
2.00		Generator Sets	0.67	7.20	5.90	0.31	0.28	1217.66
	2	Graders	1.45	8.65	12.98	0.72	0.66	1667.81
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Construction Equipment	0.49	4.49	4.70	0.25	0.23	817.03
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Plate Compactors	0.04	0.21	0.25	0.01	0.01	34.45
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Pumps	0.23	2.38	1.95	0.10	0.10	396.14
2.00	3	Rollers	0.43	3.77	4.28	0.25	0.23	698.78
2.00		Rough Terrain Forklifts	0.24	4.06	2.99	0.10	0.10	745.77
2.00		Rubber Tired Dozers	2.21	11.05	21.39	0.98	0.90	2362.06
3.00	3	Rubber Tired Loaders	0.90	9.35	8.97	0.30	0.28	1988.60
2.00	4	Scrapers	2.12	18.18	22.12	0.86	0.79	4028.45
0.00	1	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
	2	Tractors/Loaders/Backhoes	0.43	3.92	4.21	0.23	0.21	838.04
1.00		Trenchers	0.40	2.10	3.51	0.25	0.23	376.67
1.00		Welders	0.28	1.68	1.47	0.07	0.06	204.74
	Grading/Excavation	pounds per day	13.4	111.1	128.6	5.9	5.4	21893.0
	Grading	tons per phase	0.6	4.9	5.7	0.3	0.2	963.3

Drainage/Utilities/Subgrade Override of Default Number of Vehicles	Default Number of Vehicles *Program-estimate*		ROG pounds/day	CO pounds/day	NOx pounds/day	PM10 pounds/day	PM2.5 pounds/day	CO2 pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
	1	Air Compressors	0.38	3.28	2.62	0.16	0.14	507.95
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
5.00		Cement and Mortar Mixers	0.42	2.21	2.64	0.10	0.09	361.76
1.00		Concrete/Industrial Saws	0.28	2.89	2.21	0.12	0.11	467.14
1.00		Cranes	0.38	3.00	4.07	0.17	0.16	601.73
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Forklifts	0.12	0.90	1.06	0.07	0.06	165.47
	1	Generator Sets	0.33	3.60	2.95	0.15	0.14	608.83
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
	1	Rough Terrain Forklifts	0.12	2.03	1.49	0.05	0.05	372.88
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	4	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00	2	Tractors/Loaders/Backhoes	0.43	3.92	4.21	0.23	0.21	838.04
1.00		Trenchers	0.40	2.10	3.51	0.25	0.23	376.67
1.00		Welders	0.28	1.68	1.47	0.07	0.06	204.74
	Drainage	pounds per day	3.1	25.6	26.2	1.4	1.3	4505.2
	Drainage	tons per phase	0.0	0.1	0.1	0.0	0.0	24.8

Paving	Default Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
5.00		Cement and Mortar Mixers	0.42	2.21	2.64	0.10	0.09	361.76
1.00		Concrete/Industrial Saws	0.28	2.89	2.21	0.12	0.11	467.14
1.00		Cranes	0.38	3.00	4.07	0.17	0.16	601.73
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Generator Sets	0.67	7.20	5.90	0.31	0.28	1217.66
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Material Handling Equipment	0.34	3.97	2.75	0.15	0.14	760.75
1.00	1	Pavers	0.26	3.55	2.51	0.12	0.11	602.53
	1	Paving Equipment	0.23	3.37	2.12	0.10	0.10	532.71
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
	1	Rollers	0.22	1.89	2.14	0.12	0.11	349.39
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
	1	Signal Boards	0.18	1.20	1.07	0.04	0.04	157.43
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Surfacing Equipment	0.23	4.17	2.62	0.10	0.09	878.04
1.00		Sweepers/Scrubbers	0.20	1.57	1.79	0.12	0.11	270.09
	2	Tractors/Loaders/Backhoes	0.43	3.92	4.21	0.23	0.21	838.04
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	3.8	38.9	34.0	1.7	1.5	7037.3
	Paving	tons per phase	0.0	0.4	0.4	0.0	0.0	77.4
Total Emissions all Phases (tons per construction period) =>			0.7	5.8	6.5	0.3	0.3	1124.7

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.

Equipment		Default Values Horsepower		Default Values Hours/day
Aerial Lifts		63		8
Air Compressors		106		8
Bore/Drill Rigs		206		8
Cement and Mortar Mixers		10	10.00	8
Concrete/Industrial Saws		64		8
Cranes		226		8
Crawler Tractors		208	10.00	8
Crushing/Proc. Equipment		142		8
Excavators		163	10.00	8
Forklifts		89		8
Generator Sets		66	10.00	8
Graders		175	10.00	8
Off-Highway Tractors		123		8
Off-Highway Trucks		400		8
Other Construction Equipment		172	10.00	8
Other General Industrial Equipment		88	10.00	8
Other Material Handling Equipment		167	10.00	8
Pavers		126	10.00	8
Paving Equipment		131	10.00	8
Plate Compactors		8		8
Pressure Washers		26		8
Pumps		53		8
Rollers		81	10.00	8
Rough Terrain Forklifts		100		8
Rubber Tired Dozers		255	10.00	8
Rubber Tired Loaders		200		8
Scrapers		362	10.00	8
Signal Boards		20		8
Skid Steer Loaders		65		8
Surfacing Equipment		254	10.00	8
Sweepers/Scrubbers		64		8
Tractors/Loaders/Backhoes		98	10.00	8
Trenchers		81		8
Welders		45		8

END OF DATA ENTRY SHEET

Road Construction Emissions Model, Version 7.1.5.1

Emission Estimates for -> Sac Bypass Widening: BYPASS Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	6.1	60.4	56.6	42.7	2.7	40.0	10.7	2.4	8.3	12,519.5
Grading/Excavation	30.3	271.8	297.2	52.4	12.4	40.0	19.7	11.3	8.3	58,683.4
Drainage/Utilities/Sub-Grade	5.0	44.7	43.3	42.2	2.2	40.0	10.3	2.0	8.3	9,199.0
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	30.3	271.8	297.2	52.4	12.4	40.0	19.7	11.3	8.3	58,683.4
Total (tons/construction project)	1.5	13.1	14.2	3.0	0.6	2.4	1.1	0.5	0.5	2,821.0

Notes:	
Project Start Year ->	2023
Project Length (months) ->	6
Total Project Area (acres) ->	320
Maximum Area Disturbed/Day (acres) ->	4
Total Soil Imported/Exported (yd^3/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> Sac Bypass Widening: BYPASS Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	2.8	27.4	25.7	19.4	1.2	18.2	4.9	1.1	3.8	5,690.7
Grading/Excavation	13.8	123.6	135.1	23.8	5.6	18.2	8.9	5.2	3.8	26,674.3
Drainage/Utilities/Sub-Grade	2.3	20.3	19.7	19.2	1.0	18.2	4.7	0.9	3.8	4,181.4
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	13.8	123.6	135.1	23.8	5.6	18.2	8.9	5.2	3.8	26,674.3
Total (megagrams/construction project)	1.3	11.9	12.9	2.7	0.5	2.2	1.0	0.5	0.5	2,558.7

Notes:	
Project Start Year ->	2023
Project Length (months) ->	6
Total Project Area (hectares) ->	130
Maximum Area Disturbed/Day (hectares) ->	2
Total Soil Imported/Exported (meters ^{3}/day)->	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sume of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model

Data Entry Worksheet

Version 7.1.5.1

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a
yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells C10 through C25.

Input Type

Project Name	Sac Bypass Widening: BYPASS	
Construction Start Year	2023	Enter a Year between 2009 and 2025 (inclusive)
Project Type	2	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	6.00	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	4.00	miles
Total Project Area	320.00	acres
Maximum Area Disturbed/Day	4.00	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	0.00	yd^3/day
Soil Exported	0.00	yd^3/day
Average Truck Capacity	20	yd^3 (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.

Construction Periods	User Override of Construction Months	Program Calculated Months	2005	%	2006	%	2007	%
Grubbing/Land Clearing	1.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00
Grading/Excavation	4.00	2.70	0.00	0.00	0.00	0.00	0.00	0.00
Drainage/Utilities/Sub-Grade	1.00	1.80	0.00	0.00	0.00	0.00	0.00	0.00
Paving	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00
Totals	6.00	6.00						

NOTE: soil hauling emissions are included in the Grading/Excavation Construction Period Phase, therefore the Construction Period for Grading/Excavation cannot be zero if hauling is part of the project.

Hauling emission default values can be overridden in cells C45 through C46.

Soil Hauling Emissions	User Override of Soil Hauling Defaults	Default Values
User Input		
Miles/round trip		30
Round trips/day		0
Vehicle miles traveled/day (calculated)		0

Hauling Emissions	**ROG**	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**

Emission rate (grams/mile)	0.17	1.35	0.77	0.15	0.08	1541.90
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day	0.00	0.00	0.00	0.00	0.00	0.00
Tons per contruction period	0.00	0.00	0.00	0.00	0.00	0.00

Worker commute default values can be overridden in cells C60 through C65.

Worker Commute Emissions	User Override of Worker Commute Default Values	Default Values
Miles/ one-way trip		20
One-way trips/day		2
No. of employees: Grubbing/Land Clearing		14
No. of employees: Grading/Excavation		29
No. of employees: Drainage/Utilities/Sub-Grade		23
No. of employees: Paving		19

	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**
Emission rate - Grubbing/Land Clearing (grams/mile)	0.093	0.105	0.999	0.047	0.020	441.716
Emission rate - Grading/Excavation (grams/mile)	0.093	0.105	0.999	0.047	0.020	441.716
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.093	0.105	0.999	0.047	0.020	441.716
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)	0.292	0.154	2.207	0.004	0.004	96.196
Emission rate - Grading/Excavation (grams/trip)	0.292	0.154	2.207	0.004	0.004	96.196
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.292	0.154	2.207	0.004	0.004	96.196
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing	0.130	0.137	1.344	0.057	0.024	540.946
Tons per const. Period - Grub/Land Clear	0.001	0.002	0.015	0.001	0.000	5.950
Pounds per day - Grading/Excavation	0.272	0.285	2.810	0.119	0.050	1131.069
Tons per const. Period - Grading/Excavation	0.012	0.013	0.124	0.005	0.002	49.767
Pounds per day - Drainage/Utilities/Sub-Grade	0.213	0.223	2.199	0.093	0.039	885.184
Tons per const. Period - Drain/Util/Sub-Grade	0.002	0.002	0.024	0.001	0.000	9.737
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period	0.016	0.017	0.163	0.007	0.003	65.454

Water truck default values can be overriden in cells C91 through C93 and E91 through E93.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Miles Traveled/Day	Default Values Miles Traveled/Day
Grubbing/Land Clearing - Exhaust	2.00	1		40
Grading/Excavation - Exhaust	2.00	1		40
Drainage/Utilities/Subgrade	2.00	1		40

	ROG	**NOx**	**CO**	**PM10**	**PM2.5**	**CO2**
Emission rate - Grubbing/Land Clearing (grams/mile)	0.17	1.35	0.77	0.15	0.08	1541.90
Emission rate - Grading/Excavation (grams/mile)	0.17	1.35	0.77	0.15	0.08	1541.90
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.17	1.35	0.77	0.15	0.08	1541.90
Pounds per day - Grubbing/Land Clearing	0.03	0.24	0.14	0.03	0.01	271.70
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	2.99
Pound per day - Grading/Excavation	0.03	0.24	0.14	0.03	0.01	271.70
Tons per const. Period - Grading/Excavation	0.00	0.01	0.01	0.00	0.00	11.95

Pound per day - Drainage/Utilities/Subgrade	0.03	0.24	0.14	0.03	0.01	271.70	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	2.99	

Fugitive dust default values can be overridden in cells C110 through C112.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period
Fugitive Dust - Grubbing/Land Clearing		4	40.0	0.4	8.3	0.1
Fugitive Dust - Grading/Excavation		4	40.0	1.2	8.3	0.2
Fugitive Dust - Drainage/Utilities/Subgrade		4	40.0	0.8	8.3	0.2

Off-Road Equipment Emissions

Grubbing/Land Clearing Override of Default Number of Vehicles	Default Number of Vehicles *Program-estimate*	Type	ROG pounds/day	CO pounds/day	NOx pounds/day	PM10 pounds/day	PM2.5 pounds/day	CO2 pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
	1	Crawler Tractors	0.57	5.57	6.27	0.24	0.22	1027.72
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	2	Excavators	0.51	6.97	4.00	0.20	0.18	1431.85
1.00		Forklifts	0.11	0.90	0.97	0.06	0.06	165.47
2.00		Generator Sets	0.62	7.18	5.49	0.27	0.25	1217.66
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Off-Highway Tractors	0.40	5.07	3.36	0.16	0.15	986.29
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Other Construction Equipment	0.90	8.98	8.47	0.44	0.41	1633.88
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Scrapers	2.04	18.17	20.49	0.80	0.74	4028.00
0.00	8	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.40	3.93	3.86	0.19	0.18	838.98
1.00		Trenchers	0.38	2.10	3.36	0.23	0.21	376.96

		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	5.9	58.9	56.3	2.6	2.4	11706.8
	Grubbing/Land Clearing	tons per phase	0.1	0.6	0.6	0.0	0.0	128.8

Grading/Excavation	Default Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
4.00	1	Crawler Tractors	2.27	22.27	25.08	0.97	0.89	4110.89
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	3	Excavators	0.77	10.46	6.00	0.29	0.27	2147.78
2.00		Forklifts	0.22	1.80	1.94	0.12	0.11	330.93
2.00		Generator Sets	0.62	7.18	5.49	0.27	0.25	1217.66
	2	Graders	1.28	8.65	11.16	0.61	0.57	1667.45
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Other Construction Equipment	0.45	4.49	4.24	0.22	0.20	816.94
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Plate Compactors	0.04	0.21	0.25	0.01	0.01	34.45
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
4.00	2	Rollers	0.64	6.04	6.39	0.35	0.32	1118.06
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Rubber Tired Dozers	1.66	8.84	15.69	0.72	0.66	1890.27
3.00	1	Rubber Tired Loaders	0.84	9.35	7.87	0.26	0.24	1988.26
20.00	2	Scrapers	20.36	181.73	204.86	8.03	7.39	40279.99
0.00	8	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
	4	Tractors/Loaders/Backhoes	0.80	7.86	7.71	0.38	0.35	1677.96
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	30.0	268.9	296.7	12.2	11.3	57280.6
	Grading	tons per phase	1.3	11.8	13.1	0.5	0.5	2520.3

Drainage/Utilities/Subgrade	Default Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
	1	Air Compressors	0.36	3.27	2.43	0.14	0.13	507.95
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00

1.00		Cement and Mortar Mixers	0.07	0.35	0.42	0.02	0.02	57.88
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Cranes	0.36	3.00	3.71	0.15	0.14	601.71
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Forklifts	0.11	0.90	0.97	0.06	0.06	165.47
2.00	1	Generator Sets	0.62	7.18	5.49	0.27	0.25	1217.66
	1	Graders	0.64	4.33	5.58	0.31	0.28	833.72
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	1	Plate Compactors	0.04	0.21	0.25	0.01	0.01	34.45
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
	1	Pumps	0.22	2.37	1.81	0.09	0.08	396.14
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
	1	Rough Terrain Forklifts	0.11	2.03	1.41	0.05	0.04	372.94
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
	1	Scrapers	1.02	9.09	10.24	0.40	0.37	2014.00
0.00	8	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
	3	Tractors/Loaders/Backhoes	0.60	5.89	5.78	0.29	0.26	1258.47
1.00		Trenchers	0.38	2.10	3.36	0.23	0.21	376.96
1.00		Welders	0.26	1.67	1.43	0.06	0.05	204.74
	Drainage	pounds per day	4.8	42.4	42.9	2.1	1.9	8042.1
	Drainage	tons per phase	0.1	0.5	0.5	0.0	0.0	88.5

Paving	Default Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	*Program-estimate*	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00

		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	8	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
Total Emissions all Phases (tons per construction period) =>			1.4	12.9	14.1	0.6	0.5	2737.6

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.

Equipment		Default Values Horsepower		Default Values Hours/day
Aerial Lifts		63		8
Air Compressors		106		8
Bore/Drill Rigs		206		8
Cement and Mortar Mixers		10		8
Concrete/Industrial Saws		64		8
Cranes		226		8
Crawler Tractors		208	10.00	8
Crushing/Proc. Equipment		142		8
Excavators		163	10.00	8
Forklifts		89		8
Generator Sets		66	10.00	8
Graders		175	10.00	8
Off-Highway Tractors		123		8
Off-Highway Trucks		400		8
Other Construction Equipment		172	10.00	8
Other General Industrial Equipment		88	10.00	8
Other Material Handling Equipment		167	10.00	8
Pavers		126	10.00	8
Paving Equipment		131	10.00	8
Plate Compactors		8		8
Pressure Washers		26		8

Pumps		53		8
Rollers		81		8
Rough Terrain Forklifts		100		8
Rubber Tired Dozers		255		8
Rubber Tired Loaders		200		8
Scrapers		362	10.00	8
Signal Boards		20		8
Skid Steer Loaders		65		8
Surfacing Equipment		254	10.00	8
Sweepers/Scrubbers		64		8
Tractors/Loaders/Backhoes		98	10.00	8
Trenchers		81		8
Welders		45		8

END OF DATA ENTRY SHEET

APPENDIX E
SECTION 404(b)(1) WATER QUALITY EVALUATION
AMERICAN RIVER COMMON FEATURES
GENERAL REEVALUATION REPORT
SACRAMENTO, CALIFORNIA

This document constitutes the Statement of Findings, and review and compliance determination according to the Section 404(b)(1) Guidelines for the proposed project described in the American River Common Features Environmental Impact Statement/Environmental Impact Report (EIS/EIR) issued by the Sacramento District. This analysis has been prepared in accordance with the Section 404(b)(1) Guidelines, 40 CFR Part 230 and the U.S. Army Corps of Engineers (Corps) Planning Guidance Notebook, Engineer Regulation (ER) 1105-2-100.

I. Project Description

a. Proposed Project

The American River Common Features General Reevaluation Report (ARCF GRR) is a cooperative effort by the Corps, the Central Valley Flood Protection Board, the non-federal sponsor, and the Sacramento Area Flood Control Agency, the local sponsor. The Corps completed the ARCF GRR final Environmental Impact Assessment/Environmental Impact Report (EIS/EIR) in September 2015. The final EIS/EIR will be referenced throughout the document to describe the existing conditions in the study area, as well as some potential impacts of the proposed project and the other alternatives.

The ARCF EIS/EIR identifies a number of problems associated with the flood risk management system protecting the city of Sacramento and surrounding areas. There is a high probability that flood flows in the American River and Sacramento River will stress the network of levees protecting Sacramento to the point that levees could fail. The consequences of such a levee failure would be catastrophic, since the area inundated by flood waters is highly urbanized and the flooding could be up to 20 feet deep.

No Action Alternative

The No Action Alternative, under NEPA, is the expected future without-project condition. Under CEQA, the No Action Alternative is the existing condition at the time the notice of preparation was published (February 28, 2008) as modified by what would reasonably be expected to occur in the foreseeable future if the project were not approved. The No Action Alternative assumes that no work would be completed by the Corps and the study area would continue to be at a very high risk of levee failure and subsequent flooding of the Sacramento Metropolitan area. This area includes the California State Capitol and many other State and Federal Agencies. For the purposes of this 404(b)(1) analysis, the No Action Alternative is also the no fill alternative. Under the no fill alternative, no measures would

be proposed to place fill material in waters of the U.S. As a result, under the no fill alternative, the levee system's identified erosion problem would not be addressed, and the Sacramento area would remain at risk of a levee failure.

Alternative 1 – Improve Levees

Alternative 1 involves the construction of fix-in-place levee remediation measures to address seepage, slope stability, erosion, and overtopping concerns identified for the American River and Sacramento River, Natomas East Main Drainage Canal (NEMDC), Arcade Creek, and Magpie Creek levees. Table 1 summarizes the measures proposed under Alternative 1.

Table 1. Alternative 1 – Proposed Levee Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, Geotextile, Slope Flattening	Bank Protection, Launchable Rock Trench	Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall, Geotextiles	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek[2]	---	---	---	Floodwall/New Levee/Detention Basin

Notes: [1]American River seepage, stability, and overtopping measures were addressed in the ARCF WRDA 1996 and 1999 construction projects. [2]In addition to the listed measures, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

Figure 1 shows the reaches where seepage, slope stability, erosion, and overtopping measures would be required.

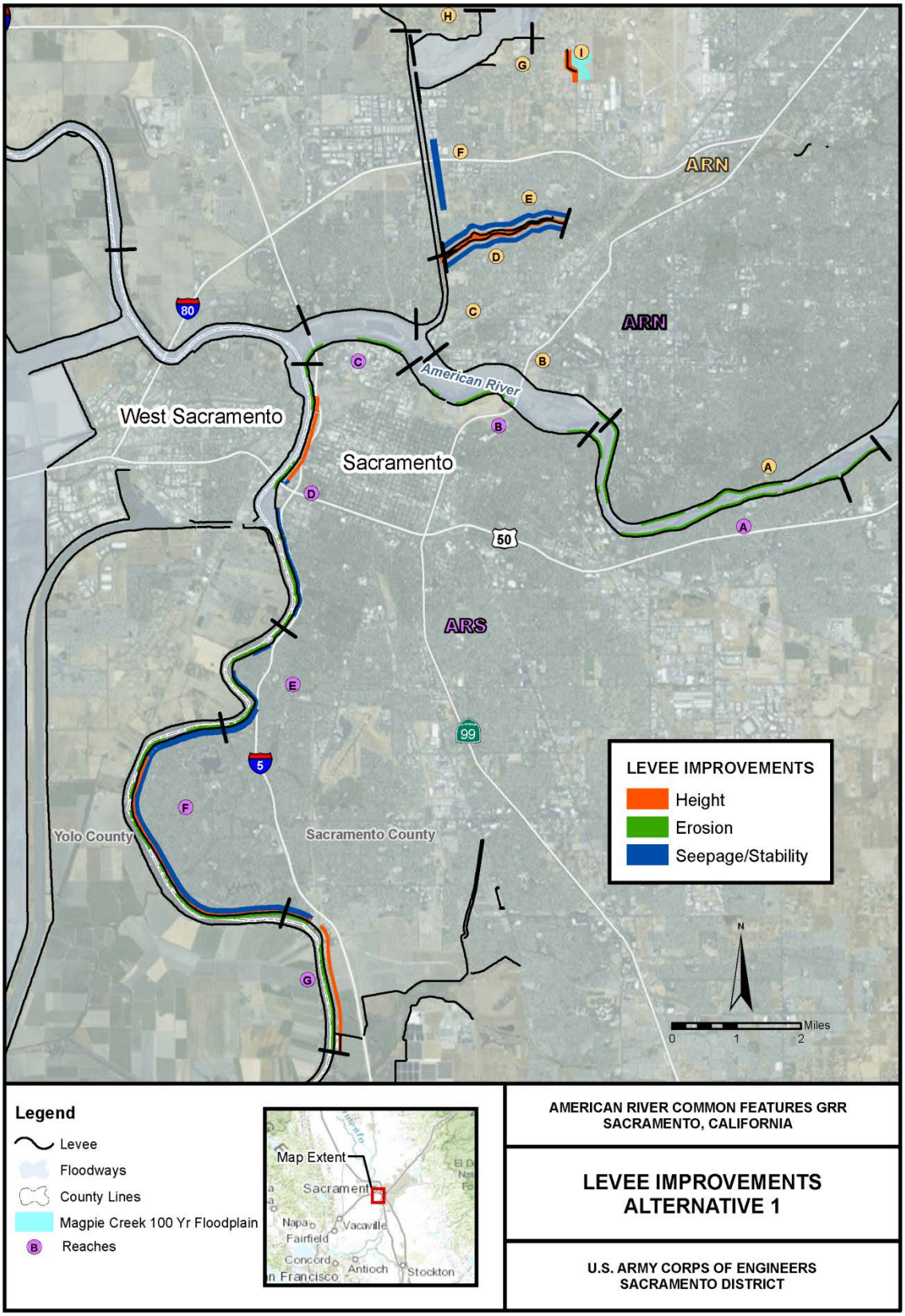

Figure 1. Alternative 1 Proposed Measures.

The proposed project would require discharge of fill material into waters of the U.S. The following subsections describe the measures proposed for Alternative 1 and identify any possible discharge of fill material associated with each measure.

Seepage and Slope Stability Measures

To address seepage concerns, a cutoff wall would be constructed through the levee crown. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall construction selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 80 feet. For cutoff walls of greater depth, the DSM method would be utilized. Prior to construction of the cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.

This measure is proposed along the Sacramento River, the east bank of the NEMDC, and Arcade Creek. Because seepage and slope stability measures would be installed directly into the levee as a cutoff wall, no fill material would be placed into waters of the U.S. by implementing this measure.

Erosion Protection

Erosion protection along the American River and Sacramento River would be addressed via either the launchable rock trench method or by standard bank protection. There are no erosion protection measures proposed for the East Side Tributaries. The erosion protection measures would involve the placement of fill into waters of the U.S. Construction methods for the bank protection and launchable rock trench measures are described in Section h below.

Overtopping Measures

Levee raises are proposed for the Sacramento River and the East Side Tributaries to address the potential for floodwaters overtopping the levees. For the Sacramento River, Arcade Creek, and NEMDC, there would be no placement of fill into waters of the U.S., because levee raises would be conducted primarily on the crown and landside of the levees and would be designed to avoid placement of fill in the waterways. At Magpie Creek, there is the potential for approximately 0.25-acre of vernal pool habitat on the landside of the levee to be permanently impacted by construction of a levee raise. Construction methods for the levee raise are described in Section h below.

Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass

Alternative 2 includes all of the measures proposed under Alternative 1, with the exception of the approximately 7 miles of levee raises on the Sacramento River. Instead, under Alternative 2, the Sacramento Weir and Bypass would be widened to lower the water surface elevations on the Sacramento River to a level that would only require approximately 1 mile of levee raises and would divert more flows into the Yolo Bypass. Table 2 shows the measures that would be implemented under Alternative 2. Figure 2 shows the project area and extent of proposed measures under Alternative 2.

Table 2. Alternative 2 - Proposed Levee Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, Geotextile, and Slope Flattening	Bank Protection, Launchable Rock Trench	Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall, Geotextile	---	Floodwall/Levee Raise
Magpie Creek[2]	---	---	---	Floodwall/New Levee/Detention Basin

Note: [1] American River seepage, stability, and overtopping measures were addressed in the American River Common Features, WRDA 1996 and 1999 construction projects.
[2]In addition to the listed measures, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

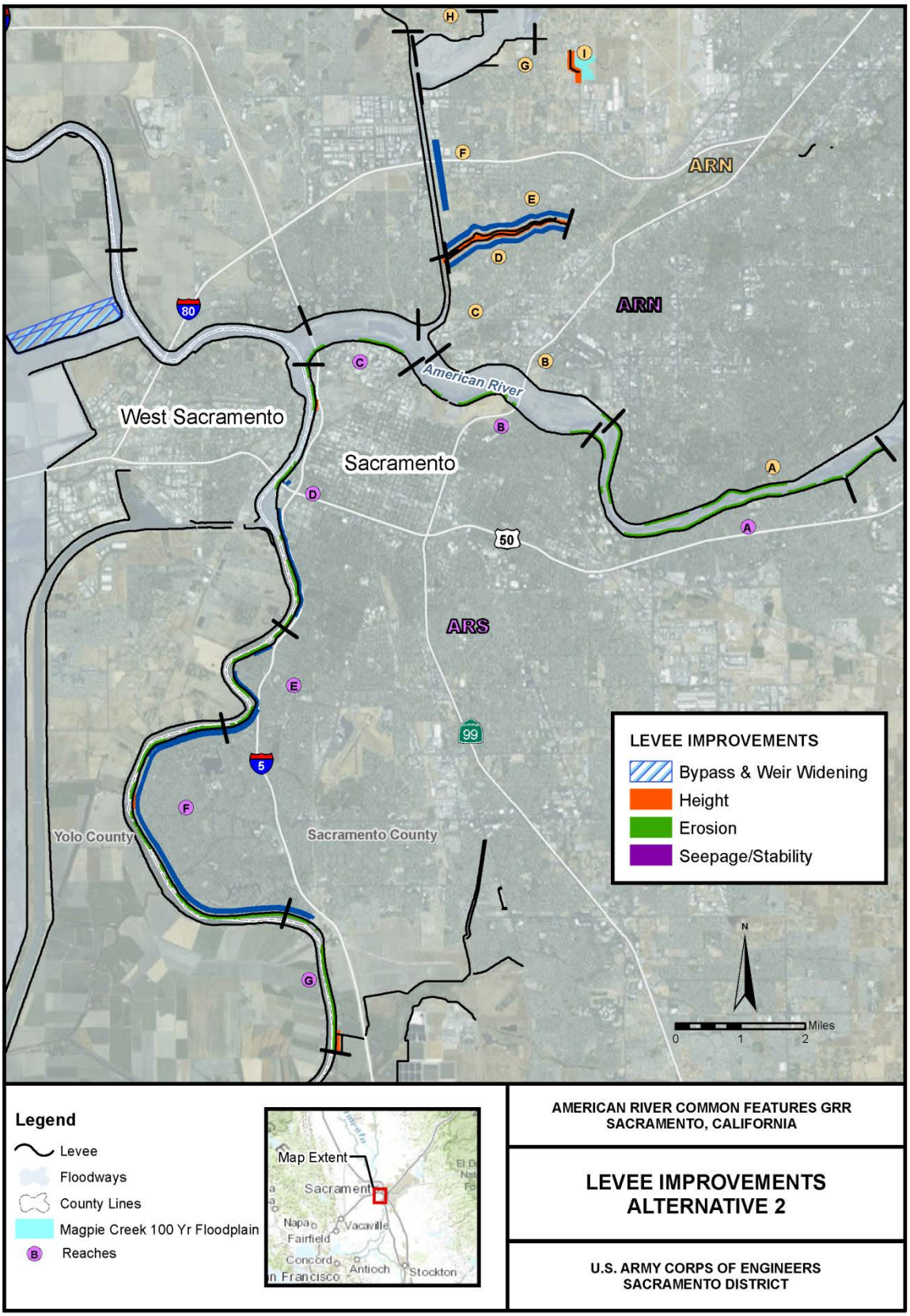

Figure 2. Alternative 2 Proposed Measures.

Sacramento Weir and Bypass Widening

The Sacramento Bypass and Weir currently allow excess flood waters to spill out of the system into the Yolo Bypass thereby reducing the loading on the levee system below. Alternative 2 leverages this existing structure by constructing a new weir structure, and relocating the levee 1,500 feet to the north. The existing weir would not be altered under this measure. The weir, combined with the increased bypass width and operations change, would allow more water to be released out of the system eliminating the need for most of the height improvements along the ARS sub-basin, Reaches D to G. However, this alternative does not reduce the need for seepage, stability and erosion improvements within those reaches. Relocation of the Sacramento Bypass levee would result in the placement of fill in waters of the U.S. Construction methods for this measure are described in Section h below.

b. Location

The proposed project is located in and around the city of Sacramento, California. The ARCF GRR study area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the NEMDC, Arcade Creek, and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento. Figure 1 shows the proposed study area for Alternative 1 and Figure 2 shows the Alternative 2 study area, which includes the additional measures to the Sacramento Weir and Bypass.

c. Purpose and Need

The purpose of this project is to reduce the flood risk and damage in the greater Sacramento area. The Sacramento Metropolitan area is one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the American River or Sacramento River would stress the network of levees protecting the study area to the point that levees could fail. The consequences of such a levee failure would be catastrophic since the inundated area is highly urbanized and the flooding could be up to 20 feet deep. Providing flood damage reduction would reduce loss of life and damage to property in the project area.

The Sacramento metropolitan area has a high probability of flooding due to its location at the confluence and within the floodplain of two major rivers. Both of these rivers have large watersheds with very high potential runoff which has overwhelmed the existing flood management system in the past. The existing levee system was designed and built many years ago, before modern construction methods were employed. These levees were constructed close to the river, which increases velocities associated with flood flows. This results in increased erosion of levees, which are critical components of the flood management system needed to reduce the flood risk in the study area.

In addition to the high probability of flooding, the consequences of flooding in the study area would be catastrophic. The flooding would rapidly inundate a highly urbanized area with minimal warning or evacuation time. As the Capital of California, the Sacramento metropolitan area is the center of State government and many essential statewide services are located here. The study area is also at the crossroads of four major highway/interstate systems that would be impassable should a flood occur. The effects of flooding within the study area would be felt not only at the local level, but at the regional, State, and National level as well.

Because of the deposits of hydraulic mining debris that washed into the American River and Sacramento River valleys, early levee builders constructed the flood management features by dredging material from the river beds and placing it on the bank near the river. This served several purposes. First, the resulting levee provided a degree of protection from flooding. Second, it removed material from the river bed, allowing it to convey more water. And finally, by placing the levees close to the river's edge, the river flow was confined, speeding its flow, and causing it to erode away the material that had been deposited by hydraulic mining, further increasing the river's capacity.

The levees continue to confine the flow into a relatively narrow channel, still eroding and degrading the river channel. However, by now, most of the sediment deposited in the river channels has been removed. Both the Sacramento River and the American River are confined by levees and have very little sediment in the water. Additionally, on the American River, Folsom Dam blocks sedimentation from upstream sources. Therefore, the energy of the flow tends to erode riverbanks and levees. This channel erosion and degradation could have detrimental effects on the levees by undercutting the foundation materials beneath the levees, particularly if the riverbank consists of easily erodible materials. The erosion of the riverbank adjacent to levee embankments may increase the underseepage through the foundation soils. It can also reduce the stability of the levee slopes by undermining the levee embankment and eroding the levees themselves. Significant erosion can lead to the failure of the levee.

Empirical evidence and prototype experiments indicate that stream bank erosion in the area can be gradual or episodic. That is to say, some erosion occurs almost every year. This is primarily due to the fact that materials have been placed on the banks by landowners in an effort to halt erosion. These materials are generally random materials, placed without regard to engineering standards. The Sacramento District is currently evaluating erosion trends as part of the Sacramento River Bank Protection Project (SRBPP).

d. Authority

The authority for the Corps to study water resource related issues in the American and Sacramento Rivers is Section 209 of the Flood Control Act of 1962, Pu. L. No.87-875, § 209, 76 Stat. 1180, 1196-98 (1962). The EIS/EIR for the project was prepared as part of the interim general reevaluation study of the ARCF Project, which was authorized by Section 130 Section 130 of the Energy and Water Development and Related Agencies Appropriations Act of 2008, Pub. L. No. 110-161, § 130,

121 Stat. 1844, 1947 (2007). Additional authority was provided in Section 366 of WRDA of 1999. WRDA 1999, Pub. L. No. 106-53, § 366, 113 Stat. 269, 319-320 (1999). Significant changes to the project cost were recommended in the Second Addendum to the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works, but before it could be forwarded to Congress, authorized total cost of the project was increased to $205,000,000 by Section 129 of the Energy and Water Development Appropriations Act of 2004, Pub. L. No. 108-137, § 129, 117 Stat. 269, 1839 (2003). The current estimated cost of the authorized project is $305,340,000. The allowable cost limit is $307,071,000.

e. Alternatives [40 CFR 230.10]

Unless otherwise noted, the information is from the September 2015 American River Common Features EIS/EIR.

(1) No action:

The No-Action Alternative is also the no fill alternative. The No Action Alternative assumes that no work would be completed by the Corps that would result in placement of fill in waters of the U.S. As a result, the identified erosion problem would not be addressed and the study area would continue to be at a very high risk of levee failure and subsequent flooding of the Sacramento Metropolitan area. Although the No Action Alternative would have no impacts on waters of the U.S., it does not meet the project purpose since it does not address the flood risk in the study area, and is, therefore, not considered to be one of the least environmentally damaging practicable alternatives (LEDPA).

(2) Other project alternatives:

Alternative 1 – Improve Levees

Alternative 1 involves the construction of fix-in-place levee remediation measures to address seepage, slope stability, erosion, and overtopping concerns identified for the American and Sacramento River, NEMDC, Arcade Creek, and Magpie Creek levees. A complete summary of the measures proposed under Alternative 1 can be found above in Table 1. The project area for Alternative 1 is shown above in Figure 1. This action is considered a practicable alternative and will be retained and evaluated in determining the LEDPA.

Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass

Alternative 2 would include all of the levee improvements described for Alternative 1, except that instead of approximately 7 miles of levee raises along the Sacramento River there would be approximately 1 mile of levee raises. Instead of the full extent of levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass, as described above. A complete summary of the proposed measures can be found in Table 2 above. The project area for Alternative 2 is

shown above in Figure 3. This action is considered a practicable alternative and will be retained and evaluated in determining the LEDPA.

f. General Description of Dredged or Fill Material

(1) General Characteristics of Material

Erosion Protection

Erosion protection measures would involve the discharge of fill material into waters of the U.S. Fill materials for erosion protection would consist of large stone riprap, ranging from 18 to 36 inches, to armor the waterside slope, or to construct a launchable rock trench, with a fine sand or silt fill over the top to allow for vegetation planting. The proposed sand or silt for the erosion protection measures would come from clean, imported fill material.

Overtopping Measures

The implementation of levee raises at Magpie Creek would involve the discharge of fill material into waters of the U.S. Fill materials for levee raises would be silty and clayey soils with a minimum content of 20% fine particles, a Liquid Limit less than 45, and a plasticity index between 7 and 15. No organic material or debris may be present in the soil. The proposed soil would be clean and would be imported from either a tested and approved borrow site, or from an commercial source.

Sacramento Bypass Widening

Relocation of the Sacramento Bypass north levee, as part of the Sacramento Bypass widening, would involve placement of fill into waters of the U.S. Fill materials associated with this action would consist of silty and clayey soils with a minimum content of 20% fine particles, a Liquid Limit less than 45, and a plasticity index between 7 and 15. No organic material or debris may be present in the soil. The proposed soil would be clean and would likely consist of the current Sacramento Bypass north levee soils, as the existing levee material is proposed for reuse to the maximum extent practicable. Any borrow material necessary would be clean and would be imported either from a tested and approved borrow site, or from a commercial source.

(2) Quantity of Material

Erosion Protection

Approximately 2.75 million tons of rock would be required to construct bank protection sites on the American River and Sacramento River. This would result in approximately 11 miles of bank protection fill on the American River and approximately 10 miles on the Sacramento River. Approximately 17 acres of fill would be placed in the American River. Approximately 15 acres of fill

would be placed into the Sacramento River. Additionally, approximately 0.4 acre of wetland would be impacted by construction of a proposed launchable rock trench on the south bank of the American River.

Overtopping Measures

Approximately 0.25 acre of soil fill would be placed in waters of the U.S. to construct the levee raise at Magpie Creek.

Sacramento Weir and Bypass

There are approximately 14 acres of soil that would be placed in farm canals and drainage ditches in the widened Sacramento Weir and Bypass area. However, the widened Sacramento Bypass area of approximately 325 acres would become permanent waters of the U.S., therefore the effect from this measure could be offset by the new floodplain habitat created within the widened bypass, due to the potential for natural establishment of wetlands within this area.

(3) Source of Material

Erosion Protection

Riprap for bank protection, seepage berms, and adjacent levees would be imported from a licensed, permitted facility that meets all Federal and State standards and requirements. The material would be transported along either existing roadways and construction access roads, or for Sacramento River sites could be imported via river barge hauling.

Overtopping Measures

Potential locations for borrow material, soil maps and land use maps were obtained for a 25-mile radius surrounding the project area. Borrow sites would be lands that are the least environmentally damaging and would be obtained from willing sellers. Material would be excavated from upland areas and not waterways, wetlands, or water bodies. The criteria used to determine potential locations were based on current land use patterns, soil types from Natural Resources Conservation Service (NRCS), and Corps' criteria for material specifications. The data from land use maps and NRCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 25 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

It is estimated that a maximum of 1 million cubic yards (CY) of borrow material (soil) could be needed to construct the project. Because this project is in the preliminary stages of design, detailed studies of borrow material needs for each alternative have not been completed. For the purposes of

NEPA/CEQA, the analysis evaluates the maximum foreseeable volume of borrow material that could be needed to construct the project. Actual volumes exported from any single borrow site would be adjusted to match demands for fill. The source of the material would come from inland areas (i.e. rock quarries).

The excavation limits on the borrow sites would provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation would be no steeper than 3H:1V. Excavation depths from the borrow sites would be determined based on available suitable material and local groundwater conditions. The borrow sites would be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites would be returned to their existing use whenever possible, or these lands could be used to mitigate for project impacts, if appropriate. Waters of the U.S. would not be impacted by source material being used.

Sacramento Weir and Bypass

Soil necessary for the Sacramento Weir and Bypass levee relocation would be reused from the existing levee and the footprint of the new Sacramento Bypass. Any additional borrow soil needed would be acquired through the methods discussed above for Overtopping Measures.

g. Description of the Proposed Discharge Site

(1) Location

Erosion Protection

Erosion protection measures would be constructed along approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River. In addition, there would be construction along the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento. On the American River south levee, a short stretch of launchable rock trench is proposed for an area that includes wetlands adjacent to the levee.

Overtopping Measures

Overtopping measures are proposed along the west bank of the Magpie Creek Diversion Canal from just downstream from Raley Boulevard to about 100 feet south of Vinci Avenue Bridge.

Sacramento Weir and Bypass

The Sacramento Bypass is located in Yolo County approximately 4 miles west of Sacramento along the northern edge of the city of West Sacramento. The Sacramento Weir runs along the west bank of the Sacramento River and separates the river from the Bypass. The Sacramento Bypass is located in a rural area owned by the State of California and operated as the Sacramento Bypass Wildlife Area. The area proposed for the Sacramento Bypass widening is currently active farm fields which include row crops and newly planted nut orchards. A series of farm canals and drainage ditches separate the fields in this area.

(2) Size

Erosion Protection

Approximately 17 acres of fill would be placed in the American River. Approximately 15 acres of fill would be placed into the Sacramento River.

Overtopping Measures

Approximately 1 acre of fill would be placed in vernal pool habitat.

Sacramento Weir and Bypass

Approximately 14 acres of fill would be placed in canals and drainage ditches in the widened Sacramento Bypass.

(3) Type of Site

Erosion Protection

To construct the erosion protection measures, riprap would be placed in the American River and Sacramento River along the waterside slope of the levee. Additionally, on the south bank of the American River, a trench comprised of riprap would be buried adjacent to the levee.

Overtopping Measures

To construct the levee raise along the Magpie Creek levee, soil would be placed along the landside of the levee in vernal pool habitat.

Sacramento Weir and Bypass

To relocate the Sacramento Bypass levee and grade the bypass area, soil would be placed in canals and drainage ditches.

(4) Type of Habitat

Erosion Protection

Habitat types along the footprint of the bank protection measures include valley foothill riparian habitat and open water habitat. These habitat types are described below.

Valley Foothill Riparian Habitat. Valley foothill riparian habitat occurs along the Sacramento and American River levees. The overstory of the riparian habitat consists of mature, well-established trees: Fremont cottonwood (*Populus fremontii ssp. fremontii*), valley oak (*Quercus lobata*), black willow (*Salix gooddingii*), and box elder (*Acer negundo var. californicum*). During the reconnaissance-level field visits, Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*) were also observed. The shrub layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and Himalayan blackberry (*Rubus discolor*). Elderberry shrubs (*Sambucus mexicana*), the host plant of the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), which is Federally listed as threatened, were observed in the riparian habitat along the Sacramento River north and south levees. Riparian habitat is listed as a sensitive natural community by the CNDDB (2009).

Open Water. The American River and Sacramento River are located within the study area and would both be impacted by placement of fill into waters of the U.S. Both of these rivers are navigable waterways that are jurisdictional under Section 404 of the Clean Water Act.

Wetlands. Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas (40 CFR 230.3[t]). Representative species observed in seasonal wetlands include Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), Italian ryegrass (*Lolium multiflorum*), water pepper (*Persicaria hydropiperpoides*), and alkali mallow (*Malvella leprosa*). Wetlands in the study area are assumed to be jurisdictional waters of the United States subject to regulation under CWA Section 404. Within the study area, wetlands also include features such as drainage ditches and farm canals, vernal pools, and open water habitat such as rivers and creeks. Vernal pools are discussed further in Section 3.8. Wetlands and vernal pools are considered sensitive habitats under CEQA.

Overtopping Measures

Habitat types in the footprint of the levee raises at Magpie Creek include potential vernal pool habitat. Vernal pool habitat is described below.

Vernal Pools. Vernal pools are depressions in areas where a hard underground layer prevents rainwater from draining downward into the subsoils. When rain fills the pools in the winter and spring, the water collects and remains in the depressions. In the springtime the water gradually evaporates away, until the pools become completely dry in the summer and fall. Vernal pools support plants and animals that are specifically adapted to living with very wet winter and spring conditions followed by very dry summer and fall conditions. The pools are most beautiful in the spring, when many specially-adapted flowering plants are in full bloom following initial evaporation of surface water. Almost all plants that occur in vernal pools are annuals, meaning they germinate, flower, set seed, and die all within one year. Many vernal pool plant species have seeds that can remain dormant for many years, an adaptation that allows them to survive through periods of drought. Many specially-adapted crustaceans, amphibians, and insects also occur only in vernal pools.

Sacramento Weir and Bypass

Habitat types in the expanded Sacramento Weir and Bypass area include primarily agricultural habitats, such as irrigated grain, row, and field crops. The habitat impacted by placement of fill is primarily open water habitat, as described above for the bank protection sites, in the form of small canals and drainage ditches.

(5) Timing and Duration of Discharge

Erosion Protection

The construction schedule for the ARCF project was estimated based on a 3 month construction window per year due to logistical constraints. Construction would likely occur during the summer months due to special status species work windows and the flood season. Construction of erosion protection measures on the American River would take approximately 9 years. Construction of the overall work proposed for the Sacramento River, including the seepage, slope stability, and height improvements, would take approximately 8 years, with bank protection construction occurring intermittently throughout that time frame.

Overtopping Measures

Construction of the levee raises at Magpie Creek would occur in one construction year. Similar to the erosion protection schedule discussed above, this schedule assumes a 3 month construction window. Construction would likely occur during the summer months due to special status species work windows and the flood season.

Sacramento Weir and Bypass

Relocation of the Sacramento Bypass levee would occur in one construction year. Similar to the erosion protection schedule discussed above, this assumes a 3 month construction window. Construction would likely occur during the summer months due to special status species work windows and the flood season.

h. Description of Disposal Method

Erosion Protection

Erosion protection along the American River and Sacramento River would be addressed via either the launchable rock trench method or by standard bank protection. There are no erosion protection measures proposed for the East Side Tributaries. Construction methods for the bank protection and launchable rock trench measures are described below.

Bank Protection

This measure consists of placing riprap on the river's bank, and in some locations on the levee slope, to prevent erosion (Figure 3). Bank protection is proposed along the American River and Sacramento River and would result in the placement of fill in waters of the U.S. Construction methods are described below.

When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and loose materials would be removed. In most cases, large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked on site.

Riprap would be imported from an offsite location via haul trucks and temporarily stored at a staging area located in the immediate vicinity of the construction site. A loader would be used to move riprap from the staging area to an excavator that would be placing the material. The excavator would place a large rock berm in the water up to an elevation slightly above the mean summer water surface. A planting trench would be established on this rock surface for revegetation purposes. The excavator would either be working from the top of the bank placing riprap on the bank beneath it and in the water, or from on top of the rock berm that it established.

The placement of rock onto the levee slope would occur from atop the levee. Rock placement from atop the levee would require one excavator and one loader for each potential placement site. The loader would then bring the rock from a staging area to the excavator and the excavator then places it on the waterside of the levee slope

The riprap would be placed on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After riprap placement has been completed, a small planting berm would be constructed in the rock where feasible to allow for some revegetation of the site, outside of the vegetation free zone required by ETL 1110-2-583. This vegetation would be designed on a site specific basis to minimize the O&M responsibility of the LMA and in such a way to not impact the hydraulic conveyance of the channel.

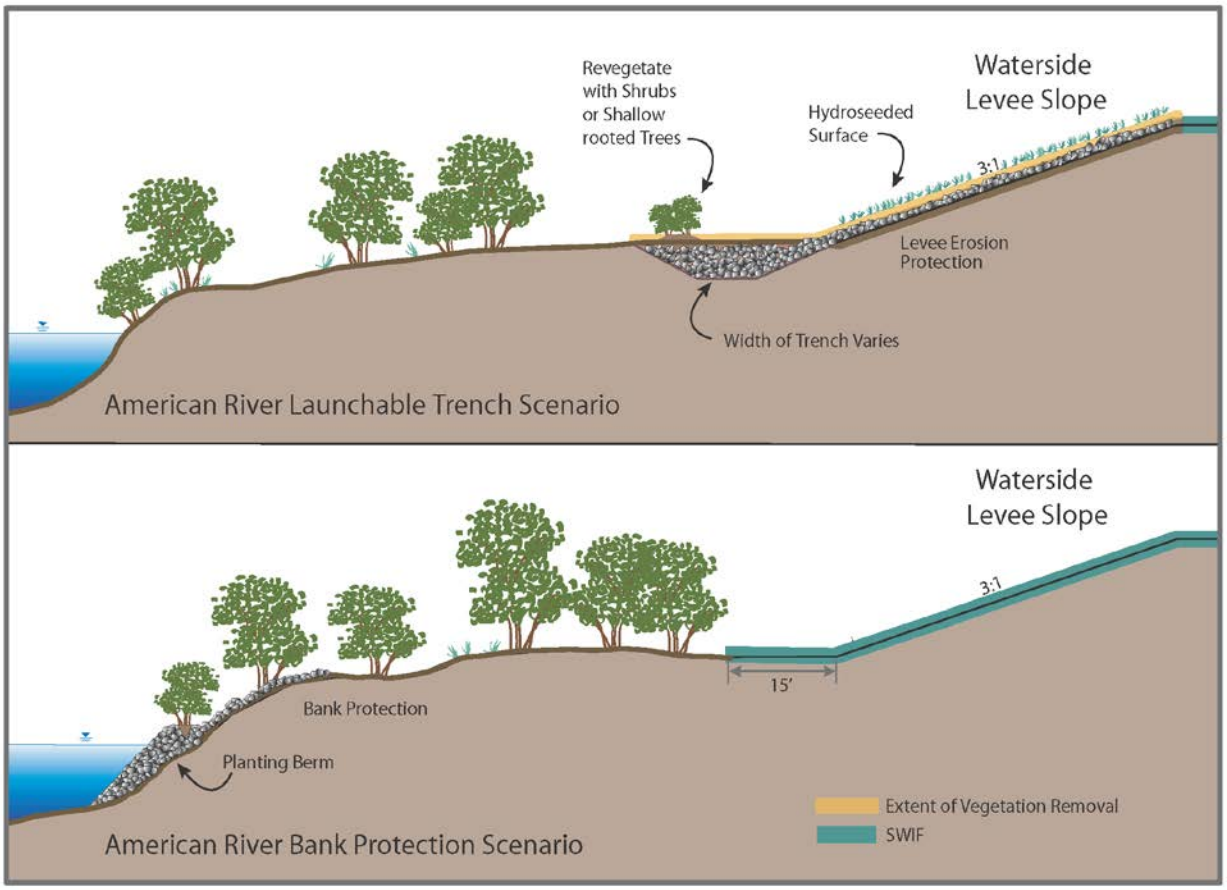

Figure 3. Erosion Protection Measures Typical Design.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it (Figure 3). All launchable rock trenches would be constructed outside of the natural river channel. As a result, launchable rock trenches would be above the ordinary high water mark and fill materials would not be placed into waters of the U.S. However, this measure is described in detail below because it is a practicable alternative to the bank protection measure.

The vegetation would be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration would include a 2:1 landside slope and 1:1 waterside slope and would be excavated at the toe of the existing levee. All soil removed during trench excavation would be stockpiled for reuse or disposal. The bottom of the trench would be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench would be filled with riprap that would be imported from an offsite location. After rock placement the trench would be covered with a minimum of 3 feet of the stockpiled soil to allow for planting over the trench. Rock placed on the levee slope would be covered with the stockpiled soil. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Some vegetation could be permitted over the trench if planted outside the specified vegetation free zone required by ETL 1110-2-583. This vegetation would likely be limited to native grasses, shrubs, and trees with shallow root systems to ensure that they do not limit the functionality of the trench during a flood event.

Overtopping Measures

To begin levee raising, the area would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) would be stockpiled at staging areas. Haul trucks or scrapers would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans. The existing levee centerline would be shifted landward, where necessary, in order to meet the Corps' standard levee footprint requirements. The levee crown patrol road would be re-established and a new toe access corridor would be added 10 feet landward of the levee toe in areas where levee raises are required.

Sacramento Weir Bypass

For this alternative, the existing north levee of the Sacramento Bypass would be degraded and a new levee constructed approximately 1,500 feet to the north. A new weir would be extended north of the existing Sacramento Weir without impacting the existing structure. The new weir would be extended approximately 1,500 feet and include a seepage cutoff wall below. The increase in Bypass flows through the new weir would occur during high water events only, when the flow released from Folsom Dam on the American River exceeds 115,000 cfs. The existing Sacramento Weir and Bypass would be operated consistent with current conditions based on the stage at the I Street gage.

The new north levee of the Sacramento Bypass would be constructed per new levee construction standards, including 3H:1V waterside and landside slopes and a minimum crest width of 20 feet. As both the existing north and south levees have experienced underseepage and slope stability related distress, the new north levee would include a 300-foot wide drained landside seepage berm (5 feet thick at the landside levee toe tapering to 3 feet thick at the berm toe and constructed of random

fill with a 1.5-foot thick drainage and filter layer at the base) with a system of relief wells located at least 15 feet landward of the berm toe and spaced at 200-foot intervals. Existing infrastructure, including roads, railways, canals, and pump stations would be relocated to maintain current operation. Placement of fill into waters of the U.S. would occur as a result of the relocation of canals and drainage ditches associated with the Bypass widening.

II. Factual Determinations

a. Physical Substrate Determinations (Sections 230.11 (a) and 230.20)

(1) Comparison of Existing Substrate and Fill

The project area generally consists of deep soils derived from alluvial sources, which range from low to high permeability rates and low to high shrink-swell potential. Soils immediately adjacent to the Sacramento River are dominated by deep, nearly level, well-drained loamy and sandy soils. The natural drainage is good, and the soils have slow to moderate subsoil permeability. The river terraces consist of very deep, well drained alluvial soils. The porous nature of the soils underneath the existing levee system is an important consideration for the design of levee improvements within the ARCF GRR study area. The major source of sediments deposited in the ARCF GRR study area is from the erosion of the Sierra Nevada mountain range and foothills to the east of the Sacramento Valley. Naturally occurring asbestos (NOA) is known to occur in the foothill metamorphic belt. Therefore, NOA may be present; however, the likelihood of project area soils containing significant concentrations of NOA is low due to the long distance from the source rock.

As discussed in Section I.f(1) above, fill material for bank protection construction would consist of large stone riprap ranging from 18 to 36 inches, to armor the waterside slope, with a fine sand or silt fill over the top to allow for vegetation planting on the berms. Approximate size of the berms would be 5 feet thick at the berm toe and construction of random fill with a 1.5-foot thick drainage and filter layer at the base). The proposed sand or silt for the bank protection would come from clean, imported fill material. The fill material for the overtopping measures and the Sacramento Bypass levee relocation would consist of silty and clayey soils with a minimum content of 20% fine particles, a liquid limit less than 45, and a plasticity index between 7 and 15. No organic material or debris may be present in the soil. The proposed soil would be clean and would be imported from either a tested and approved borrow site, or from an commercial source.

(2) Changes to Disposal Area Elevation

Erosion Protection

Due to the placement of rock bank protection along the river banks, there would be an increase in elevation of approximately 1.5 feet in the locations where fill is placed in the waters of the U.S. Launchable rock trenches would be buried beneath the surface and would not result in a change in elevation.

Overtopping Measures

Raising the Magpie Creek levee would increase the ground elevation in the footprint of the fill placement by anyway from a few inches to a few feet, depending on the slope of the levee.

Sacramento Weir and Bypass

There would be a significant increase in elevation in the footprint of the new Sacramento Bypass levee, as the levee would be constructed above the existing ground surface elevation.

(3) Migration of Fill

Erosion Protection

The erosion repairs within the project area is likely to somewhat reduce the sediment supply for riverine reaches directly downstream because the riprap would hold the bank or levee in place. However, from a system sediment perspective, the bank material that would be protected in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and, especially, the Yuba River systems.

A typical bank protection site has an approximate life span of 50 years. Over that time period, there would be a natural erosion and migration of fill occurring at the site; however it would occur at a slightly slower rate than natural conditions if no bank protection were to occur. Riprap established along the waterside levee toe is designed to stay in place and prevent further erosion. However, there is a possibility that there may be slight degradation or migration of riprap material over the years as well. The sites would be designed to avoid significant migration of newly placed fill through the use of geotextiles and the establishment of on-site vegetation.

Sediment associated with the launchable rock trench measure is not expected to migrate over time. The soil placed on the trench would be compacted and vegetation would be established to avoid long-term erosion impacts.

Overtopping Measures

Sediment associated with the levee raise at Magpie Creek is not expected to migrate over time. The soil placed would be compacted and would be seeded with natural grasses to avoid long-term erosion impacts.

Sacramento Weir and Bypass

Sediment placed to construct the relocated Sacramento Bypass levee is not expected to migrate over time. The Bypass is dry the majority of the time. During a flood event there would be some natural erosion associated with flood flows in the bypass, however, the levee would be constructed in a manner to ensure that it would not significantly degrade during a typical flood event.

(4) Duration and Extent of Substrate Change

Erosion Protection

There would be a permanent change of substrate on the riverbanks from alluvial soils to stone riprap. However the rock berms would be covered with a silty or sandy layer of soil in order to allow for the planting of vegetation along the river banks. This silty or sandy layer of soil would be of a similar substrate type to the existing condition. The launchable rock trench measure would result in a change in substrate of approximately 0.4-acre from undrained hydric soils to buried stone riprap with a silty or sandy layer of soil on the surface to allow for revegetation of the site.

Overtopping Measures

There would be a permanent change of substrate from vernal pool hardpan soils to the silty clayey soils described above for levee construction.

Sacramento Weir and Bypass

There would be a permanent change of substrate in the drainage canals to the silty clayey soils described above for levee construction. However, relocation of the Sacramento Bypass levee would not substantially alter the majority of the soil in the footprint of the new levee construction. Since the existing levee would be used to construct the new levee, and the borrow material used in the levees likely originated in the Bypass footprint, these soils would be consistent with the soil content of the overall area.

(5) Changes to Environmental Quality and Value

Alternative 1 would result in potential impacts to water quality, including increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction. Emissions from construction equipment, haul trucks, and barges also pose a potential impact to environmental quality and value during the duration of construction activities. BMPs would be implemented during construction to reduce these impacts to less than significant. There would be a permanent change in substrate in the footprint of the erosion protection areas; however these sites would be designed to be as consistent as feasible with natural riverbanks through the placement of silt over the rock layer and the planting of on-site shrubby vegetation and native grasses. To the extent feasible, large trees on the lower waterside slope would be left in place to maintain shaded riverine aquatic habitat for special-status fish species and new vegetation would be established to provide mitigation for vegetation that must be removed in order to construct the project.

Alternative 2 would reduce water surface elevation in the Sacramento River downstream of the confluence of the American River without significantly increasing water surface elevation in the Yolo Bypass downstream of the confluence of the Sacramento Bypass. Impacts associated with the placement of fill in waters of the U.S. to water quality, air quality, vegetation, and listed fish species are the same as discussed above for Alternative 1, with the addition of the 14 acres of canals and drainage ditches that would be permanently impacted as part of the Sacramento Bypass widening. However, Alternative 2 would also create approximately 300 acres of new floodplain habitat within the widened Sacramento Bypass. Impacts to existing soil and substrate conditions are the same as Alternative 1.

(6) Actions to Minimize Impacts

The following mitigation measures would be used during construction of Alternative 1 to reduce impacts to environmental quality:

- Prior to construction, the Corps or its contractor would be required to acquire all applicable permits for construction.
- Prior to construction, a Stormwater Pollution Protection Plan (SWPPP), Spill Prevention Control and Countermeasures Plan, and a bentonite slurry spill contingency plan would be prepared, and best management practices (BMPs) would be proposed to reduce potential erosion and runoff during rain events.
- Minimize ground and vegetation disturbance during project construction by establishing designated equipment staging areas, ingress and egress corridors, spoils disposal and soil stockpile areas, and equipment exclusion zones prior to the commencement of any grading operations.

- After construction of the flood risk management features is completed, the direct effects to habitat for special status species would be compensated in accordance with the Biological Opinions. Mitigation plantings would be monitored during the plant establishment period for success. Successful habitat mitigation would compensate for significant effects to vegetation, wildlife, special status species, and aesthetic resources.
- BMPs, including the Sacramento Metropolitan Air Quality Management District's Basic Construction Emission Control Practices, would be implemented to reduce emissions of criteria pollutants and greenhouse gases and to reduce potential effects to air quality and associated with climate change.
- During construction, noise-reducing measures would be employed in order to ensure that construction noise complies with local ordinances. Prior to the start of construction, a noise control plan would be prepared that would identify feasible measures to reduce construction noise, when necessary.
- Coordination with recreation user groups would occur prior to and during construction for input into mitigation measures that would reduce affects to the maximum extent practicable. Advance notice would be given to recreation users informing them of anticipated activities and detours to reduce the affects. To ensure public safety, flaggers, warning signs, and signs restricting access would be posted before and during construction, as necessary. In the event that bike trails would be disrupted, detours would be provided. Detour routes would be clearly marked, and fences would be erected in order to prevent access to the project area. In areas where recreational traffic intersects with construction vehicles, traffic control will be utilized in order to maintain public safety.

Additional mitigation associated with Alternative 2 includes:

- Planting riparian tree species within the widened Sacramento Bypass to compensate for 8 acres of permanent, direct impacts associated with construction of the new Sacramento Weir.
- Grading the new portion of the Sacramento Bypass to ensure positive drainage with the design of the existing Sacramento Bypass.
- Inclusion of fish passage features and ramp down of operation following flood events to reduce potentially adverse effects to listed fish species due to stranding within the Sacramento Bypass.

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b. Water Circulation, Fluctuation, and Salinity Determinations

(1) Alternation of Current Patterns and Water Circulation

Since Alternative 1 consists of fix-in-place levee improvements, implementation of these measures would have no effect on current patterns and water circulation.

Alternative 2 would result in a diversion of flows from the Sacramento River to the Yolo Bypass that would slightly raise water surface elevations by approximately 0.10-foot in the Yolo Bypass during large flood events events (200 year) compared to both the existing and future without project conditions. To avoid potential effects to the Yolo Bypass, the widened portion of the Sacramento Weir would only be operated when the release from Folsom Dam is increased to above 115,000 cfs. With the Folsom Dam improvements in place, releases from Folsom Dam would be above 115,000 cfs for flood events greater than 1/100 ACE event. Operation of the existing segment of the Sacramento Weir would not change from current practices.

Therefore, for events up to and including the 1/100 ACE event, only the existing weir would be operated per the criteria previously established. For events greater than the 1/100 ACE event when the release from Folsom Dam would go above 115,000 cfs, the new weir would be opened. As a result of the increased flood storage space and anticipatory releases at Folsom Dam, this translates into a reduction of flows into the Yolo Bypass with Alternative 2 in place compared to the existing conditions. Table 3 compares the flows at various locations for the Existing, Future Without Project, and with Alternative 2 in place. For the 1/100 ACE event and greater, the benefits of the Folsom Dam improvements would be realized in the form of reduced flows compared to the Existing condition.

Table 3. Comparison of 10-, 100-, and 200-year Frequency Flows under Various Conditions.

10 year event	**Existing Condition**	**Future Without Project Condition (also Alternative 1)**	**Alternative 2**
American River	43,000 cfs	72,000 cfs	72,000 cfs
Sacramento Bypass	50,000 cfs	66,000 cfs	66,000 cfs
Yolo Bypass below Sac Bypass	270,000 cfs	296,000 cfs	296,000 cfs
100 year event	**Existing**	**Future Without Project and Alt. 1**	**Alt. 2 (TSP)**
American River	145,000 cfs	115,000 cfs	115,000 cfs
Sacramento Bypass	131,000 cfs	115,000 cfs	115,000 cfs
Yolo Bypass below Sac Bypass	555,000 cfs	535,000 cfs	535,000 cfs
200 year event	**Existing**	**Future Without Project and Alt. 1**	**Alt. 2 (TSP)**
American River	320,000 cfs	160,000 cfs	160,000 cfs
Sacramento Bypass	183,000 cfs	149,000 cfs	164,000 cfs
Yolo Bypass below Sac Bypass	656,000 cfs	631,000 cfs	643,000 cfs

Although Alternative 2 would result in the creation of a new drainage area within the Sacramento Bypass, the area would be contained within the levee system and would not result in substantial additional erosion, siltation, or runoff. The expanded bypass would not create or contribute flows in excess of the existing capacity of the system, as shown in Table 12 above.

(2) Interference with Water Level Fluctuation

Because the Sacramento River and American River systems are regulated by upstream dams which allow a specific amount of water to be released into systems, the Alternative 1 and the no action/no project alternative would not change water level fluctuation patterns. Alternative 2 would change the water level fluctuation patterns by reducing and stabilizing the maximum water surface elevations on the Sacramento River during flood events, as described in Table 3 above.

Potential implications of the simulated long-term changes in bed profiles can be increased stress along the toe of the project levees or overbank berms in the degradational reaches, which may result in increased scour along unrevetted channel sections. In the aggradational reaches, an increase in bed elevations may result in higher flood stages and reduced flood conveyance.

(3) Salinity Gradients Alteration

Salinity gradients would not be affected, as salinity normally only increases in the river system during low flow events when there is a higher than average tidal influx from the Delta. With-project conditions in the system would remain consistent with existing conditions during normal and low flow periods. Flows would be increased during high water events, however the flood flows during these events would be pushing any salinity intrusion back down into the Bay-Delta system and would not result in any salinity increases in the riverine system.

(4) Effects on Water Quality

The Basin Plan states that where ambient turbidity is between 5 and 50 nephelometric turbidity units (NTUs), projects would not increase turbidity on the Sacramento River by more than 20 percent above the ambient conditions. Furthermore, if the ambient diurnal variation in turbidity fluctuates in and out of the 5 and 50 NTUs threshold, the Basin Plan states that averaging periods can be applied to data to determine compliance. For example, during the summer months, the Sacramento River turbidity could be less than 50 NTUs, and during the winter months, the turbidity could be more than 50 NTUs because of the higher flow rate causing more river scouring. Thus, the monthly average was calculated using hourly CDEC data and is presented in Table 3-3 below. Specific construction activities that are part of the potential alternatives would need to comply with the above-stated thresholds for turbidity.

Water quality impacts that could result from project construction activities and project operations were evaluated based on the construction practices and materials that would be used, the location and duration of the activities, and the potential for degradation of water quality or beneficial uses of project area waterways.

Table 3-3. Monthly Average Total Suspended Sediment and Turbidity for the Sacramento River at Freeport from 1997 to 2007.

Month	Discharge (cfs)	TSS (mg/L)	TSS Load (tons)	Turbidity (NTU)
January	41,414	104	11,670	64
February	44,084	83	9,839	68
March	39,586	70	7,476	15
April	28,552	51	3,946	11
May	25,152	48	3,279	12
June	21,461	30	1,741	17
July	20,432	37	2,019	21
August	18,235	27	1,332	9
September	16,121	29	1,266	10
October	11,950	29	940	6
November	13,612	24	868	8
December	25,105	81	5,463	12

Note: Flow and TSS data are from the USGS and are presented as monthly average from 1997 to 2007. Turbidity data are from CDEC from March 2007 to January 2009 and also are presented as a monthly average. Turbidity data are from the Sacramento River at Hood, a few river miles downstream from the USGS station.
Source: USGS 2013; DWR 2012b.

Where bank protection construction is proposed, riprap would be placed along the river bank to prevent erosion. The placement of riprap along the river banks would temporarily generate increased turbidity in the immediate vicinity of the construction area. Additionally, placement of riprap in the water could result in a sediment plume, generated from the channel bottom and levee side, becoming suspended in the water and could generate turbidity levels above those identified as acceptable by the Basin Plan. Turbidity effects from landside construction (e.g., vehicle, staging, placement of construction equipment) would be limited to stormwater runoff carrying loose soil from staging areas and construction vehicle access areas. Best management practices would be implemented to reduce the effect of runoff into the stormwater system to less than significant. Best management practices include such things as coir mats or hay bales to prevent runoff, rock groins to retain sediment, sand bags to prevent erosion, and drain screens to prevent sediment from traveling outside the construction area footprint and into the storm drains system.

As rock riprap is placed in the open water, significant indirect effects would result as the sediment and turbidity plume would drift further downstream and later affect the water qualify in those areas further downstream of the project area. By implementing the BMPs contained within the SWPPP, impacts would be reduced to less than significant.

Effects to water quality for Alternative 2 would be the same as Alternative 1 with the additional effects associated with the widening of the Sacramento Weir and Bypass. Construction of the new north levee would occur when water is not flowing through the bypass, and therefore there would be not impacts to water quality during construction of the new north levee of the bypass. However, effects could occur during the construction of the expanded weir along the Sacramento River. There is a potential for water quality impacts to occur if the weir is constructed in a way that debris or other construction materials could enter the Sacramento River. However, it is likely that the weir could be constructed behind the existing levee, which would result in no impacts to water quality.

(a) Water Chemistry

The potential of hydrogen (pH) is a unit for measuring the concentration of hydrogen ion activity in water and is reported on a scale from 0 to 14. If a solution measures less than 7, it is considered acidic. If a solution measures more than 7, it is considered basic, or alkaline. If a solution measures 7, it is considered neutral. Many biological functions occur only within a narrow range of pH values. The Basin Plan objective for pH is between 6.5 and 8.5. Furthermore, discharges cannot result in changes of pH that exceed 0.5. The monthly average pH of the Sacramento River from 2003 to 2009 remained stable throughout the year (Table 3-4). Construction materials such as concrete or other chemicals could affect the pH of the Sacramento River if a discharge were to occur. The proposed materials and construction activities have the potential to affect water chemistry during the duration of construction. Construction contractors would be required to prepare and implement a SWPPP and comply with the conditions of the NPDES general stormwater permit for construction activity. The contractor would be required to obtain a permit from the CVRWQCB detailing a plan to control any spills that could occur during construction. The plan would describe the construction activities to be conducted, BMPs that would be implemented to prevent discharges of contaminated stormwater into waterways, and inspection and monitoring activities that would be conducted.

(b) Salinity

The proposed materials and construction activities are not expected to affect salinity.

(c) Clarity

Placement of fill materials would temporarily reduce clarity due to an increase in total suspended solids within the project area. Clarity is not expected to be substantially affected outside the immediate project area. However, the reduction of clarity caused by construction activities would be short in duration and would return to pre-construction levels upon project completion.

(d) Color

The proposed project is expected to affect color only during fill activities. Placement of fill materials would temporarily induce a color change due to an increase in turbidity. These effects would be consistent with those discussed above for clarity. The change in color caused by construction activities would be short in duration and would return to pre-construction levels upon project completion.

(e) Odor

The proposed project would not result in any major sources of odor, and the project would not involve operation of any of the common types of facilities that are known to produce odors (e.g., landfill, wastewater treatment facility). Odors associated with diesel exhaust emissions from the use of onsite construction equipment may be noticeable from time to time by adjacent receptors. However, the odors would be intermittent and temporary and would dissipate rapidly from the source with an increase in distance. Furthermore, as required by CARB regulation 13 CCR 2449(d)(3), no in-use off-road diesel vehicles may idle for more than 5 consecutive minutes. Therefore, this direct effect would be less than significant. In addition, implementation of mitigation measures, which are required under other air quality effects, would further reduce exhaust emissions and provide advanced notification of construction activity.

(f) Taste

The proposed materials and construction activities are not expected to affect taste.

(g) Dissolved Gas Levels

The proposed materials and construction activities are not expected to affect dissolved gases.

(h) Temperature

Construction activities have the potential to create substantial turbidity affecting water temperature. Implementing the BMPs established in the SWPPP, conducting work during low flow periods, and installing sediment barriers to reduce sediment from entering waterways would be required to control turbidity and the mobilization of pollutants that may be present in sediments. There is the potential for some increases in water temperature, due to the removal of waterside vegetation during construction. However, the vegetation that would be removed would primarily consist of shrubby vegetation and grasses, which do not significantly contribute to shade. The larger trees in the bank protection footprint, which are the primary contributors to shade, would be protected in place, which would help to maintain consistent long-term water temperatures after construction. Additionally, shrubs would be planted on the bank protection planting berms during construction to allow the vegetative cover near the banks to redevelop long-term.

(i) Nutrients

The proposed materials and construction activities have the potential to affect nutrient levels in the water. Release of suspended sediments during construction could potentially cause turbidity thresholds for metals and nutrients to be exceeded. Turbidity would be controlled outside the working area using a combination of BMPs as appropriate. Development and implementation of an approved SWPPP would also prevent release of excess nutrients. Long-term nutrient levels would not be significantly altered by project construction because existing vegetation on the waterside slopes of the levee would be protected in place, and the shaded riverine aquatic corridor would still remain a source of nutrients for the rivers. In addition, nutrients from the upstream watershed would remain in the system.

(j) Eutrophication

The project is not expected to contribute excess nutrients into the stream or promote excessive plant growth due to BMPs and the high content of rock in disposal material.

c. Suspended Particulate/Turbidity Determinations

(1) Alteration of Suspended Particulate Type and Concentration

Where bank protection construction is proposed, riprap would be placed along the river bank to prevent erosion. The placement of riprap along the river banks would temporarily generate increased turbidity in the immediate vicinity of the construction area. Additionally, placement of riprap in the water could result in a sediment plume, generated from the channel bottom and levee side, becoming suspended in the water and could generate turbidity levels above those identified as acceptable by the Basin Plan. Turbidity effects from landside construction (e.g., vehicle, staging, placement of construction equipment) would be limited to stormwater runoff carrying loose soil from staging areas and construction vehicle access areas. Best management practices would be implemented to reduce the effect of runoff into the stormwater system to less than significant. Best management practices include such things as coir mats or hay bales to prevent runoff, rock groins to retain sediment, sand bags to prevent erosion, and drain screens to prevent sediment from traveling outside the construction area footprint and into the storm drains system.

As rock riprap is placed in the open water, significant indirect effects would result as the sediment and turbidity plume would drift further downstream and later affect the water qualify in those areas found further downstream of the project area. By implementing avoidance and minimization measures, discussed in Section 3.5.6 of the ARCF GRR EIS/EIR, impacts could be reduced to less than significant.

(2) Particulate Plumes Associated with Discharge

Placement of riprap in the water could result in a sediment plume, generated from the channel bottom and levee side, becoming suspended in the water and could generate turbidity levels above those identified as acceptable by the Basin Plan. As rock riprap is placed in the open water, significant indirect effects would result as the sediment and turbidity plume would drift further downstream and later affect the water qualify in those areas found further downstream of the project area. By implementing avoidance and minimization measures, discussed in Section 3.5.6 of the ARCF GRR EIS/EIR, impacts could be reduced to less than significant.

(3) Changes to Environmental Quality and Value

There could be significant affects to water quality due to increased turbidity during construction, as discussed above. Additionally, on the Sacramento River, the use of barges to install the riprap could cause additional turbidity as the barge moves into the site and anchors. With the implementation of the BMPs that will be established in the SWPPP, these effects would be reduced to less than significant during construction. Once construction is complete there could be reduced turbidity in the direct vicinity of the site because there would be no exposed soil to erode and deposit into the river. Further, the bank protection sites would include the installation of riparian vegetation which could slow the flows down and reduce turbidity during high flows.

Construction contractors would be required to prepare and implement a SWPPP and comply with the conditions of the NPDES general stormwater permit for construction activity. The contractor would be required to obtain a permit from the Central Valley RWQCB detailing a plan to control any spills that could occur during construction. The plan would describe the construction activities to be conducted, BMPs that would be implemented to prevent discharges of contaminated stormwater into waterways, and inspection and monitoring activities that would be conducted.

(4) Actions to Minimize Impacts

Environmental commitments included in the project to reduce the potential for impacts to water quality include: preparation and implementation of the SWPPP, Spill Prevention Control and Countermeasures Plan (SPCCP), and a bentonite slurry spill contingency plan (BSSCP).

<u>d. Contaminant Determinations</u>

The proposed project is not expected to add contaminants to any body of water; however, if there were a release of contaminants into adjacent water bodies, that could result in significant effects. Therefore, BMPs are proposed during construction to ensure that no contaminants enter the waterways.

Under Alternative 1, construction activities would involve the use of potentially hazardous material, such as fuels, oils and lubricants, and cleaners, which are commonly used in construction projects. Construction contractors would be required to use, store, and transport hazardous materials in compliance with Federal, State, and local regulations during project construction and operation. Testing of borrow sites would occur prior to the use of material and sites which have contaminated soils would not be used for this project. Any hazardous substance encountered during construction would be removed and properly disposed of by a licensed contractor in accordance with Federal, State, and local regulations. Compliance with applicable regulations would reduce the potential for accidental release of hazardous materials during transport and construction activities. The risk of significant hazards associated with the transport, use, and disposal of these materials is low.

Project areas would be tested for HTRW contaminants prior to construction, and any materials found would be disposed of by the non-federal sponsor in accordance with all Federal, State, and local laws and regulations at an approved disposal site. Implementation of these mitigation measures would reduce the impacts from hazardous materials at project sites to less than significant. If significant time has elapsed between approval of this document and construction, additional investigations should be done to reduce the risk of encountering a site during construction. If construction activities would occur in close proximity to sites listed in the existing conditions section, a Phase II ESA should also be conducted. This would further reduce the risk of exposure to workers and the public during construction and assist in the remediation planning.

Alternative 2 would have the same impacts as Alternative 1, with the additional affects associated with the expansion of the Sacramento Weir and Bypass. A known HTRW site, the Old Bryte Landfill, is currently present within the area proposed for the expanded Sacramento Bypass. No construction activities would occur in proximity to this site until the site has been completely remediated and meets all Federal, State, and local regulatory requirements. Therefore, this alternative would have no impacts.

Compliance with applicable laws and regulations would reduce the potential for accidental release of hazardous materials during construction of both Alternatives 1 and 2. The contractor would also be required to prepare a SWPPP, which details the contractors plan to prevent discharge from the construction site into drainage systems, lakes, or rivers. This plan would include BMPs, as detailed in Section 3.5.6 of the ARCF GRR EIS/EIR, which would be implemented at each construction site.

In addition, a SPCCP would be prepared prior to project construction. An SPCCP is intended to prevent any discharge of oil into navigable water or adjoining shorelines. The contractor would develop and implement an SPCCP to minimize the potential for adverse effects from spills of hazardous, toxic, or petroleum substances during construction and operation activities. The SPCCP would be completed before any construction activities begin. Implementation of this measure would comply with state and Federal water quality regulations. The SPCCP would describe spill sources and spill pathways in addition to the actions that would be taken in the event of a spill (e.g., an oil spill from engine refueling would be immediately cleaned up with oil absorbents). The SPCCP would outline descriptions of containments

facilities and practices such as doubled-walled tanks, containment berms, emergency shut-offs, drip pans, fueling procedures and spill response kits. It would also describe how and when employees are trained in proper handling procedure and spill prevention and response procedures.

e. Aquatic Ecosystem and Organism Determinations

(1) Effects on Plankton

Plankton are drifting organisms that inhabit the pelagic zone of oceans, seas, or bodies of fresh water. Project construction activities would be temporary and short-term. The only short-term effect would be a less abundant supply of plankton for the Delta smelt, and other fish and aquatic organisms. With implementation of mitigation measures and BMPS, this project would not introduce materials that would disrupt the nutrient supply for plankton, and as a result effects to plankton would be temporary and not significant.

(2) Effects on Benthos

Benthic organisms may be disturbed during construction, but following construction, the rock berm would be covered with a silty soil layer, and native benthic organisms would be expected to recolonize the area.

(3) Effects on Nekton

Nekton are actively swimming aquatic organisms that range in size and complexity from plankton to marine mammals. Native fish present in the project area can be separated into anadromous species and resident species. Native anadromous species include four runs of Chinook salmon, steelhead trout, Delta smelt, and green sturgeon. All of these anadromous species are expected to use habitat in parts of the study area.

Within the ARCF GRR study area, the Sacramento River and Sacramento Bypass are designated critical habitat for winter-run Chinook salmon. Critical habitat for spring-run Chinook salmon includes all river channels and sloughs within the ARCF study area on the Sacramento River and on the American River from the confluence to the Watt Avenue bridge (NMFS 2006b). Critical habitat for Central Valley steelhead includes the stream channels and the lateral extent as defined by the ordinary high-waterline or bank-full elevation in the designated stream reaches of the Sacramento and American River, NEMDC and Dry/Robla Creek portions of the ARCF project area. Critical habitat for delta smelt consists of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the contiguous waters in the Delta (USFWS 1994). Critical habitat for delta smelt is designated in the following California counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo (USFWS 2003). Designated critical habitat for the southern DPS of green sturgeon includes the Sacramento River downstream of Keswick

Dam, the Feather River downstream of Oroville Dam, and the Yuba River downstream of Daguerre Dam; portions of Sutter and Yolo Bypasses; the legal Delta, excluding Five Mile Slough, Seven Mile Slough, Snodgrass Slough, Tom Paine Slough and Trapper Slough; and San Francisco, San Pablo, and Suisun bays.

Under Alternative 1 and 2, rock placement on the Sacramento River and American River would most likely disturb the native resident fish by increasing vibration, water turbulence, and turbidity, causing them to move away from the area of placement. In some pelagic native juvenile species utilizing the near shore habitat for cover, moving away from that cover could put them at a slight risk of predation. Direct effects to resident native fish species are less than significant, with the implementation of mitigation. Proposed mitigation for salmonid species includes the creation of planting berms to provide shade and instream woody material elements of SRA habitat. The natural bank element of SRA would be lost with the placement of rock along the levee slope. Over time sediment would settle into the rock voids and provide similar substrate characteristics as a natural bank. The direct effects would also not result in a substantial reduction in population abundance, movement, and distribution for salmonid species.

Alternative 1 and 2 would result in permanent impacts to 14 acres of Delta smelt shallow water habitat, and a change in substrate to 32 acres of Delta smelt spawning habitat. Construction-related effects include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, and alteration of spawning and incubation habitat. With the implementation of compensation for the impacts to Delta smelt shallow water habitat and spawning habitat, these effects would be reduced to less than significant.

Alternative 1 and 2 would result in significant, direct effects to green sturgeon through the loss of benthic feeding habitat due to the change in substrate at the bank protection sites. If larvae or juveniles are present during construction, in-water activities could result in localized displacement and possible injury or mortality to individuals that do not readily move away from the channel or nearshore areas. Project actions associated with bank protection measures may increase sediment, silt, and pollutants, which could adversely affect rearing habitat or reduce food production, such as aquatic invertebrates, for larval and juvenile green sturgeon. Compensation would be implemented for the impacts to benthic substrate, and construction-related monitoring would occur to help to better identify additional measures to reduce significant effects to green sturgeon.

Effects associated with Alternative 2 would be the same as described for Alternative 1 above. Proposed construction in the Sacramento Bypass would take place during the dry season when no water would be flowing through the project area from the Sacramento River. There would be no significant direct effects to native fish populations because they would not be present in the construction footprint during the proposed construction. By widening the Sacramento Weir and Bypass, the project would create additional floodplain habitat, which could benefit native fish consistent with the results of the Knaggs Ranch Study. The increase of floodplain habitat could increase opportunities for successful rearing and feeding during seasonal flooding.

Widening of the weir and bypass will increase the entrainment and stranding exposure and rates of juvenile fish species. When the weir is overtopping and water is flowing down the bypass, adult fish are attracted to the flow and follow it upstream in an attempt to reach their holding and spawning habitat. Widening the weir and bypass would increase the amount of water going over the weir and increase the attraction rate of sturgeon, salmon and steelhead. Without fish passage in place, the stranding rates of these fish would increase. Given that green sturgeon are long-lived species that have the strongest upstream migration and cohort replacement rates during wet water years and especially after high river flow conditions, the effect of the stranding occurring only two to three times over a 50 year period could be significant to sturgeon. Implementation of fish passage features, operational considerations, and grading of the expanded bypass to reduce stranding pits and ensure positive drainage would reduce these impacts to less than significant.

(4) Effects on Aquatic Food Web

Effects on the aquatic food web, or the plankton, benthic, and nekton communities, would be temporary and less than significant. Indirect effects were not considered significant to resident native fish species because it was determined that existing conditions would not be worsened by project construction, and would not result in a substantial reduction in population abundance, movement, and distribution.

(5) Effects on Special Aquatic Sites

(a) Sanctuaries and Refuges

No sanctuaries and refuges are within the project area.

(b) Wetlands

Approximately 0.4-acre of wetland could be filled and permanently lost during construction of both Alternatives 1 and 2. The Corps has proposed to purchase one acre of credit from a mitigation bank in order to compensate for this loss of habitat.

Wetlands in the existing Sacramento Bypass would not be impacted by construction of Alternative 2. There is a potential for additional wetlands to develop in the additional 300 acres since this land would no longer be farmed. The conversion of this land back to its natural state would have benefits to other wildlife and could become an expansion of the Sacramento Bypass Wildlife Refuge in Alternative 2.

Reasonable effort would be taken in the detailed design of the project to avoid disturbance to existing wetlands and implementation of environmentally sustainable designs. Any destruction, loss, or degradation of wetlands would be compensated through creation of new wetland habitat.

(c) Mud Flats

No mud flats are within the project area.

(d) Vegetated Shallows

No vegetated shallows are within the project area.

(e) Coral Reefs

No coral reefs are within the project area.

(f) Riffle and Pool Complexes

No riffle pool and complexes are within the project area.

(6) Threatened and Endangered Species

Implementation of Alternative 1 or 2 would result in direct effects to giant garter snake, valley elderberry longhorn beetle, salmonids, green sturgeon, Delta smelt, Western yellow-billed cuckoo, vernal pool crustaceans, and Swainson's Hawks. Impacts to special status fish species were addressed above in Section e(3), nekton.

Construction activities under Alternative 2 have the potential to affect giant garter snake and their habitat, due to the removal and relocation of farm canals and drainage ditches during construction of the Sacramento Weir and Bypass Widening. Giant garter snake habitat would be restored on site to the maximum extent practicable. Permanent impacts to giant garter snake habitat would be compensated through the purchase of credits at a mitigation bank.

Direct effects would occur to valley elderberry longhorn beetle due to the removal and transplanting of shrubs from the construction footprint on the American River and Sacramento River. Additionally, elderberry shrubs could be incidentally damaged by construction personnel or equipment. Potential impacts due to damage or transplantation include direct mortality of beetles and/or disruption of their lifecycle. The Corps will compensate for lost habitat onsite to the maximum extent practicable, create new offsite mitigation areas in coordination with the Sacramento County Department of Parks and Recreation, or purchase credits at a mitigation bank.

Adverse effects could occur to Western yellow-billed cuckoo and Swainson's hawk due to the removal of riparian vegetation during construction of Alternative 1 and 2 on the Sacramento River and American River. Swainson's hawk is known to nest within the study area. Prior to construction, the Corps would survey the construction area per the CDFW survey protocols and determine if nesting

hawks are present. If they are present, buffers would be set up and the nests would be monitored. Additional avoidance and minimization measures would be coordinated with CDFW, as needed. Western yellow-billed cuckoo is not currently known to nest in the project area, however the riparian habitat along the American River is suitable nesting habitat for the cuckoo. Additionally, both rivers lie within the cuckoo's migratory corridor and they are likely to be present during their migration period. As a result, the Corps proposes to compensate for the removal of riparian vegetation onsite to the maximum extent possible. If onsite mitigation is not possible, offsite mitigation would occur in coordination with the Sacramento County Department of Parks and Recreation, or credits would be purchased at a mitigation bank.

Vernal pool tadpole shrimp and vernal pool fairy shrimp could be adversely affected by the removal of 0.25 acre of vernal pool habitat due under both Alternatives 1 and 2. During the design phase of the project, a wetland delineation and survey would be conducted near Magpie Creek to verify this impact. The Corps will compensate for this impact by purchasing 1 acre of credit from a mitigation bank.

Because avoidance, minimization, and compensation measures would be implemented in accordance with the requirements of the Endangered Species Act (ESA), California Endangered Species Act (CESA) and other relevant regulatory requirements, and the protect would protect habitat in place and create habitat, potential adverse effects on special-status species and on sensitive habitats would be reduced to a less than significant level.

(7) Other Wildlife

Wildlife effects associated with the construction are expected to be temporary and no additional measures to minimize effects are needed for fill occurring in the area. Under Alternative 1, construction of levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat on the landside of the Sacramento River Parkway, and along Arcade Creek. Alternative 2 would have the same impacts on the project area in addition to the construction of the Sacramento Weir extension. That would require the widening of the Sacramento Weir and Bypass which would result in a reduced affect to landside vegetation and wildlife.

Because this area is very urbanized under Alternative 1, the primary effects to wildlife would be to avian species. Surveys would be conducted to determine if any nesting birds are present prior to construction. If nesting birds are located adjacent to the project area, coordination with the resource agencies would occur. Trees where nesting birds are located would not be removed while they are actively nesting. However, once the young have fledged the trees may be removed to construct the project. The same impacts apply to Alternative 2 with the addition of construction activities causing any wildlife within the bypass and adjacent areas to relocate to nearby rural lands and away from human activities. Once construction is complete the wildlife is expected to return to the area. Therefore, the impacts to wildlife in the Sacramento Bypass would be less than significant. Both native and non-native

fish species, along with some endangered species, use this area of the river and are discussed in Fisheries (Section 3.7) and Special Status Species (Section 3.8).

Mitigation measures would include, when possible, in-kind compensation would be planted on planting berms, on top of launchable rock trenches, or on other lands within the Parkway. A hydraulic evaluation would be conducted to determine whether mitigation could occur in the Sacramento Bypass. Additional mitigation sites are identified in Section 3.6.6 of the ARCF EIS/EIR.

To compensate for the removal of 134 acres of riparian habitat supporting Swainson's hawks and other migratory birds approximately 268 acres of replacement habitat would be created as a mitigation area. Some areas that may be considered for mitigation are Cal Expo and Woodlake. For those mitigation lands within the American River Parkway species selected to compensate for the riparian corridor removal would be consistent with the approved list of trees, shrubs, and herbaceous plants native to the Parkway. Mitigation within the Parkway would provide contiguous habitat connectivity with wildlife migratory corridors that supports the needs of important native wildlife species, without compromising the integrity of the flood control facilities, the flood conveyance capacity of the Parkway, and Parkway management goals in the Parkway Plan. To comply with the Parkway Plan, lands within the Parkway will be evaluated for compensation opportunities for any riparian habitat removed from Parkway. The exact location of the compensation lands in the Parkway would be coordinated in the design phase of the project with Sacramento County Parks Department and comply with the Parkway Plan objectives and goals. It is assumed that sufficient lands will be available within the Parkway, however, if there is not sufficient land, other locations within Sacramento County will be identified and pubic coordination will occur. Additional mitigation may be planted in the expanded Sacramento Bypass or on other lands within the Sacramento area that provide similar value to those removed.

(8) Actions to Minimize Impacts

The proposed project is not likely to result in take to these species for either Alternative as long as the applicable conservation and mitigation measures, as detailed in Section 3.8.6 of the ARCF GRR EIS/EIR are adhered to. Among other measures listed in the EIS/EIR, the conclusion of non-jeopardy is based on the Corps' commitments to: (1) avoid direct impacts by maintaining buffers around sensitive habitat (e.g. 100-foot buffer for elderberry shrubs) and/or conducting construction activities outside of sensitive timeframes (e.g. during the giant garter snake active window or fledging period of special-status birds); (2) minimize wetland losses through the purchase of credits from an approved mitigation bank; (3) implement a SWPPP and associated BMPs; including the designation of staging areas for stockpiling of construction materials, portable equipment, vehicles, and supplies and (4) appoint onsight biologists to provide worker environmental awareness training to contractors and to monitor, report, and remove and transport special-status species if necessary or suspend construction activities until special-status species leave the project on their own. Concurrent implementation of these conservation measures would adequately avoid, minimize, and mitigate adverse effects on the special-status fish, wildlife and plant species discussed in this document.

f. Proposed Disposal Site Determinations

(1) Mixing Zone Size Determination

Not applicable.

(2) Determination of Compliance with Applicable Water Quality Standards

Water quality could be affected within the actual construction area and upstream and downstream of the work area. Construction activities such as rock placement, clearing and grubbing, and slope flattening, have the potential to temporarily degrade water quality through the direct release of soil and construction materials into water bodies or the indirect release of contaminants into water bodies through runoff.

The ARCF study is located within the jurisdiction of the Central Valley RWQCB, within the greater Sacramento Valley watershed. The preparation and adoption of water quality control plans, or Basin Plans, and statewide plans, is the responsibility of the SWRCB. State law requires that Basin Plans conform to the policies set forth in the California Water Code beginning with Section 13000 and any State policy for water quality control. These plans are required by the California Water Code (Section 13240) and supported by the Federal CWA. Section 303 of the CWA requires states to adopt water quality standards which "consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses." According to Section 13050 of the California Water Code, Basin Plans consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected and water quality objectives to protect those uses. Adherence to Basin Plan water quality objectives protects continued beneficial uses of water bodies. Because beneficial uses, together with their corresponding water quality objectives, can be defined per Federal regulations as water quality standards, the Basin Plans are regulatory references for meeting the State and Federal requirements for water quality control (40 CFR 131.20). The potential effects of the proposed project on water quality have been evaluated and are discussed in Section 3.5 of the ARCF EIS/EIR. Compliance with the California Water Code will be accomplished by obtaining certifications from the Central Valley RWQCB prior to construction. In addition a CWA Section 404 review has been conducted internally by the Corps.

(3) Potential Effects on Human Use Characteristics

a) Municipal and Private Water Supplies

The Sacramento River waterways historically were used as places to dispose of contaminants. In recent decades, treatment for municipal wastewater, industrial wastewater, and management of urban stormwater runoff have increased and improved greatly. Industries and municipalities now provide at least secondary treatment of wastewater. The American River originates in the high Sierra Nevada just

west of Lake Tahoe, in the Tahoe and El Dorado National Forests. Its three main forks – the South, Middle, and North – flow through the Sierra foothills and converge east of Sacramento. The waters of the American River provide recreation, municipal power, and irrigation for the northern California area. The fill material would not violate Environmental Protection Agency or State water quality standards or violate the primary drinking water standards of the Safe Drinking Water Act (42 USC 300f-300j). Project design, compliance with State water quality thresholds and standard construction and erosion practices would preclude the introduction of substances into surrounding waters. The groundwater table is separated from the slurry wall by a non-permeable layer of soil, therefore there would be minimal risk to groundwater supply. Materials removed for disposal off-site would be disposed of in an appropriate landfill or other upland area.

b) Recreation and Commercial Fisheries

Under Alternative 1, there would be temporary closure of recreation facilities in the American River Parkway during construction, including the bike trails, walking trails, and boat launches. Alternative 2 would affect the same facilities as Alternative 1, but the possible closure of the Sacramento Bypass during hunting season. Notification and coordination with recreation users and bike groups would be arranged. Flaggers, signage, detours, and fencing would be present to notify and control recreation access and traffic around construction sites.

Alternative 1 would cause indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the placement of rock at a bank protection sites would cause an increase in turbidity. The same effects for Alternative 1 apply for Alternative 2, with the addition of widening the Sacramento Bypass, which would create a floodplain that could provide a benefit to fish species. For Alternatives 1 and 2, a vegetation variance would allow waterside vegetation, which would include native grasses, shrubs, and trees, to remain on the lower one-third of the waterside slope along the Sacramento River. Bank protection sites and launchable rock trenches would be revegetated with native grasses, shrubs and trees following construction. BMPs would be implemented to address turbidity.

c) Water-related recreation

Recreational boating is one of the primary uses of the American River. Boat access is located at Discovery Park on both the Sacramento and American River side of the park. Boat launches within the Parkway are located at Howe Avenue, Watt Avenue, and Gristmill Park. The river can become very shallow between Sunrise and Howe Avenue when releases from Folsom Dam are reduced, making motorized boating impracticable. Rafting on this stretch of the river is very common during summer months with the highest use on the weekends and holidays.

Under Alternative 1, recreational resources that could potentially be affected by construction of the erosion protection measures include Paradise Beach, the Campus Commons Golf Course, the Guy West Bridge, and the boat launches at Howe Avenue, Watt Avenue, and Gristmill Park. Construction will

also occur during the summer months when the Parkway recreation activities are at the peak. There would be short-term term significant effects along the Sacramento River reach of the project, however, there would be no long-term effects because the area would be returned to the pre-construction conditions once completed. The timing of construction cannot be mitigated as it is unsafe to perform construction activities in the floodway during the flood season.

Effects to recreation from the construction of levee improvements under Alternative 2 would be consistent with those analyzed for Alternative 1 with the addition of effects resulting from construction of levee improvements associated with the Sacramento Weir and Bypass widening. Impacts to water-related recreation are the same for both Alternatives.

If any access point needs to be closed during construction, notices will be posted providing alternative access routes. Any recreation facilities affected by the project would be replaced in-kind within the existing area and no long-term impacts are anticipated.

d) Aesthetics

Alternatives 1 and 2 would result in vegetation loss and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River. Native trees would be planted after construction is completed on planting berms and on top of launchable rock trenches; however, there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.

e) Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

Many parks are located within the American River Parkway portion of the study. Following is a description of the parks and their activities.

Discovery Park. Located just north of downtown Sacramento at the confluence of the American River and the Sacramento River, this 302-acre park is a popular site for rafters and waders. Discovery Park is the trailhead for the 32-mile long Jedediah Smith Memorial Trail. The park also features a boat launch. Discovery Park was designed to flood and take pressure off American River levees during high water events. For safety reasons, the park closes when water flows into the public areas and remains closed until the water subsides.

Sutter's Landing Regional Park. Nestled along the banks of the American River about a mile northeast of downtown Sacramento, this 172-acre park currently offers a wide variety of recreational opportunities including a covered skateboard park, a dog park, picnic areas, basketball and bocce ball courts, as well as access to trails along the American River and a boat launch for kayaks, canoes, and other non-motorized boats. Visitors can also see a diversity of wildlife at this site including river otters, beavers, jackrabbits, cottontails, coyotes, raccoons, gopher snakes, fence lizards, skunks, ground

squirrels, voles, and an occasional sea lion, as well as a wide variety of bird species ranging from shorebirds and waterfowl to raptors making it an ideal location for nature watching as well as birding. Other popular activities at this location include walking, jogging, and biking.

Paradise Beach. Just off of U.S. 50 at Howe Avenue, Paradise Beach offers a sandy beach area and is a popular spot for swimming.

Campus Commons Golf Course. Built in 1972, the 1,699 yard Campus Commons Golf Course is a public nine hole executive course located just north of California State University Sacramento, along the American River.

Guy West Bridge. The Guy West Bridge is a pedestrian-only suspension bridge crossing the historic Lower American River. It is modeled after the famed Golden Gate Bridge in San Francisco, but spans only 600 feet compared to the Golden Gate's 6,450 feet. The bridge was constructed to tie the California State University campus to a business and residential community on the north side of the American River.

Howe Avenue. Located down river from California State University, Sacramento, this car-top launch site allows small boats and rafts to be launched into the American River. Because of the swift rapids, this site is not conducive to swimming and wading.

Waterton and Save the American River Association. Just off of U.S. 50 at Watt Avenue, Waterton Access is a small site providing access along the river. The area is inhabited by deer and jackrabbits, so it is ideal for nature watching. The nearby Save the American River Association Access offers similar opportunity.

Watt Avenue. Just off Watt Avenue is an American River access point popular as a take-out spot for rafters, canoeists, and kayakers. Fishing is also popular here because of the range of shallow and deep water.

Gristmill Park. Located off Mira Del Rio Drive and Folsom Boulevard in Rancho Cordova, Gristmill Park is a popular place for fishing, bird watching, and nature watching/photography. The area also has some nice walking paths popular with the locals that wind through oak woodlands along the southern bank of the river in either direction from the parking area. In addition to the usual assortment of birds in these woodlands such as woodpeckers, Northern flickers, and red-shouldered hawks, it is not unusual to spot deer and coyote here as well. Due to the calmness of the river at this location, it is a popular launch spot for kayaking and canoeing.

William Pond Recreation Area. Located off Arden Way, the William Pond Recreation Area is one of the most well-established and popular parks along the river. Named in honor of the first director of County Parks, the park is handicap-friendly and offers a man-made fishing pond with a specialized fishing pier and ramp and paved walking trails that gently slope around the park.

River Bend Park (formerly Goethe Park). River Bend Park, formerly C.M. Goethe Park, is one of Sacramento's oldest county parks. It is located at U.S. 50 and Bradshaw Road and offers many recreation facilities. Horse and hiking trails wind through the park for plenty of wildlife viewing. This facility also has large group picnic sites often used for community events. River Bend Park is the endpoint for many recreational rafters on the American River.

Soil Born Farms. Located on the American River in Rancho Cordova (40 acres) and in Sacramento on Hurley Way (1.5 acres), Soil Born Farms organically grows a wide variety of fruits and vegetables linked to the seasons and temperament of the Sacramento region. All produce is harvested within a day of distribution to local restaurants, famers markets, and at their own farm stand at the American River ranch location from May to November. This nonprofit farm is actively involved in fostering organic farming through their farm apprentice program and youth education. All water used in irrigation comes from the American River and no synthetic pesticides or fertilizers are used.

Miller Park. Adjacent to the Sacramento Marina, off Harborview Drive from Front Street, this 57 acre city park is right on the Sacramento River. The park includes picnic areas, boat trailer parking, and a boat ramp and dock. There is also a store called Rat's Snack Shop.

Garcia Bend Park. Located between Pocket Road and the Sacramento River, this 19-acre community park is a popular place for recreation providing soccer fields, lighted tennis courts, play areas, picnic areas, restrooms, and a public boat ramp providing access to the Sacramento River.

The Riverfront Promenade. A new addition to Sacramento's riverfront, a couple blocks were opened in 2001. It is located just downstream of Old Sacramento and is still in the early stages of development. When complete, the promenade will be a mile long walking and cycling path that connects Old Sacramento to Miller Park.

For Alternative 1, construction of erosion protection measures is expected to take up to 10 years, with construction occurring in multiple locations within the Parkway at the same time. While this would not be a permanent long-term affect, 10 years of linear construction would be considered a significant effect to recreation activities because it would reduce the quality of existing recreation activities. Portions of the road on top of the levee would be closed to pedestrian access during the construction period. Additionally, construction of the launchable rock trench would temporarily disturb several miles of bike trails as well as access to public parks and boat launches within or adjacent to the Parkway. Such closures and disturbances would result in non-compliance with the American River Parkway Plan which states that flood control berms, levees and other facilities should be, to the extent consistent with proper operation and maintenance of these facilities, open to the public for approved uses, such as hiking, biking and other recreational activities. Once construction is complete the recreation facilities would be returned to the pre-construction conditions and long term effects would be less than significant.

These closures and disturbances would also result in direct and adverse effects to recreation, an outstandingly remarkable value under the Wild and Scenic Rivers Act. Recreational resources that could potentially be affected by construction of the erosion protection measures include Paradise Beach, the Campus Commons Golf Course, the Guy West Bridge, and the boat launches at Howe Avenue, Watt Avenue, and Gristmill Park.

Effects to recreation from the construction of levee improvements under Alternative 2 would be consistent with those analyzed for Alternative 1 with the addition of effects resulting from construction of levee improvements associated with the Sacramento Weir and Bypass widening. Construction of levee improvements associated with the Sacramento Weir and Bypass widening would have possible short-term effects on recreational use. During construction, certain areas would be closed to the public while other areas might be used as haul routes or borrow/disposal sites. Activities such as bird watching, walking, running, and jogging along the Sacramento Bypass levee crown and nearby roads would be restricted. Construction activities could potentially overlap with hunting season in the Sacramento Bypass Wildlife Area, which occurs from September 1 through January 31, restricting hunting activities for a limited period of time. In addition, there may be temporary effects to the Yolo Shortline Railroad. Construction activities would have a significant effect on the Yolo Shortline Railroad as portions of the railway may have to be shut down or relocated during construction activities.

To ensure public safety, flaggers, warning signs, and signs restricting access would be posted before and during construction, as necessary. In the event that bike trails would be disrupted, detours would be provided. Detour routes would be clearly marked, and fences would be erected in order to prevent access to the project area. In areas where recreational traffic intersects with construction vehicles, traffic control will be utilized in order to maintain public safety. The public will have continued access to the Parkway and recreation facilities during construction, but bike and running trail users would likely be required to detour onto public roads or alternative trails. If any access point needs to be closed during construction, notices will be posted providing alternative access routes.

These mitigation measures will reduce the effects on recreation; however, impacts would still be significant because of the duration of construction and the inability to provide similar quality recreation during construction. Any recreation facilities affected by the project would be replaced in-kind within the existing area and no long-term impacts are anticipated.

g. Determination of Cumulative Effects on the Aquatic Ecosystem

Effects of the proposed action include reductions in nearshore aquatic and riparian habitats that are used by aquatic and terrestrial species. Corps actions which could create a cumulative effect on waters of the U.S. in the Sacramento area include the West Sacramento Project, the Southport Early Implementation Project, the American River Common Features Project, the North Sacramento Streams Project, the Sacramento River East Levee Project, and the Sacramento River Bank Protection Project (SRBPP). The North Sacramento Streams Project and the Sacramento River East Levee Project are proposed by SAFCA to construct certain features that are also part of the ARCF GRR Alternative 2. The

North Sacramento Streams Project includes proposed measures on Arcade Creek and NEMDC, and the Sacramento River East Levee Project includes the seepage and stability measures on the Sacramento River that are also proposed by the Corps under the ARCF GRR project, but with limited erosion protection.

The purpose of the West Sacramento Project is to investigate and determine the extent of Federal interest in plans that reduce flood risk to the City of West Sacramento. The proposed alternative for this project consists of levee improvements to 50 miles of existing levees surrounding the city and extending down along the Sacramento Deep Water Ship Channel to address identified seepage, stability, and erosion concerns through the construction of slurry walls and bank protection. In addition, the project proposes to set back the Sacramento River levee in the Southport area of West Sacramento. The recommended West Sacramento Project includes the geographic area and project features that are also being considered in the Southport Early Implementation Project. The Southport Early Implementation Project is being proposed by the West Sacramento Area Flood Control Agency and the State of California to provide 200-year protection consistent with the State's goal for urbanized areas, as well as to provide opportunities for ecosystem restoration and public recreation. The Southport Early Implementation Project's proposed alternative includes the Sacramento River setback levee in the Southport area of West Sacramento. The Southport project is planned to begin construction in 2016. The West Sacramento and Southport projects propose to implement a combined 16,000 linear feet of rock protection on the west bank of the Sacramento River in the study area.

The SRBPP was authorized to protect the existing levees and flood control facilities of the SRFCP. The SRBPP is a long-range program of bank protection authorized by the Flood Control Act of 1960. The SRBPP directs the Corps to provide bank protection along the Sacramento River and its tributaries, including that portion of the lower American River bordered by Federal flood control project levees. Beginning in 1996, erosion control projects at five sites covering almost two miles of the south and north banks of the lower American River have been implemented. Additional sites at RM 149 and 56.7 on the Sacramento River totaling one-half mile have been constructed since 2001. During 2005 through 2007, 29 critical sites totaling approximately 16,000 linear feet were constructed under the Declaration of Flood Emergency by Governor Schwarzenegger. This is an ongoing project, and additional sites requiring maintenance will continue to be identified indefinitely until the remaining authority of approximately 24,000 linear feet is exhausted over the next 3 years. WRDA 2007 authorized an additional 80,000 linear feet of bank protection, however sites for implementation have not been selected at this time.

The construction periods and related effects from these projects could all occur simultaneously. For the ARCF and West Sacramento projects, to include the Sacramento River East Levee Project and the Southport Project, this means that similar construction-related effects such as rock placement or tree removal could be occurring at the same time for the stretch of the projects from the I Street Bridge to the Stone Locks. To avoid potentially significant construction-related cumulative effects, the two projects would coordinate to ensure that construction sites are offset from each other (i.e., sites directly across the Sacramento River from each other where there is bank protection being installed, specifically from the I-Street Bridge downstream to the Stone Locks, would not be constructed in the same

construction season). These are also different types of bank protection. The West Sacramento side has some berm between the levee and the channel, and therefore it is really a "bank" fix, while the ARCF side has levee toe underwater and includes rock berm. Both of these projects propose to implement planting berms and new SRA habitat, and to protect lower waterside trees in place to preserve the existing habitat to the maximum extent possible.

Additionally, levee maintenance activities by state agencies and local reclamation districts are likely to continue, although any effects on waters of the U.S. will be addressed through the Section 404 permitting process with the Corps Regulatory Division. Potential cumulative effects on the aquatic ecosystem could include: wave action in the water channel caused by boats that may degrade riparian and wetland habitat and erode banks; dumping of domestic and industrial garbage; land uses that result in increased discharges of pesticides, herbicides, oil, and other contaminants; and conversion of riparian areas for urban development.

h. Determination of Secondary Effects on the Aquatic Ecosystem

The placement of rock would not only reduce the risk of erosion, but would also anchor remaining trees in place and reduce the potential for trees falling over during a high flow event. The understory, which provides habitat for small rodents, ground nesting birds and waterfowl, and various reptiles, would be removed in order to provide a clean surface to place the rock. Because the riprap is a hard surface it would not support the growth of large amounts of vegetation. In areas with a soil trench or soil placed over rock on the lower portion of the slope vegetation would be planted or allowed to establish naturally. The riprap would also provide basking areas for some small reptiles such as snakes and lizards. Because the riparian corridor and shaded river aquatic habitat left in place would still provide value to fish and wildlife species, and compensatory mitigation would be implemented for trees that were removed, impacts are consider less than significant.

Risk exists for the unintentional placement of dredge and/or fill material to be placedoutside of the proposed project area. Unintentional placement could result in additional adverse impacts to water quality, erosion and accretion patterns, aquatic and other wildlife habitat, recreation, aesthetics and air quality. In order to reduce the risk of such impacts, contract specifications would require the contractor to mark the project boundaries, and that the contractor install erosion control (i.e. silt fencing, silt curtains) where possible within any standing waters.

III. Findings of Compliance or Non-Compliance with the Restrictions on Discharge

a. Adaptation of the Section 404(b)(1) Guidelines to this Evaluation

No significant adaptations of the guidelines were made relative to this evaluation.

b. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site

The only practicable alternative to the proposed bank protection sites along the American River is the launchable rock trench measure, which was described in Section I(h) above. This measure would involve digging a trench in the berm at the waterside toe of the levee and filling it with rock. The rock would be covered with soil, and as the berm slowly erodes away during a high water event, the rock would "launch" and cover the bank to form a barrier to prevent further erosion. While this measure would minimize impacts associated with the placement of fill in waters of the U.S., it would still result in the removal of 0.40-acre of wetlands on the south bank of the American River. Additionally, this measure would result in significant impacts to vegetation, wildlife, and recreation during construction due to the removal of 65 acres of riparian habitat during construction, and disruption or closure of trails within the American River Parkway during construction. It is anticipated that this measure will be used in some locations on the American and Sacramento Rivers, however, the least environmentally damaging alternative would be a combination of both this measure and bank protection, with onsite environmental and recreational conditions taken into account when selecting the appropriate measure. Implementation of the launchable rock trench would reduce the quantity of fill in the American River from what was analyzed in this 404(b)(1) analysis by reducing the quantity of in-river bank protection required, while implementation of the bank protection would reduce significant effects on riparian habitat, recreational resources, and could avoid impacts to 0.40-acre of wetlands..

Additionally, in some locations where the river flow velocity is low, it may be practicable to use a biotechnical measure rather than bank protection or launchable trenches to provide erosion protection. This measure would involve using biomaterials such as fallen trees to protect the banks from erosion. This would be the least environmentally damaging measure, however it is not practicable for the majority of the river because currents are too strong. As a result there are only minimal locations where this measure could be feasibly implemented.

Because of the significant effects associated with the launchable rock trench measure, the feasibility of the biotechnical measures, and the placement of fill associated with the bank protection measure, a combination of these measures would be the least environmentally damaging practicable alternative.

c. Compliance with Applicable State Water Quality Standards

The proposed project would implement BMPs to ensure that it does not violate State water quality standards identified in the Central Valley Basin Plan (CVRWQCB 1998).

d. Compliance with Applicable Toxic Effluent Standard or Prohibition Under Section 307 of the Clean Water Act

The discharges of fill materials will not cause or contribute to, after consideration of disposal site dilution and dispersion, violation of any applicable State water quality standards for waters. The discharge operations will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

e. Compliance with Endangered Species Act of 1973

The placement of fill materials in the project area(s) will not jeopardize the continued existence of any species listed as threatened or endangered or result in the likelihood of destruction or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973.

f. Compliance with Specified Protection Measures for Marine Sanctuaries Designated by the Marine Protection, Research, and Sanctuaries Act of 1972

Not applicable.

g. Appropriate and Practicable Steps Taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem

Appropriate and practicable steps to minimize potential adverse effects of discharge and fill on the aquatic ecosystem include: placing fill material only where it is needed for the proposed project and confining it to the smallest practicable area. The areas disturbed by construction would be returned as close as possible to pre-project conditions when practicable.

On the basis of the guidelines, the proposed project is specified as complying with the inclusion of appropriate and practical conditions to minimize pollution or adverse effect on the aquatic ecosystem. Alternative 2 has been identified as the Least Environmentally Damaging Practicable Alternative, as it minimizes the footprint of the levee improvements through the removal of the majority of the levee raises along the Sacramento River, results in less impacts to aquatic resources, and also proposes to create approximately 300 acres of new floodplain habitat through the widening of the Sacramento Bypass.

INTRODUCTION

This appendix provides responses to public and agency comments on the American River Common Features (ARCF) Draft Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) and General Reevaluation Report (GRR), as received during the public comment period.

PUBLIC COMMENT SUMMARY

The draft GRR and EIS/EIR were circulated for public review beginning on March 13, 2015. The notice of availability (NOA) was published in the Federal Register on March 13, 2015. The draft GRR and EIS/EIR were made available both on the Sacramento District, Corps of Engineers website as well as the website for the Central Valley Flood Protection Board. Hard copies of the draft GRR and EIS/EIR were provided to area libraries. Letters and/or DVD copies of the GRR and EIS/EIR were sent to interested parties, local residents, and to the agencies and elected officials listed in Section 6.4 of the EIS/EIR. Public workshops were held during the review period to provide additional opportunities for comments on the draft documents. All comments received during the public review period were considered and incorporated into the final GRR and EIS/EIR as appropriate. The meeting locations, dates and times were as follows:

- April 8, Hagginwood Community Center—3270 Marysville Blvd, Sacramento (5-7 p.m.).
- April 9, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5-7 p.m.).
- April 15, Library Galleria—828 I Street, Sacramento (3-5 p.m.).
- April 17, Arden-Dimick Library— 891 Watt Ave., Sacramento (5-7 p.m.).

A total of 137 people attended the four meetings. Comments were solicited through the use of court reporters at the meetings. Additionally, comments could be submitted through mail or electronic mail. Oral and written comments were made throughout the series of meetings by local, State, and Federal agencies, community organizations, and individuals.

During the Draft EIS public review period, a total of 471 comments were received from the public in the following manner:

- 39 different parties commented, including 2 Federal agencies, 7 State of California agency, 9 local agencies and organizations, 1 Native American Tribe, and 20 private citizens.
- 9 people presented verbal comments to the court reporter at the public meetings.
- 4 people left hand-written comment cards at the public meetings.

A summary of the major issues from the public comments are included below. Original letters, e-mails, and the transcripts of the public hearings follow. Responses to the public comments are included in the table that follows.

RESPONSES TO PRIMARY COMMENTS

Public comments on the draft documents focused in part on: 1) access to recreational features during and after construction; 2) design, placement and justification for rock erosion protection along the American and Sacramento Rivers; 3) effects to vegetation as a result of the recommendations; 4) clear presentation of the anticipated level of the performance of the project; and 5) coordination with stakeholders in future phases of the project.

MATRIX OF COMMENTS AND RESPONSES

The following pages include the posters from the public scoping meeting. Following the posters are all public comments received and a matrix of the Corps' responses to those comments. The responses are annotated to refer back to the corresponding letters and comments that precede them. Each letter and comment has been annotated with a designation such as "C-5". The letter, "C" refers to the comment letter, and the number, "5" refers to the comment number within the letter.

Welcome

Welcome to our

Sacramento Area Levee Improvements

public meeting

US Army Corps of Engineers

SAFCA

Please Sign In

Introduction

- Together, the State of California, Sacramento Area Flood Control Agency and the U.S. Army Corps of Engineers have made tremendous progress in reducing flood risk for Sacramento – perhaps America's most at-risk city for severe flooding.

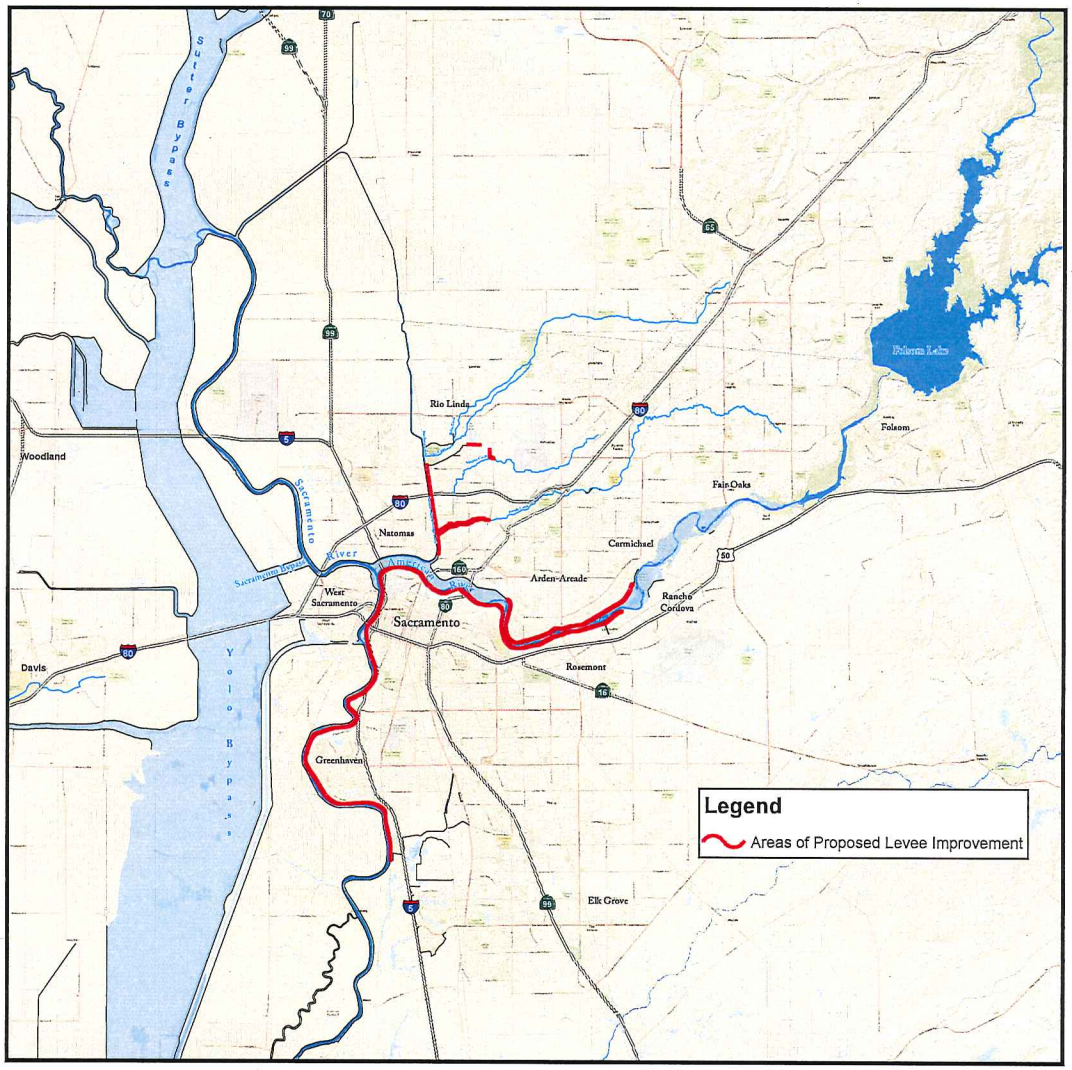
- Modernizing Sacramento's aging flood infrastructure still requires a lot of work. These proposed plans recommend $1.46 billion in further improvements to modernize Sacramento's flood infrastructure so it reliably and sustainably reduces Sacramento's flood risk for decades to come.

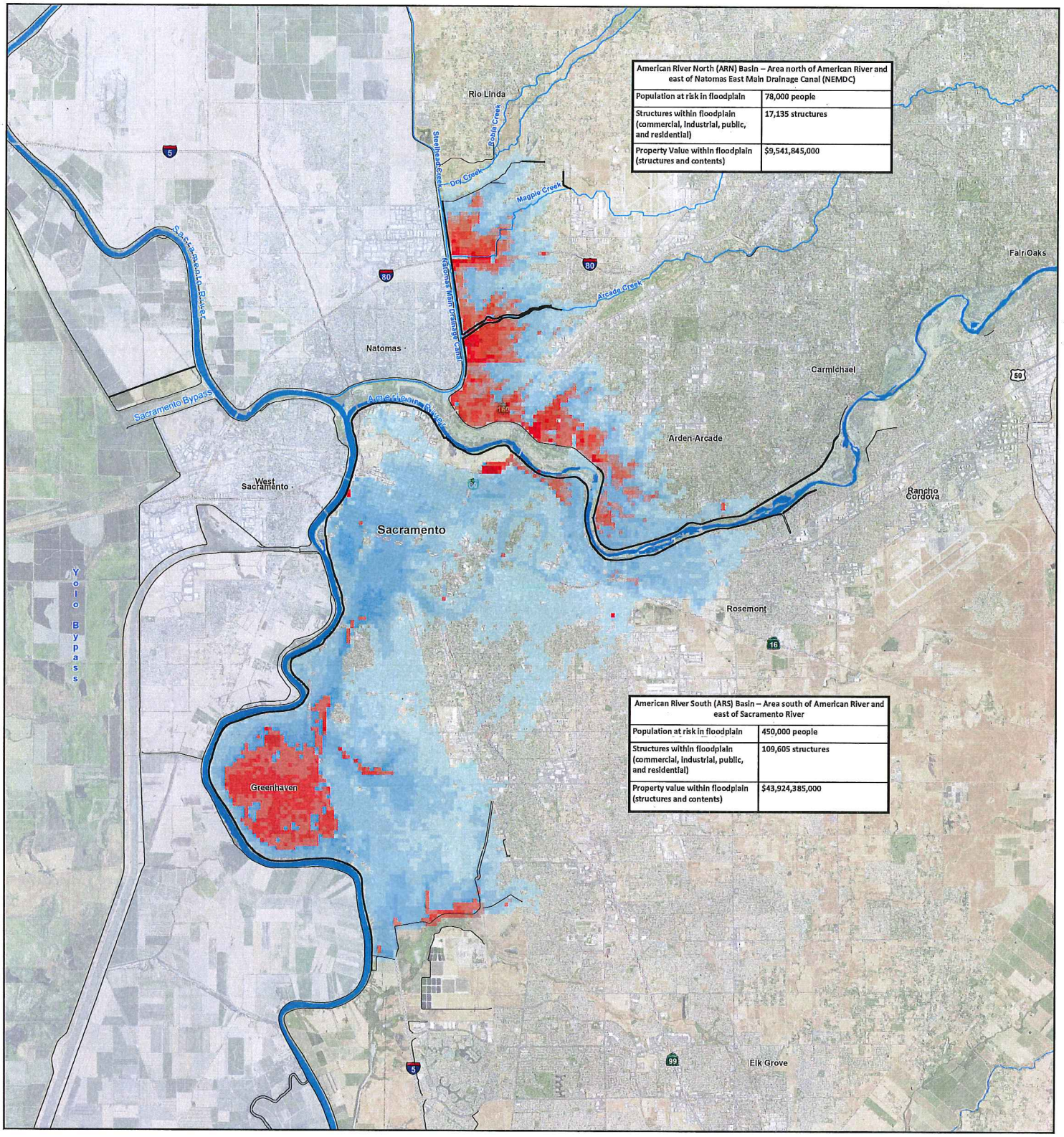
- SAFCA's plan and the Corps' are well coordinated and work together to achieve the same goals.

- We need your feedback. These proposals are drafts, and this is your chance to have a say in the development of the project.

US Army Corps of Engineers.

SAFCA





Existing 200-Year Floodplain

(Study Areas Only)

Legend

- Proposed Projects
- Existing Levees
- River/Creek
- Major Roads
- Interstate/Highway

Floodplain Depth (Feet)

- 0 - 4
- 5 - 8
- 9 - 12
- 13 - 16
- 17 - 20
- 21 - 24
- 25 - 28

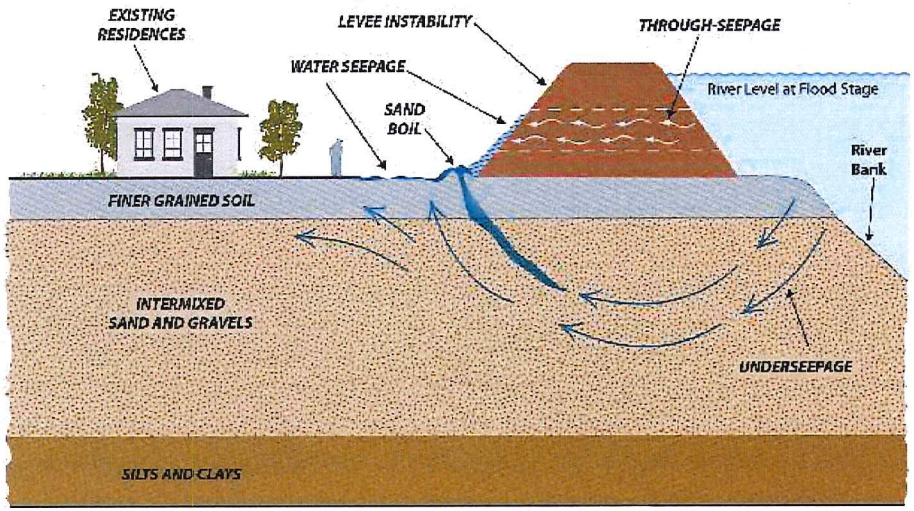
N

0 0.5 1 2 3 4 Miles

* West Sacramento & Natomas floodplain not shown.

SAFCA Sacramento Area Flood Control Agency

Seepage & Stability Issues



Seepage and stability problems

Levee Instability:

Saturated soil and sand layers may cause levee slopes to slump, or levee foundation to settle risking levee failure at flood stage.

Levee Through-Seepage:

When the river is approaching flood stage, high water pressure at some locations causes seepage through the levee.

Levee Underseepage:

High river levels lead to seepage through sandy and gravelly soils. High water pressure beneath the surface can emerge at the landside levee toe, causing sand boils, and can also appear at the surface up to several hundred feet landside of the levee. Sand boils could cause loss of levee foundation, and eventual collapse of levee.

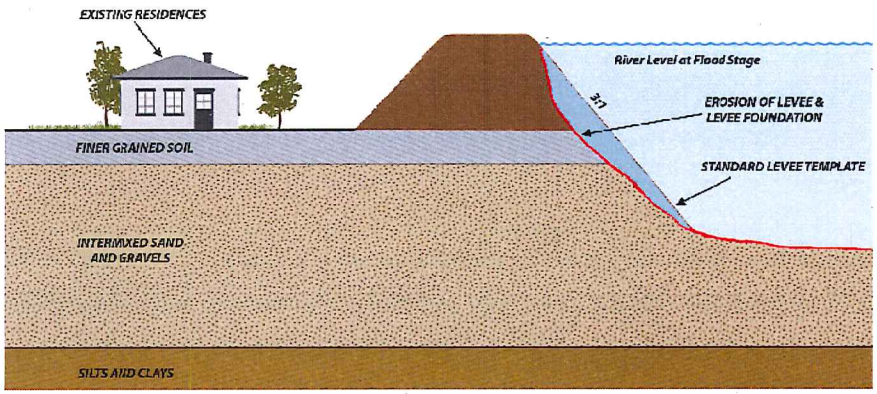
Seepage problem

Levee instabiity problem

US Army Corps of Engineers.

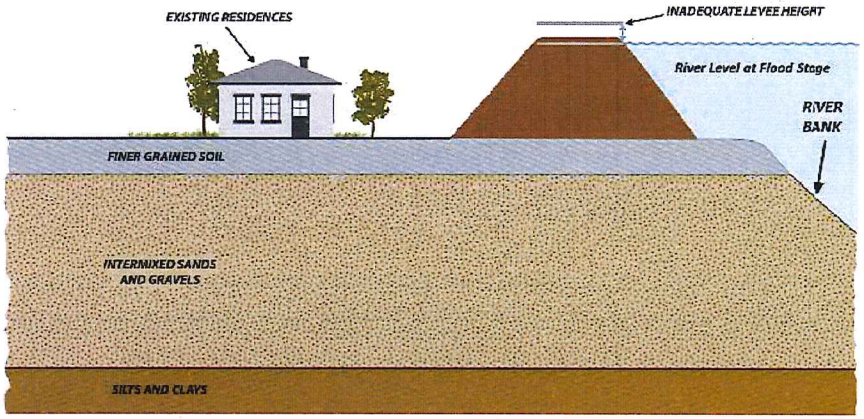
SAFCA

Erosion & Height Issues



Levee Erosion Problems:

River currents remove soil material from channel bank. Eventually, or sometimes suddenly, a portion of the levee and/or levee foundation erodes away which greatly reduces the stability of the levee.



Levee Height Problems:

Levee height may be too low to contain high river flows, account for uncertainty in the design water level, and/or contain wind-wave run-up.

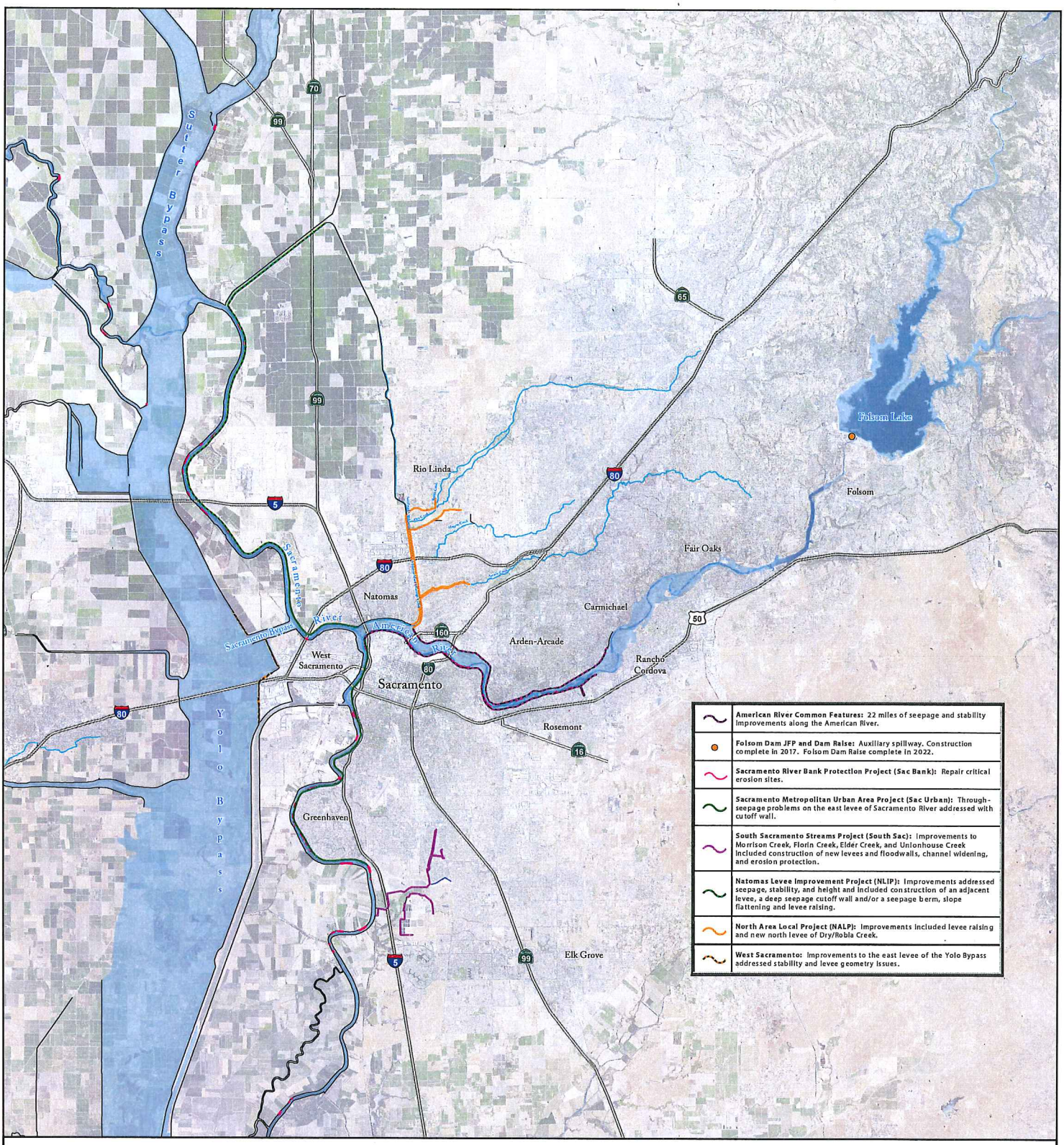
Erosion problems

Erosion problems

Levee overtopping problem

US Army Corps of Engineers.

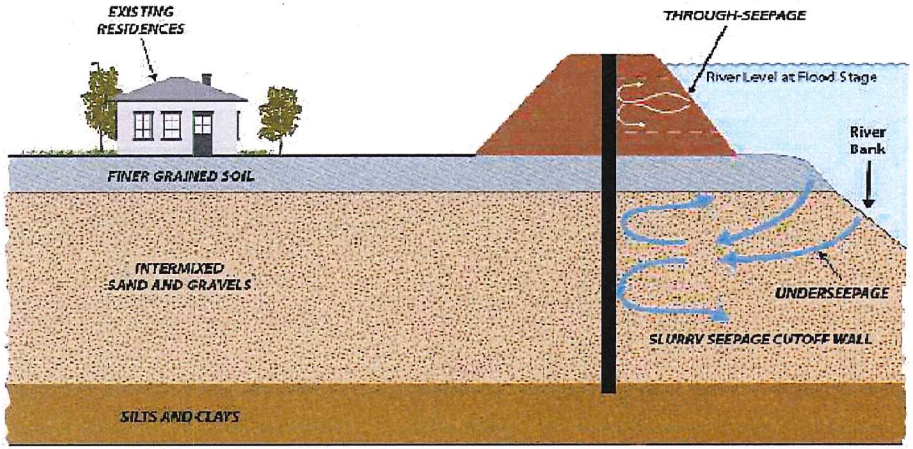
SAFCA



What We've Accomplished

SAFCA
Sacramento Area Flood Control Agency

Seepage & Stability Addressed



Levee Seepage:

Primarily addressed by constructing a seepage cutoff wall. Water pressure is greatly reduced as it passes through the wall so that seepage and boils on the landside toe are either eliminated or greatly reduced.

Levee Instability:

Stability problems are typically addressed by construction of a seepage cutoff wall, with either soil reinforcement or levee slope flattening improvements constructed. In areas needing soil reinforcement, geotextiles will be placed within the levee in layers. In areas needing slope flattening, new soil material will be added to the levee slope and compacted.

RIGHT: Deep soil mixing seepage cutoff wall

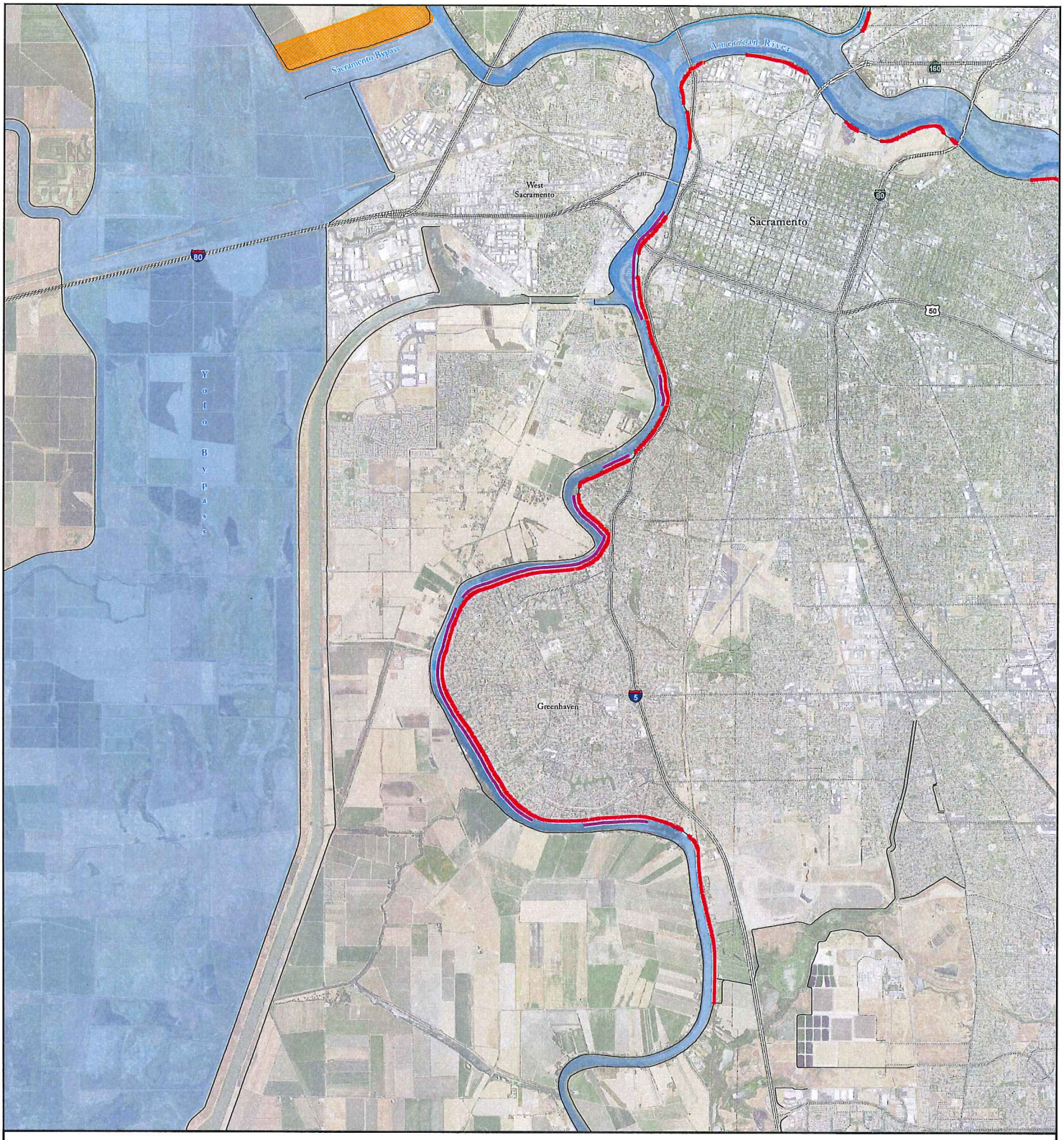
BELOW: Levee instability repair

ABOVE: Levee instability repair

LEFT: Conventional seepage cutoff wall construction

US Army Corps of Engineers.

SAFCA



USACE & SAFCA Projects

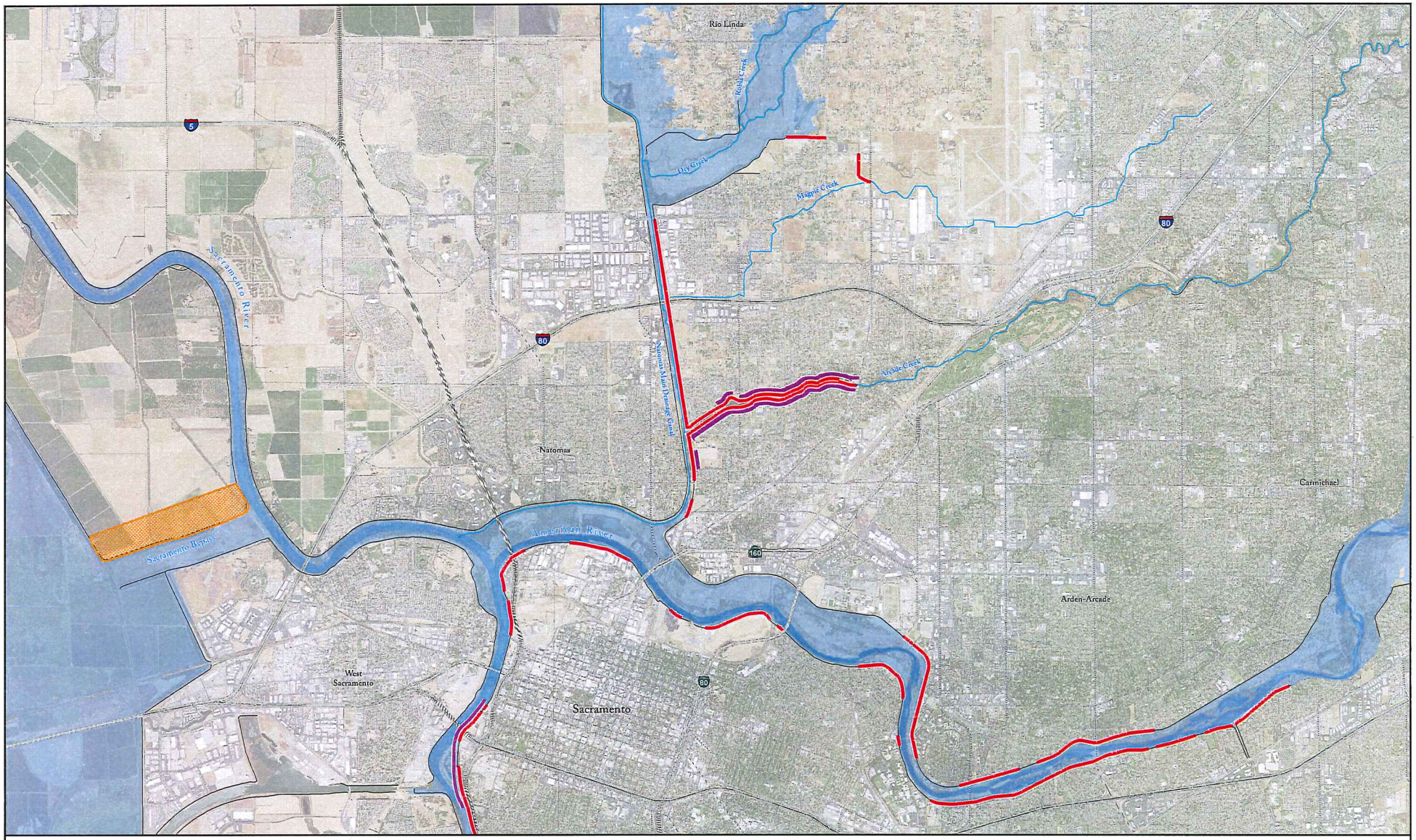
Legend

- USACE Plan
- SAFCA Plan
- Existing Levees (not part of this project)
- River/Creek
- Major Roads
- Interstate/Highway

N

0 0.25 0.5 1 1.5 2
Miles

SAFCA
Sacramento Area Flood Control Agency



USACE & SAFCA Projects

Legend

- USACE Plan
- SAFCA Plan
- Existing Levees (not part of this project)
- River/Creek
- Major Roads
- Interstate/Highway
- Sac Bypass Expansion

N

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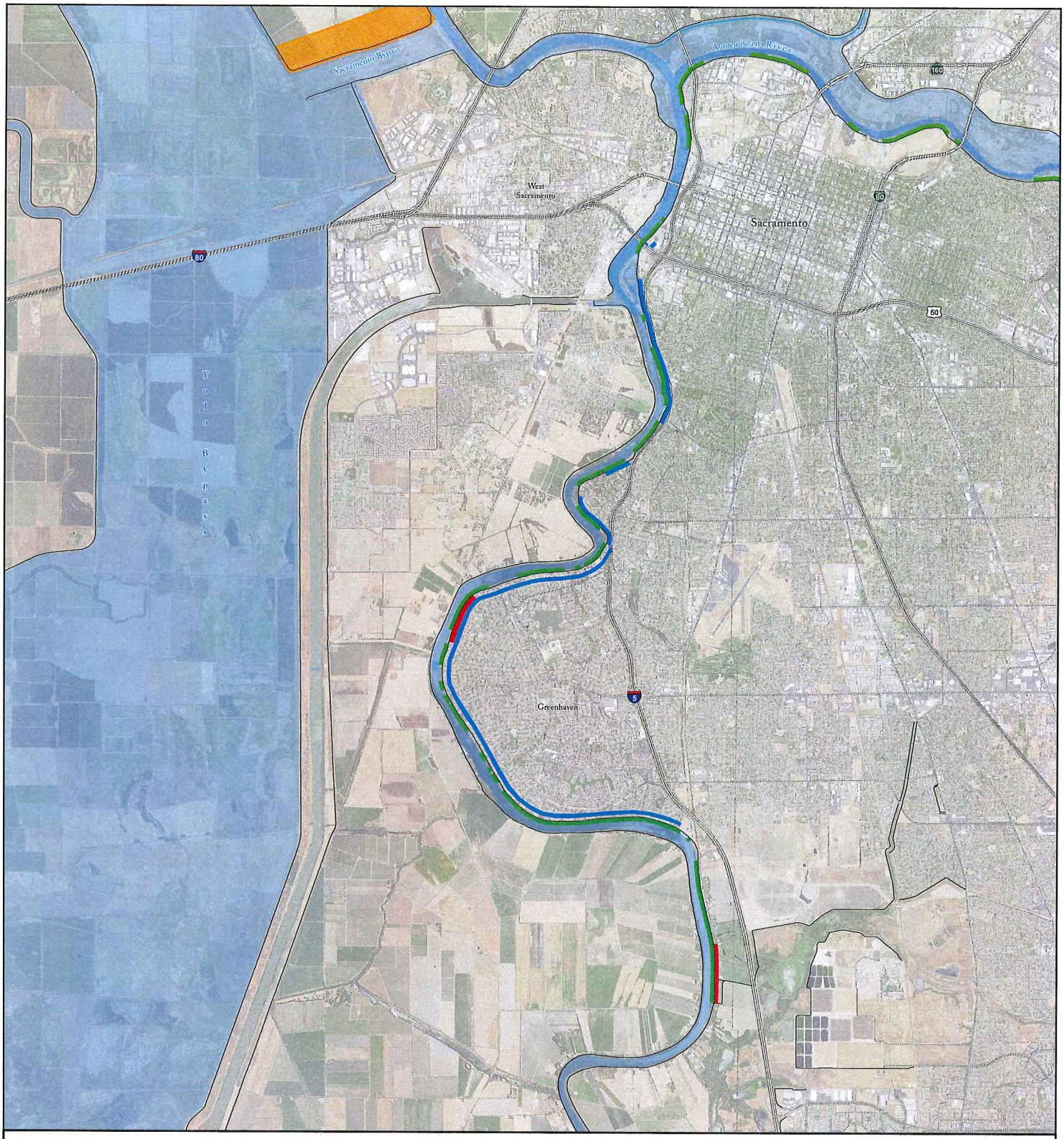
Miles

SAFCA
Sacramento Area Flood Control Agency



USACE Plan

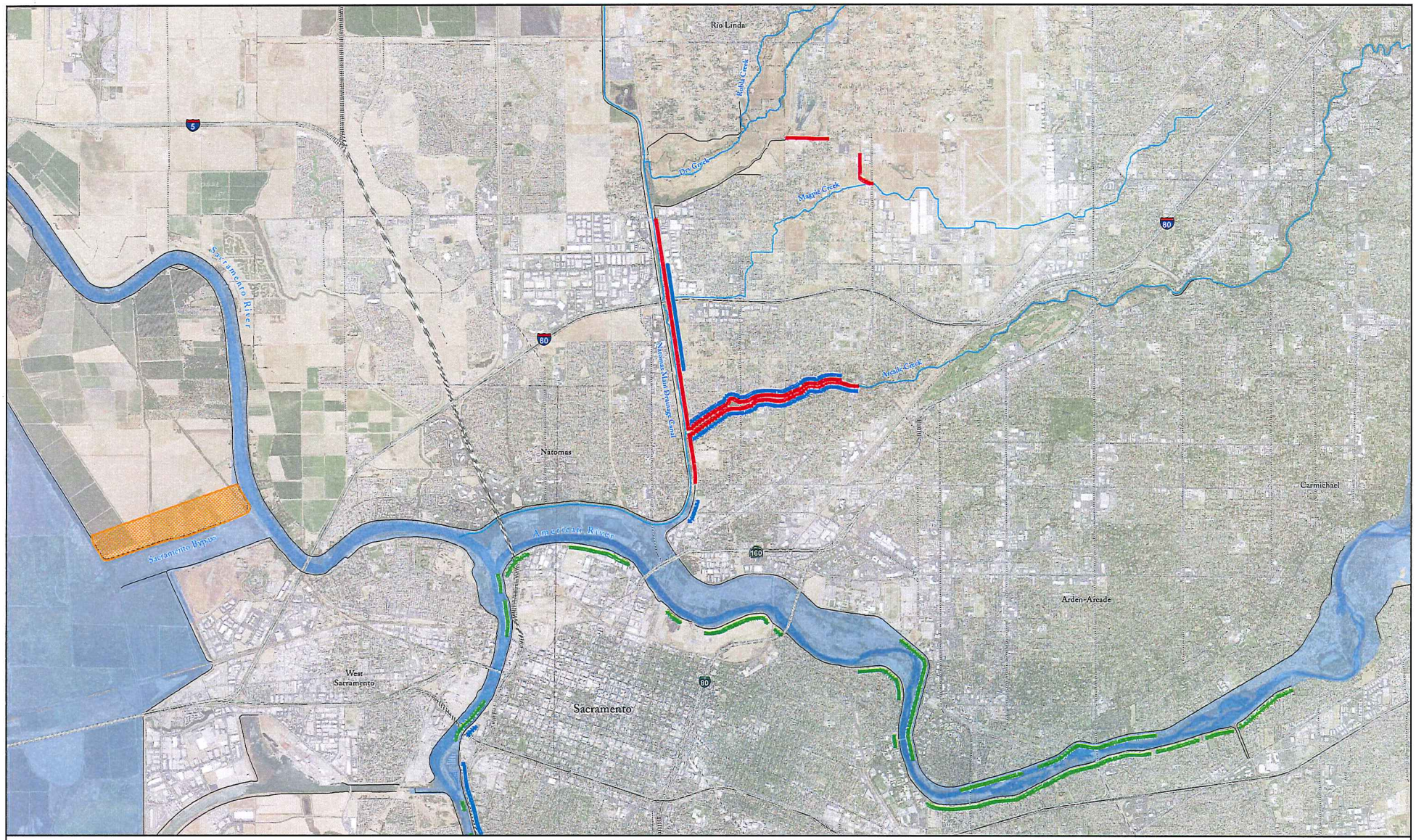
Legend

- Height Improvements
- Seepage/Stability Improvements
- Erosion Improvements
- Existing Levees (not part of this project)
- River/Creek
- Major Roads
- Interstate/Highway

N

0 0.25 0.5 1 1.5 2
Miles

SAFCA
Sacramento Area Flood Control Agency



USACE Plan

Legend

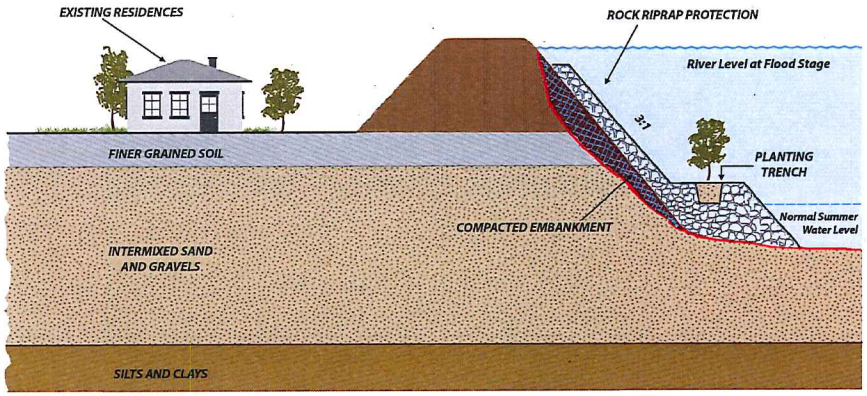
- Height Improvements
- Seepage/Stability Improvements
- Erosion Improvements
- Existing Levees (not part of this project)
- River/Creek
- Major Roads
- Interstate/Highway
- Sac Bypass Expansion

N

0 0.25 0.5 1 1.5 2
Miles

SAFCA
Sacramento Area Flood Control Agency

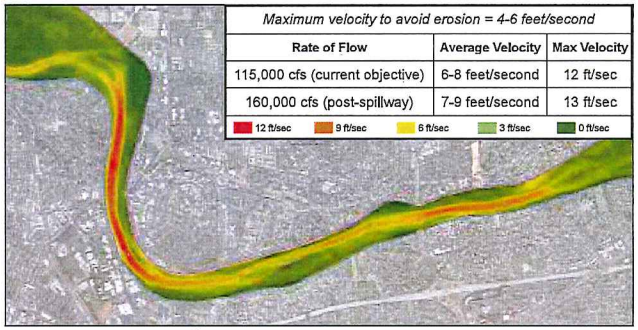
Erosion Addressed



Levee Erosion:

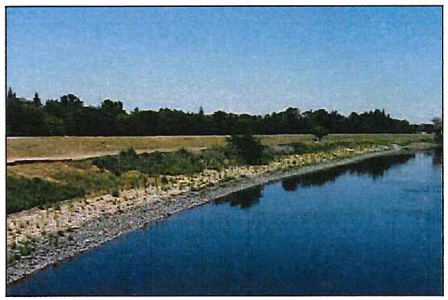
Primarily addressed by placing rock riprap revetment either on channel bank or at toe of levee. Construction from barge preferred, where practical.

Velocity:

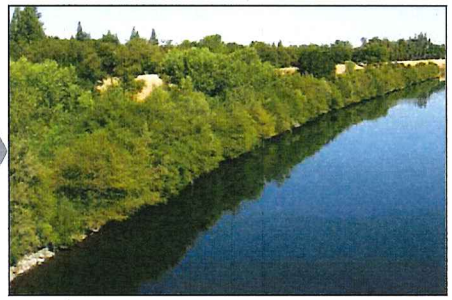


Levees were historically constructed from highly erodible mining deposits and sands, close to the main channel so more land was available for urban development. The American River downstream of Folsom Dam is very steep, creating faster, stronger stream flows confined between levees that could promote erosion. History shows that a levee can fail because of erosion on American River, and Sacramento will experience significant flood risk reduction when the issue is addressed.

Typical bank protection placing rock riprap revetment from barge



Typical bank protection as constructed at Lower American River Site 4 between Guy West bridge and H Street Bridge in 2001



Lower American River Site 4 in 2010

US Army Corps of Engineers.

SAFCA

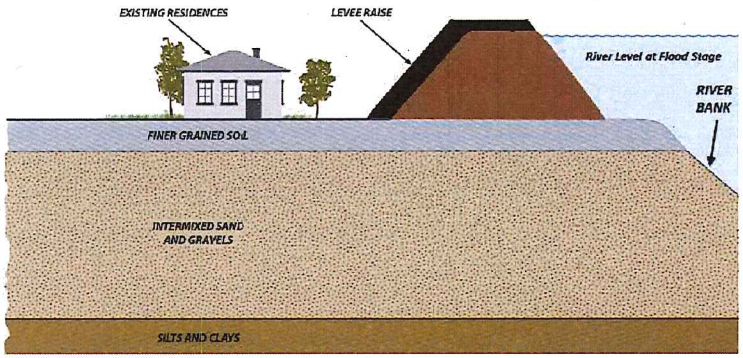
Height Addressed: Bypass vs. Levee Raise

In order to convey a flood event with an annual chance of exceedance of 1 in 200, the Sacramento River downstream of the American River requires either eight miles of levee to be raised or a combination of conveyance improvements with less than one mile of levee raising.

Alternative 1 (NED plan) shows approximately 8 miles of levee raises.

Alternative 2 (recommended plan) relies upon widening the Sacramento Weir and Bypass, reducing the need to raise the levees identified in the NED plan. Less than one mile of levee raising would still be necessary.

Alternative 2 is recommended because it requires less raise construction and improves the operational flexibility provided by widening the Sacramento Weir and Bypass.

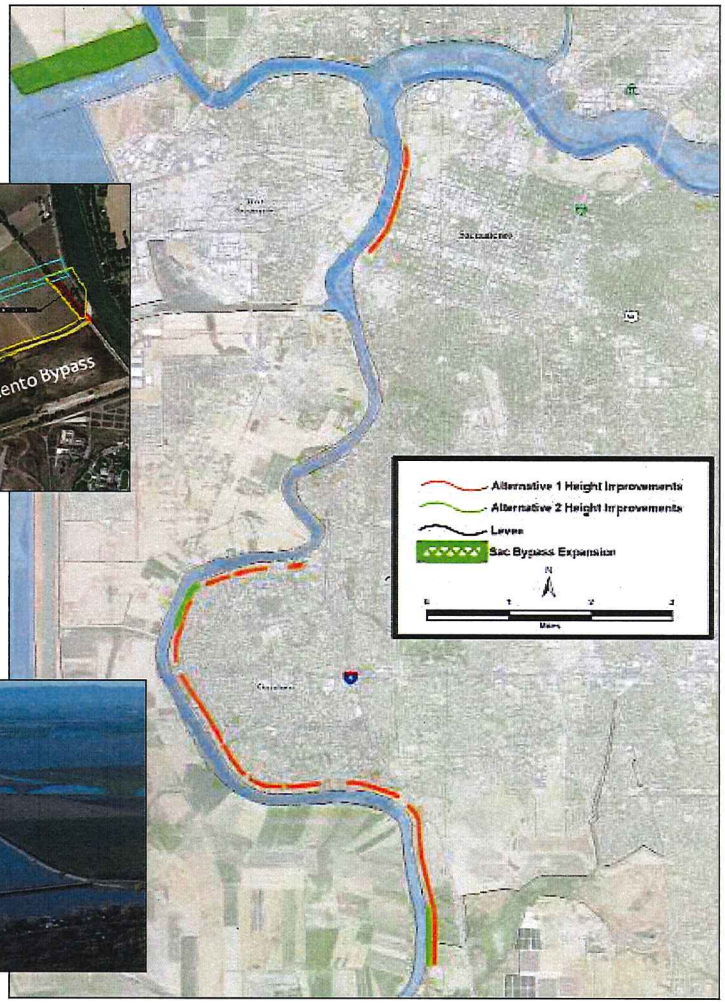


Levee Height:

Primarily addressed by raising levee with soil or constructing a floodwall on top of levee. In some cases, the need to increase levee height can be reduced by diverting flow away from the river such as by widening Sacramento Weir & Bypass.

ABOVE: Drawing of widened Sacramento Weir & Bypass

BELOW: Aerial of Sacramento Weir and bypass from Sacramento River

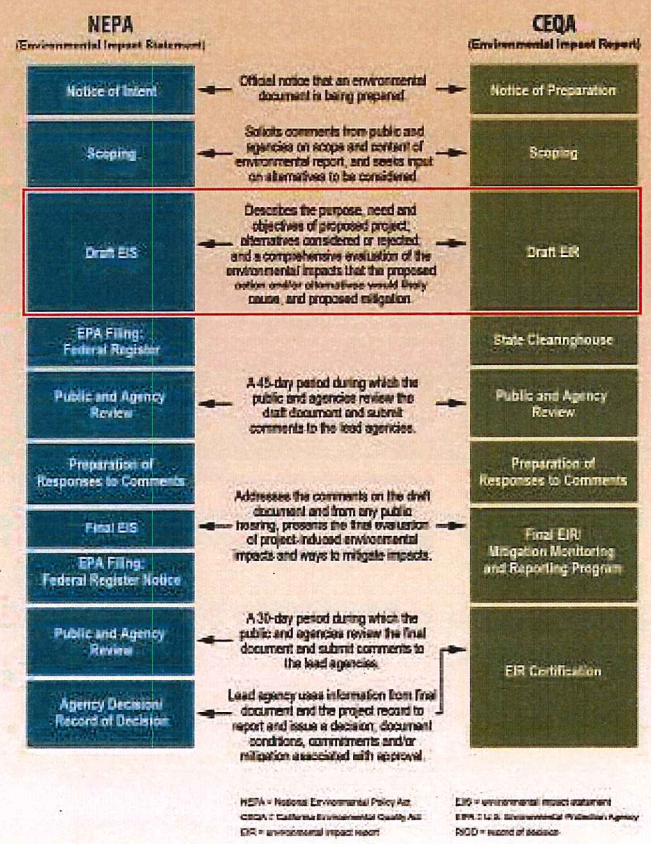


US Army Corps of Engineers.

SAFCA

NEPA/CEQA

Understanding the environmental review processes



Environmental Topics Addressed:

Air Quality, Noise, Traffic and Water Quality

- Temporary effects during construction.
- Best management practices and environmental commitments for construction will reduce localized construction effects.

Biological Resources

- Compliance with Corps Levee Safety policy requires vegetation to be removed from the levees, however:
  - Acquisition of a variance from the policy would allow vegetation to remain on the lower waterside slopes to protect habitat for listed species.
  - Locals will implement a Systemwide Improvement Framework (SWIF), to allow vegetation to be addressed on a "worst-first" basis.
  - Vegetation will only be impacted in the construction footprint; approximately the upper half of the levee slope.
- Vegetation removal could adversely impact listed species, such as the valley elderberry longhorn beetle and Swainson's hawk.
- Other construction activities could adversely impact giant garter snake, vernal pool crustaceans, and listed fish species such as salmon, steelhead, sturgeon, and Delta smelt.

Cultural Resources

- Potential effects on archaeological resources. A Programmatic Agreement between the Corps, the CVFPB, and State Historic Preservation Officer will govern the phased approach to comply with Section 106 of the National Historic Preservation Act.
- Ongoing coordination with tribal representatives will continue throughout implementation of the Programmatic Agreement.

US Army Corps of Engineers.

SAFCA

Public Comments Received on the ARCF GRR

A	Verbal Comments Received at Public Meeting on Wednesday April 8, 2015 at Joe Mims Jr. Community Center
B	Verbal Comments Received at Public Meeting on Thursday April 9, 2015 at Sacramento Elks Lodge #6
C	Verbal Comments Received at Public Meeting on April 15, 2015 at Sacramento Library Galleria
D	Verbal Comments Received at Public Meeting on April 17, 2015 at Arden-Dimick Library
E	Public Meeting Comment Card from Lissa McKee
F	Public Meeting Comment Card from Carolyn Baker
G	Public Meeting Comment Card from Ellen Broms
H	Public Meeting Comment Card from Mary M. Schwartz
I	E-mail from Dan Kopp
J	E-mail from Stan Jones
K	E-mail from Janet Fullwood
L	E-mail from James Geary
M	E-mail from Maggie Beddow
N	E-mail from United Auburn Indian Community of the Auburn Rancheria
O	Letter from the California Department of Transportation
P	Letter from the California Department of Fish and Wildlife
Q	Letter from the U.S. Department of the Interior
R	Letter from the Sacramento County Department of Transportation
S	Letter from the Sacramento Metropolitan Air Quality Management District
T	Letter from the California State Lands Commission
U	Letter from Tremaine & Associates
V	Letter from Tremaine & Associates
W	Letter from the Delta Stewardship Council
X	Letter from the Delta Stewardship Council
Y	Letter from the Delta Protection Commission
Z	Letter from the Metropolitan Water District of Southern California
AA	Letter from the U.S. Environmental Protection Agency
BB	Letter from the Central Valley Regional Water Quality Control Board
CC	Letter from the Sacramento Regional County Sanitation District
DD	Letter from Joseph E. O'Connor Jr.
EE	Letter from Friends of the River, Habitat 2020, and Save the American River Association
FF	Letter from Save the American River Association
GG	Letter from James Morgan
HH	E-mail from Gay Jones
II	Letter from the State Water Resources Control Board
JJ	Letter from Sacramento County
	Letter from Ken Cooley

PUBLIC MEETING FOR
NORTH SACRAMENTO STREAMS,
SACRAMENTO RIVER EAST LEVY,
LOWER AMERICAN RIVER,
AND RELATED FLOOD IMPROVEMENTS PROJECT

--oOo--

Wednesday, April 8, 2015
5:00 p.m.

--oOo--

Joe Mims Jr. Community Center
3271 Marysville Boulevard
Sacramento, CA 95834

--o0o--

PUBLIC COMMENTS

Reported by: CATHERINE D. LAPLANTE
CSR License No. 10140

COURT REPORTER DEPOT
Phone (877) 808-3376 Fax (973) 353-9445
www.courtreporterdepot.com

MS. MAXWELL: My name is Sandra Maxwell, S-A-N-D-R-A, M-A-X-W-E-L-L. I am a resident. I live on Verano Street. V, as in Victor, E-R-A-N-O, Street. It's --

How do I explain this?

Periodically we get high water. In '95 because of a tree falling down along -- further on down the creek, and then it rained like crazy, the house flooded, and I was out of my house for five months.

Luckily, my mother -- I mean, it was her house. A-1 I was living with her because she had Alzheimer's. Luckily she had flood insurance, so we were okay, except financially -- except we were out of the house for five months, and if you've ever dealt with an Alzheimer's patient, it's traumatic.

So all these years I've carried flood insurance. Now, I have been notified by the flood insurance people, FEMA, that I'm losing my discount, but there's no -- there's no explanation as to what happens after that loss.

So we came over tonight when Arcade Creek was mentioned. Runs along the back of the property. Was that going to effect us in any rate? Didn't really get that answered.

But I have a phone number and a name, and I'm

going to give him a call and see if they have any information.

The levy work that they're talking about does not appear to affect my house. It's not going to be in that area. It's to the west of us, which solves the problem of them cutting down trees, which I read that in the paper. That's not a worry.

I still don't know whether I'm considered in the flood plain or not, that the flood insurance people are concerned about.

A-1
(Cont.)

Is the work that they're going to be doing going to make the bank and the flood insurance people happier?

Is the City going to come in and clean all the silt out that has built up over the years?

I mean, it didn't rain very much in February, but the creek almost went over into my backyard because it's so shallow back there because of the crude buildup of silt.

So I solved the problem by being the squeaky wheel every year. I start in the spring, come clean the creek out, and in October they usually show up. They didn't this last year.

So that's where I'm at.

The City fenced off years ago, years ago fenced

A-1
(Cont.)

off the creek, so the homeowners can't get back there, and cut down weeds and clean up trash and do anything.

We can't get back there and get -- the City doesn't adequately take care of what they fenced off.

Okay.

THE REPORTER: Is there a number that they can reach you at?

MS. MAXWELL: Area code 916-922-3176. And they can --

I rarely answer the phone. If I don't recognize the phone number, I don't answer, but I will call back when they leave a message.

Okay. Thank you very much. Thank you.

(Conclusion at 7:00 p.m.)

REPORTER'S CERTIFICATE

I, CATHERINE D. LAPLANTE, a Certified Shorthand Reporter for the State of California, do hereby certify:

That I am a disinterested person herein; that the foregoing was reported in shorthand by me, CATHERINE D. LAPLANTE, a Certified Shorthand Reporter of the State of California, and thereafter transcribed into typewriting; that the foregoing is a true and correct record given.

IN WITNESS WHEREOF, I hereby certify this transcript at my office in the County of Placer, State of California, this 15th day of April, 2015.

_____

CATHERINE D. LAPLANTE, CSR #10140

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PUBLIC MEETING FOR
NORTH SACRAMENTO STREAMS,
SACRAMENTO RIVER EAST LEVY,
LOWER AMERICAN RIVER,
AND RELATED FLOOD IMPROVEMENTS PROJECT

--oOo--

Thursday, April 9, 2015
5:00 p.m.

--oOo--

Sacramento Elks Lodge #6
6446 Riverside Boulevard
Sacramento, CA 95831

--o0o--

PUBLIC COMMENTS

Reported by: CATHERINE D. LAPLANTE
CSR License No. 10140

COURT REPORTER DEPOT
Phone (877) 808-3376 Fax (973) 353-9445
www.courtreporterdepot.com

MS. NASON: My name is Beverly, B-E-V-E-R-L-Y. Last name is Nason, N-A-S-O-N. And I live at 6728 Benham, Way, B-E-N-H-A-M, Way, and that's 95831.

And my e-mail address is [redacted], [redacted].

And my comment is we have been at our house like 30, 35, 36 years, so we've gone through a lot of -- two times digging down the slurry.

Our house backs up to the levy, and so they've done two times with the -- down the middle of the levy, and if it rains a foot, which I'm grateful of.

B-1

I don't know how many years ago that was, the last incident, which quite made me come to this, is they put, I guess, erosion, the cement, the big barges came, and then they would dump the -- the big cement. I guess they were for erosion, which I was glad they were doing but didn't realize it was cracking our house, which it did.

We have a stucco house, and it got cracked.

I didn't know anything about it. I was just glad they were doing the work that I wouldn't get flooded again.

And my friend lived about half a mile in the new section, and they're three houses from the levy. Our house backs up to the levy. Hers, the new units,

are the levy, and they're three houses in. All three houses from the levy had cracked damage, and they were all fixed. They put in a complaint, and they were all fixed.

I did not know to do that, so that's why I'm here today, so in case that was going to happen again, I would know who to call.

So I appreciate the meeting tonight so that I'm a more-informed consumer. Yeah.

So that's what it's all about because I didn't get it done, and I should have because I was a victim of, but I'm glad to see it raised, glad to see it was not going to flood again.

B-1
(Cont.)

Glad everyone did it, but I wished I would have put in for the damage. I did have damage.

So now I have a card, and I will be able to -- if they do do that.

I didn't think it was going to be done again because they've done it, erosion correction, that's where the big cement, that's where the vibration cracked the houses, damage was done from the -- I guess the soil is such that --

So now I'm glad that we had this meeting.

Thank you.

* * * * * * * * * * *

MS. BIGELOW: Pamela Bigelow. B-I-G-E-L-O-W. Address [redacted], Sacramento, just the number [redacted]

The first thing I want to say is I have a walnut tree within 15 feet of the levy that I would like removed. It has the family of squirrels that live in it. You can replace it with another tree, that's just fine.

It is, however, on City property, but there are quite a few squirrels that have lived there for many, many years, so I'm sure there are a lot of burrows there.

B-2

Right behind it is a large oak tree, which they live in. The squirrels live in the oak tree because they eat the acorns, and they eat the walnuts.

Second thing is I'd like consideration for not having -- for not having a staging area on the big lot next to Marlton Court.

We had one there in the early '90s, and we think we've done our duty, so if you could please find another place for a staging area, we would very much appreciate it.

Third thing, which goes to the City of Sacramento, the cul-de-sac and levy need to have the grass cut on a monthly basis rather than an annual

B-2 (Cont.)

basis. The group of neighbors in our cul-de-sac is paying a gardener to cut the levy grass because it's a fire hazard, and it's dangerous, and people fall down the levy all the time because they can't see where they're going because the grass is so tall.

So we would like to request the grass be cut much more often.

That's it.

* * * * * * * * * * *

B-3

MS. SHORT: My name is Shirley. Last name Short, S-H-O-R-T, and I live along the river and brick yard, and I don't want to be contacted. There's no reason to.

I was just disappointed, that my impression was this was going to be a meeting tonight, and that there was going to be a presentation by the agencies involved, and we would have an opportunity to ask questions, and we have had an opportunity to ask questions, and they've provided a lot of really good information.

But I think a meeting where they gave us a presentation would have been more helpful to us, and some -- you know, some things to take away, some handouts would have also been more helpful.

I was disappointed. I thought this was going to be a meeting. That's what they told us it was going

B-3 (Cont.)

to be, so why didn't they have a meeting?

That's my comment.

* * * * * * * * * * *

MR. CARROLL: Craig, C-R-A-I-G, Carroll, C-A-R-R-O-L-L. [redacted].

My first concern is the vegetation, the existing vegetation that is on the water side of the levy behind my property.

Prior to any removal of the vegetation, will there be a report or a document available on which trees or which -- what vegetation will be removed prior to the removal in the event that I can challenge, legally challenge whether or not it meets the criteria of a hazardous tree or the question -- the reason for the removal.

B-4

I know the trees are tagged, and I would like to see in the proposal that these tag numbers be included on which trees will be removed and which trees won't be removed.

My piece of property is actually between Reach 15 and 16. That's the first concern.

And the second will be the privacy issue. Right now we're not allowed to have privacy fences because of the regulations on the fence sizes, heights, has to be see-through.

Whether or not there's going to be any screens or any sort of privacy protection, so while we're enjoying our pool or backyard during the construction phase of it, whether or not we just have to live with one or two, three months, however long the project is, of people in our backyard with little or -- giving us little or no privacy are my two biggest concerns.

So vegetation removal and the privacy issue are my two issues with this particular project.

Also, the existing permits, the use permits that we have on our piece of property, if they encroach -- for the encroachment permits, if they encroach into the area of the levy that will be constructed or affected by the construction, and it's required to be removed.

B-4
(Cont.)

A, who's going to pay for the cost of removal, and, B, whether or not it will be replaced after the construction's over, and the cost to that, and whether or not I'll have to reapply for a new permit, or if I can use the existing permit and reconstruct what was in there.

So the three issues are cost of removal, the cost of replacing it after the construction is over, and whether or not I will be able to get a permit, or if I can use -- if I'll have to apply for a permit all over

B-4
(Cont.)

again, or if I can just use the existing permit to repair what was removed.

(Conclusion at 7:00 p.m.)

REPORTER'S CERTIFICATE

I, CATHERINE D. LAPLANTE, a Certified Shorthand Reporter for the State of California, do hereby certify:

That I am a disinterested person herein; that the foregoing was reported in shorthand by me, CATHERINE D. LAPLANTE, a Certified Shorthand Reporter of the State of California, and thereafter transcribed into typewriting; that the foregoing is a true and correct record given.

IN WITNESS WHEREOF, I hereby certify this transcript at my office in the County of Placer, State of California, this 15th day of April, 2015.

_____

CATHERINE D. LAPLANTE, CSR #10140

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---oOo---

PUBLIC COMMENT TRANSCRIPT

SAFCA MEETING

APRIL 15, 2015

---oOo---

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JOHN LUNDGREN: On behalf of the county's regional parks director, Jeff Leatherman, I'm just a little bit concerned about a lack of specificity for the improvements along the American River because it makes it hard for us to evaluate the impacts to American River Parkway. We're specifically concerned about a loss of revenue from parkway fees and sales of annual passes, and we're concerned about a loss of use, meaning that that park won't be available for the regular users.

C-1

We agree with the draft document that the impacts to recreation will be significant and unavoidable, but we would like to see more specific mitigation with performance criteria. We're also concerned that the Campus Commons Golf Course will be impacted, and we're not sure we saw that in the document to date, and with past Corps projects in the parkway, we've experienced some confusing information from the contractor when directing parkway users around closed areas and would like extra effect and coordination in the future to work on a more consistent, unified public information system.

Okay. Now the comments are from me, so I'm representing the county's mining program. And the SAFCA portion of the project has several borrow sites identified. For those sites within unincorporated

C-2

C-2
(Cont.)

Sacramento County, they will need to obtain a borrow site permit pursuant to county code and the State Surface Mining and Reclamation Act, SMARA, S-M-A-R-A. Please leave enough time in the process to coordinate permitting with the county. We're available to assist with early consultation to streamline the process.

Some of the areas may not require a borrow permit, but still will require a grading permit. If the specific impacts of that grading are not analyzed in this document, you will need to leave time in the process for analyzing them under a future CEQA document. There's a potential borrow site identified in the Dry Creek Parkway. Please be aware that the area is particularly sensitive for cultural resources and may be regulated by the Dry Creek Parkway Plan.

COURT REPORTER'S CERTIFICATE

STATE OF CALIFORNIA)
) ss.
COUNTY OF PLACER)

I, Lindsey R. Perry, hereby certify:

I am a duly qualified Certified Shorthand Reporter, in the State of California, holder of Certified Shorthand Reporter Certificate No. 12806 issued by the Court Reporters Board of California and which is in full force and effect.

I am the reporter that stenographically recorded the comment in the foregoing transcript, and the foregoing transcript is a true record of the comment given.

Dated: April 27, 2015

LINDSEY R. PERRY, CSR NO. 12806, CRR, RPR

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---o0o---

SAFCA & US ARMY CORPS OF ENGINEERS

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SACRAMENTO, CALIFORNIA 95834

FRIDAY, APRIL 17, 2015

5:00 P.M.

---o0o---

REPORTED BY: JILLIAN M. SUMNER, CSR No. 13619

COURT REPORTER DEPOT
Phone (877) 808-3376 Fax (973) 353-9445
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BE IT REMEMBERED, that on Friday, April 17th, 2015, commencing at the hour of 5:00 p.m., at the Dimick Library, 891 Watt Avenue, Sacramento, California before me, JILLIAN M. SUMNER, a Certified Shorthand Reporter in and for the county of Sacramento, state of California, was present and recorded verbatim the following proceedings:

COMMENTS BY THE PUBLIC:

(Comments made by Pat Hara and Jack Burrows, collectively:)

PAT HARA:

D-1

Basically, we live in -- what is it -- Walnut View Estates. That's off of Sierra Boulevard. And my flood insurance goes up 100 bucks a year, $1,700. And I'm going, that's just -- what can we do?

So we talked to Pete about the issues of the flooding in that area and the drainage issues, and I need to find a way to get my flood insurance down, if at all possible.

JACK BURROWS:

What Pete was telling us was that what was really required is a larger pump capacity. But the cross-benefit analysis is not there. So he's recommending that we get something from the County, meet with a man by the name of George Booth to evaluate her elevation.

Because I'm not paying any flood insurance in my home. I have another home a few houses down that I'm paying 400 and something. Jane is paying -- across the street from me -- paying 400 and something.

D-1
(Cont.)

PAT HARA:

And the kids are right next to the canal. So, yeah, that's the issue.

We originally wanted to have to put up another Cal Expo to pump water out of the slough when the water backs up. But obviously that's not going to work. We have too many issues working against us there.

JACK BURROWS:

So Pete said to bring the comment to your attention, and he'll bring it to the County's --

D-1 (Cont.)

George Booth and the County to see if there's anything we can do. And we'll bring it to his attention also.

Thank you.

(Next commenter:)

JUDITH SCOTT:

I just wanted to say everybody was very helpful and friendly, and I love the charts. And several people answered a lot of questions that we've had.

D-2

And another neighbor came in, and we picked Pete's brain, and heard we're supposed to talk to George -- somebody.

It was all very well done and everybody was very helpful. We got our questions answered. But we're not as affected as the other people here are.

(Whereupon, the meeting concluded at 7:00 p.m.)

REPORTER'S CERTIFICATE

STATE OF CALIFORNIA)
) ss
COUNTY OF SACRAMENTO)

I, JILLIAN M. SUMNER, a Certified Shorthand Reporter, licensed by the state of California and empowered to administer oaths and affirmations pursuant to Section 2093 (b) of the Code of Civil Procedure, do hereby certify:

The said proceedings were recorded stenographically by me and were thereafter transcribed under my direction via computer-assisted transcription;

That the foregoing transcript is a true record of the proceedings which then and there took place;

That I am a disinterested person to said action.

IN WITNESS WHEREOF, I have subscribed my name on April 25, 2015.

_____
JILLIAN M. SUMNER
Certified Shorthand Reporter No. 13619

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US Army Corps of Engineers.

Public Comment Sheet

NAME: Lissa McKee PHONE: [redacted]

POA for Ann McKee

ADDRESS: [redacted]

E-MAIL: [redacted]

we have no dock
we have erosion

COMMENT/QUESTION: we are interested in restoration of cottonwood

US Army Corps of Engineers.

Public Comment Sheet

NAME: Carolyn Baker PHONE: [redacted]

ADDRESS:

E-MAIL: [redacted]

COMMENT/QUESTION:

Very concerned about vegetation removal - trees, shrubs + habitat for threatened / endangered species. Hopeful ACE will rethink philosophy & allow maximum / most of veg to remain. Prefer SAFCA approach. ACE needs to update its printed materials (poster boards) to reflect more enlightened reality, not "slash & burn" mentality that all veg in footprint will be removed. Hope SAFCA gets there first & gets the job done.

G

US Army Corps of Engineers

Public Comment Sheet

NAME: Ellen Broms PHONE: [redacted]

ADDRESS: [redacted]

E-MAIL: [redacted]

COMMENT/QUESTION: I am a senior and not in the best health I am concerned about the proposed staging area behind my house. Please don't have it there. That is my major concern. ALSO, The trees (walnuts orange) + the grassy area at the foot of the area are a concern as well. What does SAFCA propose to do about that + other vegetation that attracts burrowing animals like squirrels + vole.

H

US Army Corps of Engineers

SAFCA

Public Comment Sheet

NAME: Mary M. Schwartz PHONE: [redacted]

ADDRESS: [redacted]

E-MAIL: None

COMMENT/QUESTION:

I Live across, At the corner of Ironwood + Riverdale Way + have since 11/70. I Did not get a notice, I Found the Meeting and the presenters knowledgeable + interesting: The big black mark is Not all residents - including me - can walk about + stand For 5+ minutes + speak to a Presenter, I thought public information meetings had to be handicapped friendly

~~The City Councilmember District ... Jennings is not here~~

I would like clarification that the levy system in the worst or N in the USA and now "the powers to be" say it can't be fixed until 2017!

If I can help get this through sooner some - let me know!

1/1/15

From: Dan Kopp [redacted]
Sent: Tuesday, April 07, 2015 3:35 PM
To: Baker, Anne E SPK
Subject: RE: [EXTERNAL] American river Common Features Project (UNCLASSIFIED)

I

Hi Anne,

I already sent the following question/comment to a DWR contact several days ago; I made it a bit less caustic at the end for you:

My home abuts the levee on the south side of the American River Parkway bewteen Howe and Watt Ave., and I noticed trees were tagged several years ago, I believe 30 feet away from the toe on the river side and 20 feet or so on the residential side; does this project intend to remove trees? If so, how many and why?

I-1

If there is a tree removal component to this project, have measures been put in place to manipulate vegetation outside the breeding season for birds (starting in January for Great-horned Owls and Anna's Hummingbirds; beginning late February/early March for songbirds and continuing through August)? I can see an active Swainson's Hawk nest from my living room, and there are noise buffers that are usually put in place for this listed California Threatened species.

I-2

Also, I noticed at the bottom of page 13 of the Environmental Site Assemssment, under Sacramento East Maps, the last bullet states:

The Sacramento East map of 1975 was a photo revision of the 1967 edition and added a crossing at Howe Road.

I am a firm believer in getting the small details correct, especially in a project like this, so when I see that Howe Avenue was mis-named as Howe Road, even though it was correct in the bullet right above, it makes me wonder if any other details were mixed-up in the analysis.

I-3

Anyway, those are my main concerns: unnecessary tree removal (from my perspective) and limbing/tree removal during the avian nesting season.

The comment reflects my duties as an editorial board member for the Central Valley Bird Club Bulletin, where I read every word to help ensure everything is as grammaticaly and factually correct as possible. It is not meant as a personal attack; just an observational extrapolation.

Thanks,

Dan Kopp

Sacramento

> From: Anne.E.Baker@usace.army.mil
> To: [redacted]
> Subject: RE: [EXTERNAL] American river Common Features Project (UNCLASSIFIED)
> Date: Tue, 7 Apr 2015 21:39:09 +0000
>
> Classification: UNCLASSIFIED
> Caveats: NONE
>
> Hi Dan,
>
> You can send your comments to me via e-mail. I will look forward to seeing them!
>
> Thank you,
>
>
> Anne E. Baker
> Environmental Manager
> Environmental Analysis Section, Planning Division
> Sacramento District, US Army Corps of Engineers
> 1325 J Street
> Sacramento, CA 95814-2922
> (916) 557-7277
>
>
>
> -----Original Message-----
> From: Dan Kopp [redacted]]
> Sent: Tuesday, April 07, 2015 2:10 PM
> To: Baker, Anne E SPK
> Subject: [EXTERNAL] American river Common Features Project
>
> Anne,
>
> Can I send my comments about the DEIS/DEIR via email or do I need to send them in the regular mail?

>
> Thanks,
>
> Dan Kopp
> Sacramento
>
>
> Classification: UNCLASSIFIED
> Caveats: NONE
>
>

From: Stan Jones [redacted]]
Sent: Friday, April 10, 2015 12:10 PM
To: Baker, Anne E SPK
Cc: Stan Jones
Subject: [EXTERNAL] Sac. River Levee Work

J

Hi,
Thank you for providing an opportunity to comment on the proposed levee upgrades. I have a few thoughts on this.

The public should be able to see what we're getting for the millions & millions being spent. I propose some "viewing areas" along the levee during the work, to see what's being done. These should be accessible to the public. Maybe a sign or 2 explaining what is being done.

J-1

Get rid of all the gates & fences that criss/cross the levees in South Sacramento. They are an "attractive nuisance" to kids, who have been seen climbing on them. Some fences have barbed wire, another has 'concertina wire' at the top. This could be a huge liability. Most all of the fences can be bypassed by walking down to the water's edge and going around them, so they don't really accomplish anything. Most of the fences do not have legally valid permits anyway. Removal of all the gates & fences will certainly make the repair work easier and more efficient.

J-2

There are a number of dead & sick trees along the Pocket and Little Pocket areas of the levee. Also a number of trees infested with mistletoe that need attention. Were any of these dead trees to topple over in a storm, they might take out a huge rootball of dirt and rock, and leave a large gaping hole in the side of the levee. This work should receive a high priority.

J-3

I live 3 blocks from the Sacramento River, and enjoy walking and bike riding on the levee, and kayaking on the Sacramento River. We are very much in favor of stronger levees! I'd be happy to provide additional information to you if requested.
Best Regards,

Stan Jones

K

From: Janet Fullwood [redacted]
Sent: Friday, April 10, 2015 5:08 PM
To: Baker, Anne E SPK
Subject: [EXTERNAL] public comment - levee reinforcement

Hello there - I would like to submit the following public comments regarding levee improvements in the Pocket Area. Would you please forward to Tyler Stalker, who is evidently the person collecting them? That's who the hand-out forms on the table at the Elk's Club last night were addressed to. But email is much more efficient than filling out a form by hand and mailing by snail mail.....

Name: Janet Fullwood
Address: 6470 Surfside Way 95831
Phone: 916.718.5666
Email: jfullwood@me.com

Comment No. 1:

The last round of levee reinforcement, in 2007, stopped at my house on the downstream end (My property is at the intersection of Surfside and Cruise Way). Only one time since has the river come up high enough for the effectiveness of the repairs to be tested, that being during the high-water winter of 2010-2011. Before the reinforcement, water seeped and weeped from the sidewalks in front of every river-side house on my block. This last time: every sidewalk on the street was dry except mine, which wept just as badly as before. I also had water pooled under my house that had to be pumped out via the sump installed after the 1997 floods that brought eight inches of water under my house (neither federal or homeowners flood insurance would pay for repairs by the way; hydrostatic seepage is not covered, only breaches in the levee). Evidently the water is creeping in through angled sediments. Please make note of this and get in touch if you need more detail.

K-1

Comment No. 2:

During the 2007 repairs, new sod was planted on the river side of the levee. Unfortunately, what came up was two species of spear grass, colloquially known as foxtails, that are lethal to animals. Every farmer and rancher in the state is trying to get rid of this invasive, unwanted stuff, and we get stuck with a sea of it. The explanation I've gotten is that the seeds were embedded in "imported" soil. Imported from where, I don't know, but these invasive species are an unwelcome hazard. Last year, the levee was not mowed until after the awns had set and it was bad news for a number of pets that were infected and incurred huge vet bills.Who knows how many wild animals were hurt, too?. When the next round of repairs is made, can we please kill that stuff off and replant with certified weed-free native grasses? Something needs to be done; it's s shameful situation.

K-2

That's all for now. My thanks to all the Corps and SAFCA and city representatives who turned out last night at the Elk's Lodge and for all the great graphics and explanations.

Sincerely,

Janet

L

From: James Geary [redacted]]
Sent: Saturday, April 11, 2015 12:38 PM
To: Baker, Anne E SPK
Subject: [EXTERNAL] Public Workshop with SAFCA & the Army Corp of Engineers at Elk's Lodge #6, 4/14/15

As part of these projects, neither SAFCA or the Army Corps should replace any of the nine fences that presently cross the levees in the Pocket areas. None of the fences are in compliance with their permits and most of the permits are not held by the present homeowners. No government agency should be engaged in replacement of obstructions on the levee that are illegal and add to the danger of the flooding in the Pocket area.
James Geary
[redacted]

From: Maggie Beddow [redacted]
Sent: Sunday, April 12, 2015 3:03 PM
To: Baker, Anne E SPK
Subject: [EXTERNAL] SAFCA public comment feedback

M

Hello Ms. Baker,

I am writing to provide SAFCA public comment on the upcoming levee project. As a resident of Sacramento and the Pocket community, I would like to strongly urge that the fences across the levee NOT not be replaced during this levee improvement as each one of those fences are illegal and/or are not properly permitted by SAFCA. Replacing the illegal fences will only further exacerbate community concerns about levee access, impartiality, and objectivity. With this new levee project, SAFCA has a perfect opportunity to not only save taxpayer dollars, but to also disengage in any activity that replaces illegal fences with more illegal fences.

Thank you for your consideration.

Respectfully submitted,

Dr. Maggie Beddow, Pocket resident

N

From: Marcos Guerrero [redacted]
Sent: Thursday, April 16, 2015 4:00 PM
To: Montag, Melissa L SPK; Erin.Brehmer@water.ca.gov; Baker, Anne E SPK
Cc: Jason Camp; Danny Rey; TribalpreservationDG
Subject: [EXTERNAL] DEIR/DEIS ARCF General Reevaluation Report, CVFPB

Hello All, please see UAICs comments to the DEIR ARCF General Reevaluation Report, CVFPB, Sacramento County, Ca.

After an internal review of the project documentation the DEIR/DEIS for the Project has some significant deficiencies beyond those already noted.

1. DEIR/DEIS does not appear to contact an Environmentally Preferred Alterative that is required under CEQA Guidelines 15126.6(e)(2) and NEPA. The tribe would like to be allowed to microsite or get other design features incorporated to reduce the potential for direct cultural impacts. N-1 N-2

2. UAIC left out of DEIR/DEIS analysis as Tribe, government or partner. There is no discussion of the Tribe/tribal values in areas of controversy, construction timing, project and alternatives screening criteria (i.e., a tribal burial mound avoidance alternative), environmental commitments for cultural resources, social effects, environmental justice or identified as a viewer group for visual impacts. The UAIC requests to be allowed to participate in the EIR analysis. N-3 N-4 N-5

4. On Alternatives, it appears that very little consideration was given to any others. The rationale for rejecting other design features and preservation in place falls short of what the Tribe considers a minimum level of effort. The Tribe requests a complete and full analysis of such preservation in place and avoidance alternatives as setback levees, and seepages and stability berms. N-6

5. If the USACE/CVFPB materially revises any section of the DEIR/DEIS then the document should be recirculated. USACE/CVFPB shall evaluate, determine effects, and develop treatment before the project construction activities begin. The tribe does not consider data recovery appropriate which is in fact a negative effect and direct impact to the cultural resources. The DEIR/DEIS addresses solely scientific archeology, there is zero discussion regarding tribal cultural values, sanctified cemeteries, or cultural landscapes. Include a section on why preservation in place is a feasible alternative. DEIR/DEIS does not admit that human remains could be impacted and that state law would be followed. N-7 N-8 N-9 N-10

6. The DEIR/DEIS also will any new sections on PG&E utility relocation be in the DEIR/DEIS? Especially of this work includes use of cranes, land leveling, poll removal and relocation, tree replanting and vegetation removal - all activities that could have significant impacts on cultural resources. N-11

7. The cumulative impact section is wholly deficient and also contains improper analysis such as cultural resources are typically not subject to cumulative effects which is unsupported in CEQA/NEPA. Yet DEIR/DEIS then admits impacts are cumulatively significant but then offers no mitigation for that impact. Again, there is no mention of tribes or cultural landscapes, the latter is especially relevant when dealing with cumulative effects or effects across several phases or projects over wide geography. N-12

8. Specific borrow and staging sites were not identified in the DEIR/DEIS. N-13

9. Will there be a section on Wetland delineation. N-14

10. will the project be avoiding FEMA land use restrictions and are barges included in the project - use of barges could help to reduce impacts on cultural resources? N-15

11. Other interesting points, we would like to discuss are:

· Admits no further federal action assumed, raises question of whether feds could assume the project without reopening the environmental review; N-16

· No analysis of vibration or compression effects on project on cultural resources; N-17

· No analysis of vegetation impacts that relate to native or cultural plants including those that might have been part of the burial mounds or part of the tribal cultural landscape; N-18

· Will there be conservation bank purchased for giant garter snake - why not for cultural landscape; N-19

· Please note that post approval technical studies are not okay; N-20

· No section in climate change discussing whether it makes sense to raise structure instead of hardening levees. N-21

· No text references to NPS Bulletin 38 (TCPs) or ACHP guidance on cultural landscapes, document takes a very stilted view of what Section 106 means. We understand this may be in the DEIS, yet to be developed, but it would be good to include the important of place, setting, landscape, to the Tribe. N-22

· NAHC not listed as a trustee agency. N-23

We will also be submitting additional comments and would like to schedule a government to government meeting to discuss this project.

Marcos Guerrero, RPA

Cultural Resources Manager

United Auburn Indian Community of the Auburn Rancheria

[redacted]

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DEPARTMENT OF TRANSPORTATION
DISTRICT 3 – SACRAMENTO AREA OFFICE
2379 GATEWAY OAKS DRIVE, STE 150 – MS 19
SACRAMENTO, CA 95833
PHONE (916) 274-0635
FAX (916) 263-1796
TTY 711

Serious drought.
Help save water!

April 27, 2015

032015-SAC-0059
03-SAC-50 / PM 3.6
SCH# 2005072046

Ms. Alicia E. Kirchner
Environmental Resources Branch Sacramento District
U.S. Army Corps of Engineers,
1325 J Street
Sacramento, CA 95814-2922

American River Water Shed Common Features, General Reevaluation Report - Draft Environmental Impact Statement, Environmental Impact Report (DEIR/EIS)

Dear Mr. Johnson:

Thank you for including the California Department of Transportation (Caltrans) in the environmental review process for the project referenced above. Alternative 1 of the project involves the construction of fix-in-place levee remediation measures to address seepage, slope stability, erosion, and overtopping concerns. Alternative 2 of the project seeks to improve levees and widen the Sacramento Weir and Bypass. The study area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Dry, Robla, and Arcade Creeks and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento.

Caltrans new mission, vision, and goals signal a modernization of our approach to California's transportation system. We review this local development project for impacts to the State Highway System (SHS) in keeping with our mission, vision, and goals for sustainability/livability/economy, and safety/health. We provide these comments consistent with the State's smart mobility goals that support a vibrant economy, and build communities, not sprawl. The following comments are based on the DEIR/EIS.

Levee Stability

Caltrans recognizes the importance of levee improvements to the mobility of travelers using the SHS. The continued stability of the levee is necessary to prevent a complete levee failure, which would result in the harm, and perhaps total destruction of a highway segment. Additionally, levee work is necessary to prevent seepage, which could undermine a substantial section of the adjoining highway.

Bridge Structures and Maintenance

Below is the list of bridges in Sacramento County in which Caltrans has identified as scour critical. A complete modeling of any affected bridge may be required for Alternatives 2 and 3.

O-1

Bridge No.	Feature Intersected	Dist	Cnty	Route		Mile Post	Insp Date	Structure Name
240001L	**AMERICAN RIVER**	**03**	**SAC**	**00160**	**R**	**44.47**	**05/28/2013**	**AMERICAN RIVER (160 SB)**
24 0020L	COSUMNES RIVER	03	SAC	00099		8.40	01/29/2014	COSUMNES RIVER
24 0020R	COSUMNES RIVER	03	SAC	00099		8.40	01/29/2014	COSUMNES RIVER
24 0021R	COSUMNES RIVER OVERFLOW	03	SAC	00099		7.92	01/29/2014	COSUMNES RIVER OVERFLOW
24 0045L	LAGOON CREEK	03	SAC	00099		4.98	01/24/2014	LAGOON CREEK
24C0004	COSUMNES RIVER	03	SAC	00000		.00	04/09/2013	COSUMNES RIVER
24C0080	ARCADE CREEK	03	SAC	00000		.00	01/16/2014	ARCADE CREEK
24C0293	ELDER CREEK	03	SAC	00000		.00	11/18/2014	ELDER CREEK
24C0328	CHICAGO CREEK	03	SAC	00000		.00	04/15/2014	CHICAGO CREEK

O-2 Caltrans routinely inspects bridges for the purposes of bridge maintenance. Therefore, bridge engineers and other authorized workers require access to the underside of the bridges. In the path of levees or flood wall height increases, a Caltrans-approved method of bridge access needs to be designed and installed.

O-3 A bridge embankment seepage analysis, including any mitigation, needs to be submitted to Caltrans for review.

O-4 Any new bridge or existing bridge modification needs to be designed based on the current Caltrans Bridge design codes.

O-5 Flood walls or levees cannot exceed the bridge embankment in height proportionally.

Construction Traffic

As identified by this project's traffic study, this project plans to transport 1 million yards of borrow material and 2.8 million tons of rock for construction. The construction period is estimated to take approximately 10 years. As the result, there will be substantial increases in traffic on local roadways associated with truck haul trips during construction activities. In addition, traffic controls would cause, or contribute to, temporary substantial increases in traffic levels and speed differentials on several roadways, as traffic is detoured or slowed. Traffic controls could cause delays particularly during the morning and evening peak commute hours.

O-6 The project sponsor would require the contractor to prepare a Traffic Control and Road Maintenance Plan to address its construction traffic impacts. Caltrans requests the project sponsor to haul its building materials by barges as much as possible to reduce truck trips. If the building materials could be hauled by barges, this would reduce the project's traffic impacts significantly. Caltrans would like to review the Traffic Control and Road Maintenance Plan.

Bicycle and Pedestrian Travel on Levees

O-7 The Pocket levees are a well-used recreational and commute bicycle route. Please consider providing convenient alternate means of travel for bicyclists and pedestrians during construction of the levees. Also, please consider providing for connected bicycle and pedestrian access along the levees following construction. The levee paths provide important parallel alternatives for non-motorized travel and help reduce demand on the SHS.

O-8 Please provide our office with copies of any further actions regarding this project. We would appreciate the opportunity to review and comment on any changes related to this development.

If you have any questions regarding these comments or require additional information, please contact Larry Brohman, Intergovernmental Review Coordinator, at (916) 274-0627 or by email at: larry.brohman@dot.ca.gov.

Sincerely,

ERIC FREDERICKS, Chief
Office of Transportation Planning – South

c: Scott Morgan, State Clearinghouse

State of California - Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
North Central Region
1701 Nimbus Road, Suite A
Rancho Cordova, CA 95670-4599
916-358-2900
www.wildlife.ca.gov

P

April 27, 2015

Erin Brehmer
Department of Water Resources
3464 El Camino Avenue Room 200
Sacramento, CA 95864

Subject: DRAFT ENVIRONMENTAL IMPACT ASSESSMENT/ENVIRONMENTAL IMPACT REPORT FOR THE AMERICAN RIVER COMMON FEATURES PROJECT, SCH # 2005072046.

Dear Ms. Brehmer:

The California Department of Fish and Wildlife (Department) has reviewed the draft environmental impact statement/draft environmental impact report (DEIS/DEIR) from the Army Corps of Engineers (ACOE) and the Central Valley Flood Protection Board regarding the American River Common Features Project (Project).

As a trustee for California's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species (Fish & G. Code, § 1802). The Department may also act as a Responsible Agency (Cal. Code Regs., § 21069) for a project where it has discretionary approval power under the California Endangered Species Act (CESA) (Fish & G. Code, § 2050 et seq.) and the Lake and Streambed Alteration (LSA) Program (Fish & G. Code, § 1600 et seq.). The Department also administers the Native Plant Protection Act (NPPA), Natural Community Conservation Program (NCCP), and other provisions of the Fish and Game Code that afford protection to California's fish and wildlife resources.

The Department offers the following comments and recommendations for this Project in our role as a trustee and responsible agency pursuant to the California Environmental Quality Act (CEQA).

PROJECT DESCRIPTION AND ALTERNATIVE ANALYSIS

The Project intends to reduce the overall flood risk within the city of Sacramento and surrounding areas. The DEIS\DEIR identifies three alternatives, the No Action Alternative, Alternative 1 Improve Levees, and Alternative 2 Improve Levees and Widen the Sacramento Weir and Bypass (Tentatively Selected Plan).

Alternative 1 involves the construction of fix-in-place levee remediation measures to address seepage, slope stability, erosion, and overtopping concerns identified for the

American and Sacramento River, Natomas East Main Drainage Canal, Arcade, Dry/Robla, and Magpie Creek levees. A vegetation variance would be sought to allow for vegetation to remain on the lower portion of the waterside levee slope.

Alternative 2 would include all of the levee improvements discussed in Alternative 1, except levee raises along the Sacramento River would be included to a lesser extent. Instead of the full extent of levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The levees along the American River, NEMDC, Arcade, Dry/Robla, and Magpie Creek, would be improved to address identified seepage, stability, erosion, and height concerns. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns. A small amount of levee raising would be required on the Sacramento River. Due to environmental, real estate, and hydraulic constraints within the study area, the majority of the levees would be fixed in place.

ENVIRONMENTAL SETTING

The final environmental document should include a complete assessment of the existing biological conditions within the Project area including but not limited to the type, quantity and locations of the habitats, flora and fauna. Adequate mapping and information regarding the survey efforts should be included within the document. The DEIS\DEIR only identifies impacts to riparian habitat. The environmental document needs to clarify what type of riparian habitats will be impacted by the proposed Project. The Department recommends the use of A Manual of California Vegetation 2nd Edition (Sawyer and Keeler-Wolf 1995, and Sawyer, Keeler-Wolf and Evens 2009).

P-1

To identify a correct environmental baseline, the final EIS/EIR should include a complete and current assessment of the habitats, flora, and fauna within the Project area. The DEIS\DEIR lacks analysis of other sensitive species, and locally unique species such as but not limited to white-tailed kite (*Elanus leucurus*), burrowing owl (*Athene cunicularia*), Cooper's hawk (*Accipiter cooperii*), purple martin (*Progne subis*), Sanford's arrowhead (*Sagittaria sanfordii*), woolly rose-mallow (*Hibiscus lasiocarpos*).

CEQA guidelines Section 15125, subdivision (c) requires lead agencies to provide special emphasis to sensitive habitats and any biological resources that are rare or unique to the area.

IMPACT ANALYSIS AND MITIGATION MEASURES

Sensitive Species and Habitats

The final EIS/EIR should include an impact analysis to other sensitive species as identified in the Environmental Setting Section that could be present within the Project limits and could be impacted by the proposed Project. Avoidance, minimization, and/or mitigation measures should be proposed if any potential significant impacts to other sensitive species and/or their habitats are identified. The Department recommends that

P-2

P-2 (Cont.) maps showing the different habitats and the Project impacts are included in the final environmental document.

Fisheries

The Department is concerned that Project impacts caused by widening the Sacramento Weir and Bypass are not fully analyzed in the DEIS/DEIR. An impact analysis with respect to the potential entrainment of adult and juvenile listed fish species should be included in the environmental document. The DEIS/DEIR should analyze how listed fish species are able to egress out of the Sacramento Bypass to continue their migration once entrained. This is especially important since the document does not include any activities that could reduce the entrainment potential within the Sacramento Bypass.

P-3 The operation of the weir directly alters juvenile salmonid emigration routes. Juvenile salmonids have access to the Sutter bypass when the Sacramento bypass is active, increasing the length of the Sacramento Bypass weir will provide a greater chance of juvenile entrainment in both bypasses. While it is shown that some salmonids may use the bypasses to rear when given access (wet years), some juvenile salmon become trapped in swales within the bypasses when flows recede. The Department frequently performs fish rescue activities within the Project area where sturgeon and salmon species are relocated from swales and depressions present within the Project vicinity. The Department recommends that the proposed Project include activities to eliminate swales and depressions that could strand and isolate fish species within the Sacramento Bypass. Any areas that may be flooded as a result of this Project should be designed in a way that the area will drain completely to avoid the creation of predatory fish habitat.

P-4 The Department is concerned about placing rock boulders at erosion sites along the Sacramento and American Rivers. Rock boulders constitute good habitat for predatory fish species that prey on juvenile listed species. The EIS/EIR should analyze potential impacts caused by the installation of rock boulders within the wetted portions of the levees. Additional avoidance, minimization and/or mitigation measures should be proposed if these impacts are deemed significant.

P-5 The DEIS/DEIR states that the ACOE will request a vegetation variance so the waterside vegetation on the lower one-third of the waterside of the levee will be protected along American and Sacramento Rivers. The Department recommends that the EIS/EIR describe what would occur if the variances are not obtained.

P-6 The Department recommends that the EIS/EIR includes specific mitigation measures to offset the proposed Project long term effects to listed fish species. The Department recommends that filling existing swales within the Sacramento Bypass is included in the DEIS/DEIR as a potential mitigation measure to offset long term effects to listed fish species.

Sacramento Weir and Bypass

P-7 The DEIS/DEIR states that the expansion of the Sacramento Weir will impact rice fields and canals. There is no rice grown in the 1,550 feet footprint north of the bypass levee only dryland annual row crops in this area. Please revise the document accordingly. The

P-8 Department recommends that the new area that will be added to the Sacramento Bypass is incorporated to the existing wildlife area to enhance recreational activities and to provide a consistent land management of the Sacramento Bypass.

P-9 The Sacramento Bypass Wildlife area is a great asset to the public and gets over 1,500 user days per year. It is very important that the recreation opportunities are not affected by the Project. If impacts to recreational wildlife viewing, hunting, and fishing aspects are determined significant additional mitigation is required. Please contact the Department to develop specific measures to ensure that recreation activities are not impacted by the Project. If the main parking lot located at the north levee of the Sacramento Bypass will be impacted by the Project, alternative public parking should be proposed on the new north levee to enhance parking and public access to the area.

P-10 Major hunting seasons and high use days expand from September 1st until January 31st. The Department recommends that construction around the Sacramento Bypass should avoid this timeframe as much as possible. In addition to this, turkey hunting season starts in mid-March and extends until May.

P-11 The final environmental document should include specific information regarding what activities will occur within the over 300 acres that will be impacted by the widening of the weir. The canals constitute a valuable habitat for species like giant garter snake (GGS) (*Thamnophis gigas*) and potential Project related impacts should be disclosed in the final environmental document. The Department is concerned that leaving land that will

P-12 only be flooded sporadically will promote the introduction of invasive species in the area. The EIS\EIR should include specific impact analysis and proposed additional avoidance, minimization, and/or mitigation measures to offset these impacts.

P-13 The Department recommends that any depressions created by the Project within the land that will be added to the Sacramento bypass should be filled to avoid listed fish entrainment. The new area that will be added to the bypass should be sloped to the south to allow fish to find the toe drain when flows subside in the bypass.

P-14 The DEIR should include additional information about the future north levee within the Sacramento Bypass to better analyze any impacts to listed species from the Project action. The Biological Assessment (BA) also identifies a hazardous, toxic, and

P-15 radiological waste site near the existing north levee. The environmental document should include an impact analysis of the remediation activities that will be conducted as part of the Project.

Borrow sites

P-16 Figure 2 of the BA shows potential for borrow sites in the Yolo Bypass. There is a potential for environmental damage to the Yolo Bypass Wildlife Area (YBWA) as a borrow site. The EIS\EIR should include information about the borrow sites and analyze the potential impacts caused by the borrow sites. Additional avoidance, minimization, and/or mitigation measures may be required to offset borrow sites impacts. These borrow sites could be in conflict with requirements for the 2009 National Marine Fisheries Service Operational Criteria and Plan Biological Opinion for the Yolo Bypass.

P-17 The BA also states that the "borrow sites would be returned to their existing use whenever possible, or these lands could be used to mitigate for Project impacts, if appropriate." The EIS/EIR needs to include information of the existing condition in the proposed borrow sites and proposed specific mitigation measures. Restored borrow site habitat should not count as mitigation for riparian habitat removed during Project operations.

P-18 Borrow sites should not occur along side of levees, in river channels, flood plains or bypass areas. As water recedes after flood events, all fish species are subject to becoming entrained in borrow pits.

The Department also has the following specific comments:

DEIS/DEIR

P-19 1. Page, 61, Section 3.3.1: The DEIS\DEIR should include that the Sacramento Bypass is operated by the Department as a Wildlife Area and provides access to the public.

P-20 2. Page 102, Section 3.6.1: Please replace "Refuge" with "Area". Please change the word throughout the document. If the additional land incorporated to the Sacramento Bypass becomes open space it could potentially create difficulties managing the properties cohesively with the Sacramento bypass since similar habitats would get different land designation.

P-21 3. Page 109, Section 3.7.1: It is unknown if most juvenile fish emigrate from the Sacramento Bypass after it spills. Please clarify what analysis or studies have been conducted to confirm that most fish move out of the Sacramento Bypass prior to drying up. Additionally, in spring of 2011, a total of 25 adult green sturgeons and 20 adult white sturgeons were rescued from Fremont Weir and several swales within the Yolo Bypass. The DEIS/DEIR should include and /or reference the assurances and analysis that was conducted to show that survival of both juvenile and adult listed species will not be jeopardized with the Project.

P-22 4. Page 114, Section 3.7.5: The Knaggs Ranch study utilized hatchery origin fish in a controlled setting. Though they experienced considerable growth, there is no

P-22 (Cont.)

mention as to what the mortality rate was for the fish. Furthermore, there is no assurance as to how the fish can egress from the Yolo Bypass to reach the Delta. Widening the Sacramento Bypass will only create additional floodplain during periods when high flow conditions exist; however, the DEIS/DEIR does not indicate how these fish can leave the floodplain during these high flow conditions. It is very important that the Project is designed in a way that will allow listed fish to migrate from floodplains to the Delta. These activities should be identified and analyzed in the environmental document.

P-23

5. Page 115, Section 3.7.6: Avoidance, Minimization, and Mitigation Measures. Section 3.3.6 should be Section 3.7.6. The proposed construction window is incorrect. Adult Chinook salmon spawning in the lower American River spans from October through December with peak spawning occurring mid-November. The Department recommends that the construction period avoid peak spawning.

Appendix G Draft Biological Assessment

P-24

6. Page 20, Section 2.2.3: The planting berm should be constructed in a way to prevent any stranding of juvenile listed species as the water recedes.

P-25

7. Page 33, Section 2.5.1: The BA should include the citations for the compensation time periods included in this section.

P-26

8. Page 47, Section 3.3.1: The life history subsection includes information about juvenile Chinook salmon outmigration past Red Bluff Diversion Dam. The construction site is located up to 200 miles from the diversion dam. The document needs to identify when juvenile outmigration occurs at the construction sites near Sacramento in order to identify any impacts to listed species. Data collected by the Department in the Sacramento River near Knights Landing suggests that juvenile salmonids (federally listed endangered winter-run Chinook salmon) are present in October in the Sacramento River. The study cited in this section, Sommer et al. (2001), found high growth and survival rates for fall-run Chinook salmon and not winter-run. Please note that juveniles may rear on inundated floodplains during high flow events when they occur although survival is not fully understood due to isolation and stranding in swales and from farm road crossings.

P-27

9. Page 66, Section 4.2.2: It should be noted that although all four runs of Chinook salmon may enter the Yolo Bypass during intermittent high winter and spring floods, survival is not fully understood due to stranding and isolation in swales and between farm road crossings within the bypass.

P-28

10. Page 66, section 4.2.3: It should be noted that although green sturgeon can inhabit the Sacramento Bypass, when flooded, survival is not fully understood due to isolation and stranding in swales and at farm road crossings.

P-29

11. Page 79, Section 5.2.1: The Juvenile Rearing and Migration section states that juvenile winter run Chinook salmon moving downstream peaks at Red Bluff in September and October and continues until mid-March in drier years. This section should include what the peak observation of winter-run are at the construction site. Because downstream migration may be triggered by storm events, winter-run Chinook salmon may be in the vicinity of the proposed construction site in greater numbers than foreseen and could negatively impact the winter-run. This is similar for juvenile spring-run Chinook salmon, specifically for those that migrate as yearlings (October through March).

P-30

12. Page 79, Section 5.2.1: Figures 11-14: This Section of the environmental document states that riparian vegetation within a levee can be restored to a level that could benefit Chinook salmon within 5 years. Please clarify if sampling occurred at these sites to verify if juvenile Chinook salmon were utilizing these areas for rearing. The Department recommends that monitoring be done at these sites to verify their utility in providing a positive effect.

P-31

Please note that when acting as a responsible agency, CEQA guidelines Section 15096, subdivision (f) requires the Department to consider the CEQA environmental document prepared by the lead agency prior to reaching a decision on the Project. Addressing the Department's comments and disclosing potential Project impacts on CESA-listed species in any river, lake, or stream, and provide adequate avoidance, minimization, mitigation, monitoring and reporting measures; will assist the Department with the consideration of the DEIR and reduce potential delays when issuing an Incidental Take Permit under CESA and/or an LSA Agreement.

Thank you for the opportunity to comment on the DEIS/DEIR for the Project. If you have any questions regarding these comments please contact please contact Juan Lopez Torres at (916) 358-2951 or Juan.Torres@wildlife.ca.gov.

Sincerely

Tina Bartlett
Region Manager

FOR

ec: Jeff Drongesen
Isabel Baer
Juan Lopez Torres
Michael Healey
Josh Bush
Chris McKibben
Department of Fish and Wildlife

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Pacific Southwest Region
333 Bush Street, Suite 515
San Francisco, CA 94104

IN REPLY REFER:
(ER 15/0183)

Filed Electronically

4 May 2015

Ms Anne Baker
U.S. Army Corps of Engineers,
Sacramento District
1325 J Street
Sacramento, CA 95814

Subject: Review of Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) for the American River Watershed Common Features General Reevaluation Report.

Dear Ms. Baker:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) for the American River Watershed Common Features General Reevaluation Report.

We have the following comments to assist your preparation of the Final EIS.

The National Park Service's (NPS)'s primary interest in the proposed project relates to its potential impact on the Lower American River. The Lower American River is a designated National Wild and Scenic River (WSR) and is also included in the California State Wild and Scenic River program.

NPS is the federal river administering agency for the Lower American River and, as such, is the reviewing authority for "water resource projects" proposed within the WSR boundary. This boundary extends ¼ mile from the ordinary high water mark on either side of the river. The proposed projects, irrespective of the final selected alternative, clearly meet this standard.

In its role to oversee the protection and enhancement of the Lower American River, NPS considers the impacts of water resource projects on free flow, water quality, and outstanding remarkable values (ORV). The ORVs for the Lower American River are fish (anadromous species) and recreation.

The American River Common Features (ARCF) Project impacts both banks of the Lower American River for some 12 miles upstream from the river's confluence with the Sacramento

River. Erosion of the Lower American River levees has been a problem for decades and NPS has reviewed previous levee expansion and improvement projects on the Lower American River where similar vegetation removal has taken place. We have weighed in on the impacts of various levee stabilization and improvement projects through the years.

Generally, we support the selection of Alternative 2, which decreases erosion while improving the levees' stability with the construction of bank protection and launchable rock trench. We should note that, as affects the Lower American River, the protections afforded under Alternative 1 are generally the same as those under Alternative 2 (which includes the Sacramento Weir and Bypass widening), so either alternative may have been acceptable.

We note that riparian vegetation along the Lower American River is classified as "valuable shaded riverine aquatic habitat" for the federally listed (anadromous) fish species which form the basis for one of the River's outstandingly remarkable values and its original designation as a National WSR. We further note that Alternative 2 limits negative impacts to the shaded riverine aquatic habitat with the riparian zone to a "single construction season", while acknowledging indirect effects to the habitat due to vegetation removal and more direct effects due to placement of rock at bank protection sites.

Q-1

However we are aware of the protracted nature of the construction period common in this region, and recommend that the duration of time that constitutes a "season" be specified.

We are pleased to note that the ARCF project is receiving consultation with the National Marine Fisheries Service (NMFS) per Section 7 of the Endangered Species Act. We generally defer to NMFS for biological determinations on projects' effect on anadromous fish. We assume that NMFS's assessment will address our concerns for impact on fish, regardless of which alternative is ultimately adopted.

We note that there has been a history of controversy and considerable concern regarding this, and past, projects' effect on recreation, another ORV for which the Lower American River was designated as a WSR. One important component of this ORV, the Jedediah Smith Recreation Trail which lies within the American River Parkway, extends throughout the 12 mile affected area of the ARCF project.

Recreational activities take place throughout the Parkway, including the bulk of actual access to the river which occurs between the levees and the bed and banks of the River. According to the Report, Alternative 2 will result in temporary closure of the Parkway during construction including the bike and hiking trails, boat launches, and other river access sites. This is deemed to be significant effect. Notification and coordination with users and user groups and traffic control around construction areas are noted as mitigations.

NPS strongly urges that these mitigation steps (which include signage, detours, flaggers, and fencing) be strictly adhered to in view of the large population that uses the Parkway. While no cumulative effect to recreation is cited, we are again concerned about the length of the construction "season", accordingly public notice should be provided throughout the entire recreational use period.

Q-2

Q-3 A large part of the recreational experience includes the aesthetic quality of visual resources along the American River Parkway and from the vantage of the river itself. We note that, here again, the effect is substantial in that vegetation loss or construction along the Parkway will disrupt the existing riverside visual conditions. We recommend that all contractors associated with the project adhere to best management practices (including replanting of displaced trees and reseeding with native grasses) in the course of construction to limit this disruption.

Q-4 §3.14.1 Recreation, Environmental Setting - The National Wild and Scenic Rivers Act (Public Law 90-542; 16 U.S.C. 1271 et seq.) should be specifically cited.

Q-5 §6.3 Coordination With Other Federal, State, and Local Agencies - This section should also emphasize consultation and coordination with NPS. Again, as the federal administering agency for the Lower American River, NPS should be consulted regarding consistency of the ARCF projects with the WSR Act.

Almost the entire project lies within the ¼ mile boundary of the Lower American WSR and, based on the specific location of areas affected by construction on the levees, many elements of the project will have at least an indirect effect on the ORVs and water quality. As an example, activities associated with bank stabilization may cause excessive turbidity which, however temporary, has a negative effect on water quality.

Ultimately, NPS is obligated to assess the potential effects of any proposed project on the Lower American River as they pertain to consistency with the WSR Act. Therefore, we appreciate the opportunity to review the Draft EIS for the American River Watershed Common Features General Reevaluation Report and provide these comments.

Sincerely,

Patricia Sanderson Port
Regional Environmental Officer

cc: OEPC Staff Contact: Lisa Treichel, (202) 208-7116, Lisa_Treichel@ios.doi.gov
NPS Staff Contact: Barbara Rice, (415) 623-2320, Barbara_Rice@nps.gov
NPS NEPA Contact: Alan Schmierer, (415) 623-2315, Alan_Schmierer@nps.gov

R

Department of Transportation
Michael J. Penrose, Director

Divisions
Administration
Maintenance & Operations
Engineering & Design

County of Sacramento

May 1, 2015

Ms. Anne Baker
U.S. Army Corps of Engineers
Sacramento District
1325 J Street
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Anne.E.Baker@usace.army.mil

Erin Brehmer
Department of Water Resources
3464 El Camino Avenue Room 200
Sacramento, CA 95821
erin.brehmer@water.ca.gov

SUBJECT: COMMENTS ON NOTICE OF AVALIABLITY (NOA) OF DRAFT ENVIRONMENTAL IMPACT REPORT (DEIR) AND GENERAL REEVALAUTION REPORT (GRR) FOR AMERICAN RIVER COMMONS.

Dear Ms. Baker and Ms. Brehmer:

The Sacramento County Department of Transportation (SACDOT) has reviewed the NOA of the DEIR and GRR for American River Commons, dated March 2015. We appreciate the opportunity to review this document. We have following comments to offer:

R-1 1. **General.** The proposed levee improvements require the transport of approximately one million yards of soil and nearly three million tons of rock over Sacramento County roads to various levee sites within Sacramento County. The high volume of trucks and heavy weight associated with these trucks will significantly degrade affected County roadways and shorten the life of these haul roads. Due to the roadway impacts site specific studies should be done for each levee improvement area. The study should contain detailed truck traffic information including haul routes, haul volumes per truck (soil and rock), associated haul truck types, number and frequency of trucks, proposed hauling hours, and associated roadway traffic volumes. Based on the results of the project specific reports, the project applicant should provide to Sacramento County a summary of the roadway impacts and proposed remediation efforts that will be undertaken by the project sponsor to account for County roadway degradation and damage.

R-2 2. **General.** Please coordinate with the SACDOT staff in implementing the Traffic Safety and Control Plan for construction related truck traffic and any bike trail and/or roadway closures.

If you have any questions please call me at (916) 875-2844.

Sincerely,

Kamal Atwal

Kamal Atwal, P.E.
Associate Transportation Engineer
Department of Transportation

KA/mp

c: Matt Darrow, DOT
Dean Blank, DOT

SACRAMENTO METROPOLITAN
AIR QUALITY
MANAGEMENT DISTRICT

Larry Greene
AIR POLLUTION CONTROL OFFICER

S

May 4, 2015

Ms. Anne Baker
U.S. Army Corp of Engineers
Sacramento District
1325 J Street
Sacramento, CA 95814

Ms. Erin Brehmer
California Department of Water Resources
3464 El Camino Avenue, Room 200
Sacramento, CA 95821

American River Common Features General Reevaluation Report Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) (SAC201301442)

Dear Ms. Baker and Ms. Brehmer:

Thank you for providing the draft EIS/EIR for the American River Common Features (ARCF) General Reevaluation Report to the Sacramento Metropolitan Air Quality Management District (SMAQMD) for review. SMAQMD staff comments on the air quality and climate change sections of the draft EIS/EIR follow.

S-1 1. Clarify which model year on-road haul trucks will be used for the project, 2007 and newer or 2010 and newer (pages 188, 190, 196, 199 and Appendix D).

S-2 2. The emissions discussion for Alternative 2 refers to Tables 30 and 31, the emissions estimates for Alternative 1 (page 198). Since the two alternatives would result in different emissions due to expansion of the Sacramento Weir in Yolo County and reduction of levee work in Sacramento County, separate emissions tables should be provided for Alternative 2.

S-3 3. Requiring contractors to do particulate matter "dispersion" modeling prior to starting construction is not generally recommended (page 201). Emissions modeling conducted for the project assumes construction would disturb approximately 7 acres/day, which is below the 15 acres/day level that triggers dispersion modeling (Appendix D). SMAQMD's recommended fugitive dust control mitigation measures (basic and enhanced) are included in the project, therefore additional dispersion modeling is not necessary.

S-4 4. Clarify which mitigation measure is being required for off-road equipment, Tier 4 standards or SMAQMD's enhanced exhaust controls (20% NOx and 45% PM reduction) (pages 188 and 202). Is the mitigation for Alternative 1 different from Alternative 2?

S-5 5. Clarify that SMAQMD adopted GHG significance thresholds in October 2014 that can be used in subsequent environmental analyses for ARCF projects (page 212).

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www.airquality.org

S-6

6. Although greenhouse gas emissions were analyzed and determined to be less than significant, a list of measures were included that "may be considered to lower GHG" emissions during construction including the purchase of offsets for GHG emissions that exceed future significance thresholds (page 215). Since the SMAQMD has an adopted construction threshold for GHG emissions and this document already referenced the 10,000 metric ton Bay Area threshold, all reference to a 7,000 metric ton presumptive threshold should be removed from the measure.

S-7

7. Appendix D references Tables 1a and 1b, which don't appear to be included in the document.

S-8

8. All projects are subject to applicable SMAQMD rules in affect at the time of construction. A list of the most common rules that apply to construction projects is attached for your convenience. SMAQMD rules can be obtained on the SMAQMD's webpage: www.airquality.org.

If you have any questions regarding these comments please contact me at (916) 874-4881 or khuss@airquality.org. I look forwarding to receiving the final EIS/EIR.

Sincerely,

Karen Huss

Karen Huss
Associate Air Quality Planner/Analyst

Attachment

Cc: Larry Robinson, SMAQMD

ATTACHMENT - SMAQMD Rules & Regulations Statement (revised 3/12)

*The following statement is recommended as standard condition of approval or construction document language for **all** development projects within the Sacramento Metropolitan Air Quality Management District (SMAQMD):*

All projects are subject to SMAQMD rules in effect at the time of construction. A complete listing of current rules is available at www.airquality.org or by calling 916.874.4800. Specific rules that may relate to construction activities or building design may include, but are not limited to:

Rule 201: General Permit Requirements. Any project that includes the use of equipment capable of releasing emissions to the atmosphere may require permit(s) from SMAQMD prior to equipment operation. The applicant, developer, or operator of a project that includes an emergency generator, boiler, or heater should contact the SMAQMD early to determine if a permit is required, and to begin the permit application process. Portable construction equipment (e.g. generators, compressors, pile drivers, lighting equipment, etc.) with an internal combustion engine over 50 horsepower are required to have a SMAQMD permit or a California Air Resources Board portable equipment registration. Other general types of uses that require a permit include, but are not limited to dry cleaners, gasoline stations, spray booths, and operations that generate airborne particulate emissions.

Rule 403: Fugitive Dust. The developer or contractor is required to control dust emissions from earth moving activities, storage or any other construction activity to prevent airborne dust from leaving the project site.

Rule 414: Water Heaters, Boilers and Process Heaters Rated Less Than 1,000,000 BTU PER Hour. The developer or contractor is required to install water heaters (including residence water heaters), boilers or process heaters that comply with the emission limits specified in the rule.

Rule 417: Wood Burning Appliances. This rule prohibits the installation of any new, permanently installed, indoor or outdoor, uncontrolled fireplaces in new or existing developments.

Rule 442: Architectural Coatings. The developer or contractor is required to use coatings that comply with the volatile organic compound content limits specified in the rule.

Rule 460: Adhesives and Sealants. The developer or contractor is required to use adhesives and sealants that comply with the volatile organic compound content limits specified in the rule.

Rule 902: Asbestos. The developer or contractor is required to notify SMAQMD of any regulated renovation or demolition activity. Rule 902 contains specific requirements for surveying, notification, removal, and disposal of asbestos containing material.

Naturally Occurring Asbestos: The developer or contractor is required to notify SMAQMD of earth moving projects, greater than 1 acre in size in areas "Moderately Likely to Contain Asbestos" within eastern Sacramento County. Asbestos Airborne Toxic Control Measures, Section 93105 & 93106 contain specific requirements for surveying, notification, and handling soil that contains naturally occurring asbestos.

STATE OF CALIFORNIA EDMUND G. BROWN JR., *Governor*

CALIFORNIA STATE LANDS COMMISSION
100 Howe Avenue, Suite 100-South
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Established in 1938

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May 4, 2015

File Ref: SCH #2005072046

Ms. Erin Brehmer
Department of Water Resources
3464 El Camino Avenue, Room 200
Sacramento, CA 95821

Subject: Draft Environmental Impact Statement/Report (Draft EIS/EIR) for the American River Common Features General Re-evaluation Report, Sacramento County

Dear Ms. Brehmer:

The California State Lands Commission (CSLC) staff has reviewed the subject Draft EIS/EIR for the American River Common Features General Re-evaluation Report (Project), which is being prepared by the Central Valley Flood Protection Board (CVFPB), as the lead agency under the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.), and the U.S. Army Corps of Engineers (Corps) as the lead agency under the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321 et seq.). The CSLC is a trustee agency for projects that could directly or indirectly affect sovereign lands and their accompanying Public Trust resources or uses. Additionally, because the Project involves work on sovereign lands, the CSLC will act as a responsible agency. Comments on the Notice of Preparation were provided on March 28, 2008 (attached).

CSLC Jurisdiction and Public Trust Lands

The CSLC has jurisdiction and management authority over all ungranted tidelands, submerged lands, and the beds of navigable lakes and waterways. The CSLC also has certain residual and review authority for tidelands and submerged lands legislatively granted in trust to local jurisdictions (Pub. Resources Code, §§ 6301, 6306). All tidelands and submerged lands, granted or ungranted, as well as navigable lakes and waterways, are subject to the protections of the Common Law Public Trust.

As general background, the State of California acquired sovereign ownership of all tidelands and submerged lands and beds of navigable lakes and waterways upon its admission to the United States in 1850. The State holds these lands for the benefit of all people of the State for statewide Public Trust purposes, which include but are not limited to waterborne commerce, navigation, fisheries, water-related recreation, habitat

preservation, and open space. On navigable non-tidal waterways, including lakes, the State holds fee ownership of the bed of the waterway landward to the ordinary low water mark and a Public Trust easement landward to the ordinary high water mark, except where the boundary has been fixed by agreement or a court. Such boundaries may not be readily apparent from present day site inspections.

Based on the information submitted in the Draft EIS/EIR, portions of the Project are or may be located on State-owned sovereign land in the Sacramento River and the American River. Portions of the Project that are located in the American River may also be on sovereign land granted to the city of Sacramento pursuant to Chapter 519, Statutes of 1868. To the extent the proposed levee improvement project involves State-owned sovereign lands in the Sacramento River and the American River, a lease will be required. Staff of the Commission will need to review each of the specific proposed project sites prior to determining whether the project site involves land under the granted or ungranted jurisdiction of the CSLC, and whether a lease is required.

T-1

Portions of the Project located in Natomas East Main Drainage Canal are not under CSLC jurisdiction and therefore do not require a lease. Portions of the proposed Project including Arcade Creek, Dry Creek, Robla Creek, Magpie Creek and the Sacramento Weir and Bypass may involve sovereign land under the jurisdiction of the Commission, however, we are currently unable to determine the extent or location of any sovereign ownership interests of the State in these project areas, so no lease will be required for these areas of the Project. If you have any questions, please contact Wendy Hall, Public Land Management Specialist (see contact information below) to discuss the Commission's leasing requirements.

T-2

Please also be advised that the waterways involved in the Project are subject to a public navigational easement. This easement provides that the public has the right to navigate and exercise the incidences of navigation in a lawful manner on State waters that are capable of being physically navigated by oar or motor-propelled small craft. Such uses may include, but are not limited to, boating, rafting, sailing, rowing, fishing, fowling, bathing, skiing, and other water-related public uses. The activities completed under the Project must not restrict or impede the easement right of the public.

T-3

Project Description

The Project area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Dry, Robla, and Arcade Creeks and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento.

The purpose of the Project is to reduce the overall flood risk within the study area. The study area includes the city of Sacramento and surrounding areas. An unacceptably

high risk of flooding from levee failure threatens the public safety of approximately 530,000 people, as well as property and critical infrastructures throughout the study area. Additionally, the State Capitol and many State agencies reside within the study area. Historic flooding events have caused loss of life and extensive economic damages. Approximately 83,000 structures throughout the study area are at risk of flooding in a 100-year event (1% annual change of flooding). This Draft EIS/EIR evaluates the potential significant environmental impacts of the alternatives discussed in the American River Common Features (ARCF) General Re-evaluation Report (GRR) (ARCF GRR). If the ARCF GRR is authorized by Congress, the Corps would begin construction to implement the Project. Alternative 2, Improve Levees and Widen the Sacramento Weir and Bypass has been identified as the Tentatively Selected Plan (TSP) and as the least environmentally damaging alternative as it results in less riparian habitat removal along the Sacramento River.

Environmental Review

CSLC staff requests that the lead agencies consider the following comments on the Project's Draft EIS/EIR.

General Comments

1. On page ES-1, the Draft EIS/EIR makes a statement in regards to purposes and intended uses of the EIS/EIR. CSLC staff requests that this paragraph be revised as shown below, to provide a clearer understanding of the Commission's role in the proposed Project.

T-4

This ~~DEIS/DEIR~~ will also be used by CEQA lead agencies, such as the CVFPB and Central Valley Regional Water Quality Control Board (RWQCB), Sacramento Area Flood Control Agency (SAFCA), and trustee and responsible *agencies, such as the California Department of Fish and Wildlife (CDFW)* and the California State Lands Commission (CSLC), *to ensure that they have met the requirements of CEQA before deciding whether to issue discretionary permits* or leases *over which they have authority.*

Water Quality

2. Mercury/Methylmercury: Section 3.5 of the Draft EIS/EIR study area discusses mercury and methylmercury in the Sacramento and American Rivers. As noted on page 90, the placement of revetment along the river banks would temporarily generate increased turbidity in the immediate vicinity. Although section 3.5.6 (Avoidance, Minimization, and Mitigation Measures) does state that the Project would not exceed the Basin Plan turbidity objectives, and does provide for water quality testing, CSLC staff requests that the Draft EIS/EIR also include specific measures to control sediment release (and the subsequent release of mercury/methyl mercury) into waterways and onto State lands underlying those waterways, to further prevent exceedance of the turbidity objectives.

T-5

On April 22, 2010, the Central Valley Regional Water Quality Control Board (CVRWQCB) identified the CSLC as both a State agency that manages open water areas in the Sacramento-San Joaquin Delta Estuary and a nonpoint source discharger of methylmercury (Resolution No. R5-2010-0043), because subsurface lands under the CSLC's jurisdiction are impacted by mercury from legacy mining activities dating back to California's Gold Rush. Pursuant to a CVRWQCB Total Maximum Daily Load (TMDL), the CVRWQCB is requiring the CSLC to fund studies to identify potential methylmercury control methods in the Delta and to participate in an Exposure Reduction Program. The goal of the studies is to evaluate existing control methods and evaluate options to reduce methylmercury in open waters under jurisdiction of the CSLC. Any action taken that may result in mercury or methylmercury suspension within the Sacramento-San Joaquin Delta Estuary may affect the CSLC's efforts to comply with the CVRWQCB TMDL.

T-6

Cultural Resources

3. Title to Resources: CSLC staff requests that Page 172 of the Draft EIS/EIR (under Avoidance, Minimization, and Mitigation Measures), and the programmatic agreement that has been developed by the Corps in consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation, include a statement that the title to all archaeological sites, and historic or cultural resources on or in the tide and submerged lands of California is vested in the State and under the jurisdiction of the CSLC (Pub. Resources Code, § 6313). CSLC staff also requests that the following statement be included in EIR's Mitigation and Monitoring Plan: "The final disposition of archaeological, historical, and paleontological resources recovered on State lands under the jurisdiction of the CSLC must be approved by the Commission." Finally, CSLC staff requests that the lead agencies consult with Assistant Chief Counsel Pam Griggs (see contact information below) should any cultural resources on State lands be discovered during construction of the proposed Project.

T-7

T-8

T-9

Climate Change

4. Sea Level Rise: Although sea level rise is mentioned in section 3.12 of the Draft EIS/EIR, there is no discussion of how the Project would address this potential issue. A tremendous amount of State-owned lands and resources under the Commission's jurisdiction will be impacted by rising sea levels. With this in mind, the lead agencies should consider discussing the effects of sea level rise on all resource categories potentially affected by the proposed Project in the Draft EIS/EIR. Because of their nature and location, these lands and resources are already vulnerable to a range of natural events. Note that the State of California released the final "Safeguarding California: Reducing Climate Risk, an Update to the 2009 California Climate Adaptation Strategy" (Safeguarding Plan) on July 31, 2014, to provide policy guidance for state decision-makers as part of continuing efforts to prepare for climate risks. The Safeguarding Plan sets forth "actions needed" to safeguard ecosystems and resources as part of its policy recommendations for State decision-makers.

T-10

In addition, at its meeting on December 17, 2009, the CSLC approved the recommendations made in a previously requested staff report, "A Report on Sea Level Rise Preparedness" (Report), which assessed the degree to which the CSLC's grantees and lessees have considered the eventual effects of sea level rise on facilities located within the CSLC's jurisdiction. (The Report can be found on the CSLC's website, www.slc.ca.gov.) One of the Report's recommendations directs CSLC staff to consider the effects of sea level rise on hydrology, soils, geology, transportation, recreation, and other resource categories in all environmental determinations associated with CSLC leases. When considering lease applications, CSLC staff will (1) request information from applicants concerning the potential effects of sea level rise on their proposed projects, (2) if applicable, require applicants to indicate how they plan to address sea level rise and what adaptation strategies are planned during the projected life of their projects, and (3) where appropriate, recommend project modifications that would eliminate or reduce potentially adverse impacts from sea level rise, including adverse impacts on public access.

T-11

Thank you for the opportunity to comment on the Draft EIS/EIR for the Project. As a responsible and trustee agency, the CSLC will need to rely on the Final EIR for the issuance of any lease as specified above and, therefore, we request that you consider our comments prior to certification of the EIR. Please send copies of future Project-related documents, including electronic copies of the Final EIS/EIR, Mitigation Monitoring and Reporting Program (MMRP), Notice of Determination (NOD), CEQA Findings and, if applicable, Statement of Overriding Considerations when they become available, and refer questions concerning environmental review to Cynthia Herzog, Senior Environmental Scientist, at (916) 574-1310 or via e-mail at Cynthia.Herzog@slc.ca.gov. For questions concerning archaeological or historic resources under CSLC jurisdiction, please contact Assistant Chief Counsel Pam Griggs at (916) 574-1854 or via email at Pamela.Griggs@slc.ca.gov. For questions concerning CSLC leasing jurisdiction, please contact Wendy Hall, Public Land Management Specialist, at (916) 574-0994, or via email at Wendy.Hall@slc.ca.gov.

T-12

Sincerely,

Cy R. Oggins, Chief
Division of Environmental Planning
and Management

cc: Office of Planning and Research
C. Herzog, CSLC
W. Hall, CSLC
W. Crunk, CSLC
P. Griggs, CSLC

Attachment

CALIFORNIA STATE LANDS COMMISSION
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March 28, 2008

File Ref: SCH# 2005072046

Annalena Bronson
Central Valley Flood Protection Board
3310 El Camino Avenue, Room LL-40
Sacramento, CA 95821

Subject: American River Common Features General Re-evaluation Report

Dear Ms. Bronson:

The State acquired sovereign ownership of all tidelands and submerged lands and beds of navigable waterways upon its admission to the United States in 1850. The State holds these lands for the benefit of all the people of the State for statewide Public Trust purposes which include waterborne commerce, navigation, fisheries, water-related recreation, habitat preservation, and open space. The landward boundaries of the State's sovereign interests in areas that are subject to tidal action are generally based upon the ordinary high water marks of these waterways as they last naturally existed. In non-tidal navigable waterways, the State holds a fee ownership in the bed of the waterway between the two ordinary low water marks as they last naturally existed. The entire non-tidal navigable waterway between the ordinary high water marks is subject to the Public Trust Easement. Both the easement and fee-owned lands are under the jurisdiction of the State Lands Commission. The locations of the ordinary high and low water marks are often related to the last natural conditions of the river, and may not be apparent from a present day site inspection.

To the extent the proposed levee improvement project involves State-owned sovereign lands in the Sacramento River, American River or the Natomas Basin, a lease will be required. Staff of the Commission will need to review each of the proposed sites prior to making the determination that a lease is required. If you have any questions, please contact Diane Jones, Public Land Manager, at 916-574-1843, to discuss the Commission's leasing requirements.

Environmental Planning and Management Comments:

The State Lands Commission recommends any of the proposed mitigation and project construction activities consider timing of the proposed work to account for state

and federally listed endangered species. All arrangements with pertinent regulatory agencies should coincide with specific protection policies regarding incidental take and avoidance measures. Consideration should include, but not be limited to, seasonality of migratory or nesting species within the footprint of the project (i.e. Swainson's Hawks, Salmonids, etc.). Any construction activities along the water-side bank of restoration or flood protection improvements shall consider water quality issues affecting clarity and chemical reactions within the waters and make all the necessary arrangements to reduce or mitigate for these concerns.

In addition, greenhouse gas emissions information consistent with the California Global Warming Solutions Act (AB 32) should be included. This would include a determination of the greenhouse gases that will be emitted as a result of construction and ongoing operations and maintenance, a determination of the significance of the impact, and mitigation measures to reduce that impact.

If you have any questions with the environmental review, please contact Christopher Huitt, Staff Environmental Scientist, at 916-574-1938, to discuss these comments or questions.

Sincerely,

Marina R. Brand

Marina R. Brand, Assistant Chief
Division of Environmental Planning
and Management

cc: Office of Planning and Research
State Clearinghouse

Diane Jones, CSLC
Christopher Huitt, CSLC

TREMAINE & ASSOCIATES
Archaeology ~ GIS ~ Geophysics

4 May 2015

Anne Baker
Department of the Army
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, CA 95814-2922

Re: ARCF Draft EIR/EIS Comments

Dear Ms. Baker,

I reviewed the Cultural Resources Section in light of recent discoveries along the Feather River levees during degrading operations in preparation for improvements to address levee deficiencies. It is my understanding that the Sutter Buttes Flood Control Agency encountered nine buried American Indian midden sites within a nine-mile stretch in Butte County alone, some including human burials. Cultural deposits ranged anywhere from 9 to 18 feet below levee grade.

Historically, sites along the river were situated on high ground (the natural levees) in the form of mounds. As such, it stands to reason that when Euro-Americans began raising these embankments to combat floods, archaeological sites were incorporated, if possible, to save on the cost of construction efforts. Such early improvements to natural levees were then subsequently raised, enlarged, and bolstered with slope stability berms, essentially covering over any evidence pointing to the existence of cultural resource today.

U-1

My concern is that *some* sites within the ARCF study area are likely to have remained unidentified during this initial stage of the Section 106 process, given that investigations were restricted to surface observations. Mitigation Measure CR-3, Archaeological Monitoring, while addressing the possibility for undiscovered resources, essentially serves to defer the identification effort. Unfortunately, post-review discoveries occur during critical construction operations when it is too late to treat them properly and delays can be ill-afforded. I am not suggesting this mitigation measure be removed… only that, in addition, subsurface investigations be required to ensure that sites are found prior to construction when it is still possible to avoid or limit impacts. This proactive approach can be achieved through geophysical survey and ground-truthing.

Sincerely,

Kim Tremaine

Kim Tremaine

Address: 1220 Smith Court, Dixon, CA 95620 Phone: 916-637-9717

TREMAINE & ASSOCIATES
Archaeology ~ GIS ~ Geophysics

4 May 2015

Anne Baker
Department of the Army
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, CA 95814-2922

Re: ARCF Draft GRR Comments

Dear Ms. Baker,

I have reviewed portions of the Draft GRR related to Geotechnical Risk Analysis. It focused on three failure modes taking into account existing base conditions revealed through a methodology heavily dependent upon limited bore log data. From this, strengths and weaknesses of various reaches were calculated and prioritized. As one of the Independent External Peer reviewers in 2009 commented, the methods used faithfully followed USACE guidance in ETL 1110-2-547 and ETL-1110-2-556. It was, at that time, a sufficient level of analysis. In the interim, however, the National Levee Safety Program has been reevaluating their guidance and is now advocating Total Conditional Performance Analysis (i.e., the combined probability of *all* failure modes). Does the USACE plan to require the analysis be updated accordingly?

V-1

DWR, in a state-led effort to improve levee safety through new urban levee design criteria, now recognizes that urban areas are more likely to contain numerous associated embedded deteriorating features related to infrastructure and flood defenses that are potentially 100 years or older. As such, they recommend civil engineers use or conduct land-based continuous levee crown geophysical methods to assess the levee material and the upper 20 feet of foundation materials to identify unknown penetrations in an effort to meet the urban level of flood protection (Section 7.13 of their 2012 guidance). This is because aging penetrations, under certain load conditions, can result in transient and progressive interior damages, leading to localized instabilities and piping (recognized as the prime failure mechanism for almost all levee systems). Does the USACE plan to require an update of existing conditions to included fine-grained geophysical data to reduce uncertainty in performance risk assessments?

V-2

Sincerely,

Kim Tremaine

Kim Tremaine

Address: 1220 Smith Court, Dixon, CA 95620 Phone: 916-637-9717

W

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DELTA STEWARDSHIP COUNCIL

A California State Agency

May 4, 2015

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U.S. Army Corps of Engineers, Sacramento District
Attn: Ms. Anne Baker
1325 J Street
Sacramento, California 95814-2922
Anne.E.Baker@usace.army.mil

RE: Draft American River Watershed Common Features General Reevaluation Report

Dear Ms. Baker:

Thank you for the opportunity to comment on Draft American River Watershed Common Features General Reevaluation Report (GRR). As you may be aware, the Delta Stewardship Council (Council) is an independent state agency and the Council's primary mission is to further the achievement of the coequal goals of water supply reliability for California and protecting and restoring the Delta ecosystem while protecting and enhancing the Delta as an evolving place (Water Code section 85054).

The Council has a legally enforceable management framework for the Delta and Suisun Marsh called the Delta Plan. The Delta Plan applies a common sense approach based on the best available science to restore habitat, increase the diversity and efficiency of California's water supplies, enhance floodplains, improve the Delta's levee system, and preserve the Delta's agricultural values. In many cases, the Delta Plan calls for balancing competing needs in the Delta, e.g., protecting habitat while reducing flood risk. In addition, the Delta Reform Act requires the Council to develop an investment strategy for project and non-project levees in the Delta to protect people, property and the State's interests (Water Code sections 85305(a) and 85306).

The Delta Plan contains an interim set of priorities for levee investments in the Delta. These priorities, in combination with the Council's authority to assure that State agencies act consistently with the Delta Plan, ensure that levee spending by the California Department of Water Resources and the Central Valley Flood Protection Board reflects the Delta Plan's priorities. The Council is currently updating this investment strategy to better define the State's interests. The updated strategy will incorporate information on proposed projects based on system-wide risk evaluations such as the one described in this draft document. Since some of the proposed GRR project activities lie within the Delta and play an important role in

maintaining the integrity of the Delta levee system, it is essential that our agencies continue to coordinate closely on these types of efforts.

Comments on the Draft General Reevaluation Report

Comments in this letter are focused primarily on our concerns with the overly narrow definition of federal interest in the project area, uncertainty regarding achieving the urban level of flood protection for the Sacramento Metropolitan area, and mitigation of impacts to biological resources. In a separate letter to the California Central Valley Flood Protection Board (CVFPB) on the companion draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for this draft document, we provide comments specifically on the consistency of this project with the Delta Plan's 14 regulatory policies. A copy of this letter will be provided to your agency as well.

Overly Narrow Definition of Federal Interest

We are concerned about policy constraints and planning processes that have resulted in the definition of an overly narrow federal interest in the Delta. As stated in the draft GRR, the U.S. Army Corps of Engineers (USACE) is working on the Central Valley Integrated Flood Management Study (CVFIMS), which is a federal companion document to the Central Valley Flood Protection Plan of 2012 (CVFPP), Regional Flood Management Plans, and Integrated Regional Watershed Management Plans. The CVIFMS shares the CVFPP's vision of a multi-objective watershed study focused on integrated water resource management for flood risk management, ecosystem restoration, and other water resource purposes. In addition, the federal Energy and Water Development Appropriations Act of 2012 (Title II of the Consolidated Appropriations Act of 2012 [PL 112-074]) contains, in pertinent part, the following:

> *The Federal policy for addressing California's water supply and environmental issues related to the Bay-Delta shall be consistent with State law, including the coequal goals of providing a more reliable water supply for the State of California and protecting, restoring, and enhancing the Delta ecosystem....(Section 205).*

The multi-objective approach of these planning activities are also aligned with the State's two coequal goals as part of the Delta Reform Act of 2009 – providing a more reliable water supply for the Delta and protecting, restoring and enhancing the Delta ecosystem (Public Resources Code section 29702). The objectives inherent in these goals include restoring the Delta ecosystem and reducing risks to people, property and state interests in the Delta (Water Code section 85020).

The Tentatively Selected Plan (TSP), however, was developed based on the USACE's single objective of regional flood risk reduction while the GRR evaluates the flood risk management system for the American River, Sacramento River and additional five (5) adjacent small channels. We believe this is also inconsistent with USACE's *Civil Works Strategic Plan 2014-*

2018, which calls for the use of Integrated Water Resources Management, a holistic approach that considers economic benefits, ecosystem quality, and health and public safety in project formulation. Failure to include multiple objectives in the planning process results in a lost opportunity to implement projects that provide multiple benefits.

W-1 We understand that the conclusions of the GRR, along with other recently completed feasibility studies such as the West Sacramento General Reevaluation Study, Sacramento River Bank Protection Project, and the Delta Islands and Levees Feasibility Study, will support the development of the CVFIMS. Therefore, for this GRR, USACE should include a system-wide evaluation with a multi-benefit approach for the alternatives screening process to support a broader definition of the federal interest.

Clarification of Urban Level of Flood Protection

W-2 The objective of the non-federal sponsors, the State of California and Sacramento Area Flood Control Agency (SAFCA), is to meet the requirements of California Senate Bill (SB) 5 and the Central Valley Flood Protection Act to achieve an urban level of 200-year flood protection, including the Urban Levee Design Criteria (ULDC). One purpose of the ULDC requirement is to increase the likelihood that the levee will hold water until it overtops without a catastrophic breach, providing additional levee reliability and time for evacuation. It is unclear in the draft GRR whether this urban level of protection will be achieved by the TSP. According to the risk analyses from the GRR, with the TSP in place, the flood protection assurance (i.e. non-exceedance probability) for the Pocket Area of Sacramento, given a 200-year flood event, is 94%. In addition, given the project conditions, the risk analyses also show that a levee segment along the America River South Reach (index point A) around River Mile (RM) 8.9 can only provide 65% assurance, given a 200-year flood event. The results of the risk analyses from the GRR for the America River South Reach concluded that the Annual Exceedance Probability (AEP) for the America River South Reach as a whole is 1 in 147. Even with a 94% flood protection assurance, given the elevations of the natural terrain and the indicated weak link of the levee system at the RM 8.9 along the America River, we are concerned that the Pocket Area in the Delta may not attain the state-required 200-year level of flood protection. However, the GRR states that the TSP meets the goal of attaining FEMA level accreditation and meets the SB 5 criteria for urban level of protection. In the final GRR, please clarify the current annual chance of flooding, the resulting annual chance of flooding under each alternative, and whether the TSP can provide 200-year protection according to the USACE risk evaluation guidelines and state requirements. This analysis should be agreed upon by USACE and local communities.

Sacramento Weir and Bypass Widening

W-3 As the draft GRR states, widening the Sacramento Weir and Bypass as a part of the TSP will reduce the regional flood risk by lowering the flood stage during a flood event greater than a 1/100 Annual Chance Exceedance (ACE) event. It is unclear whether there is coordination

W-3 (Cont.)

between the GRR work and the Department of Water Resources (DWR) Sacramento River Basin-Wide Feasibility Study effort (including the scales and configurations for the Sacramento Weir and Bypass improvements and the analyses of potential impacts and benefits on a system-wide scale), and the draft 2017 Central Valley Flood Protection Plan Conservation Strategy. In the final GRR, please address this concern by providing additional information on current coordination between these efforts. Coordination among the USACE, CVFPB, and DWR is critical in evaluating possible measures to protect existing developed areas along the Sacramento and the American River.

Biological Resources

Our primary concerns related to this section of the draft GRR are the impacts to riparian vegetation and associated impacts on special status species as a result of the TSP and the USACE's levee vegetation policy. Dynamic complexes of riparian woody and scrub habitat along river channels and associated floodplains, particularly in areas where there is connectivity between such habitats, provide a suite of ecosystem benefits to on-site and downstream environments. Riparian vegetation provides habitat for terrestrial species, such as Swainson's hawk, white-tailed kite, yellow breasted chat, yellow-billed cuckoo, and valley elderberry longhorn beetle. For aquatic species, including various life stages of Chinook salmon, Central Valley steelhead, splittail, and sturgeon, established woody riparian vegetation provides refuge from currents and predators, and serves as a source of organic carbon in support of the aquatic food web. Riparian areas can reduce non-point source pollution from pesticides, herbicides, and nutrients from fertilizers by serving as transition zones between upland urban/agricultural areas and adjacent waterways. Additional water quality benefits include improved levels of dissolved oxygen and moderation of water temperature. Riparian areas also provide the public with opportunities for active and passive recreation, such as hiking, boating and bird watching. According to the draft GRR, the proposed project would need to remove levee vegetation in consideration of the criteria of the SAFCA Vegetation Management Decision Key, the variance for the USACE Engineer Technical Letter (ETL) 1110-2-583 Vegetation Free Zone requirements, and the USACE System-Wide Improvement Framework (SWIF) agreement. Along the main stem of the Sacramento River, the proposed vegetation removal under the TSP could result in the loss of 750 riparian trees, as well as extensive removal of shaded riverine aquatic habitat associated with placement of rock fill along nine miles of river channel. The impacts to these habitats are expected to adversely affect the special status species that depend upon them, including Chinook salmon and Swainson's hawk. If a USACE vegetation variance is approved, it would allow vegetation to remain on the lower waterside levee slope and prevent additional impacts on riparian trees and shaded riverine aquatic habitat. In the final GRR, USACE should provide assurance of granting the vegetation variance or include the status of the USACE vegetation variance application process.

W-4

Given the tremendous investment by state, federal, and local agencies, as well as nonprofit organizations and individuals, to promote recovery of salmonids and other threatened and

endangered species that use the Sacramento and American Rivers as migratory corridors, it is essential to make every effort to avoid or minimize these impacts. The benefits to special status species provided by the proposed mitigation measures in the draft GRR are unclear. We recommend that, to the maximum feasible extent, any impacts to the channel margin habitat along important salmonid migratory corridors should be mitigated on-site. In the event that off-site mitigation is necessary, we also suggest that any off-site mitigation occurs in close proximity and along the same waterway as where the impacts would occur to demonstrate that the mitigation is restoring equivalent, in-kind habitat. In the final GRR or the associated EIS/EIR, please identify and include the details of the mitigation measures with or without the USACE vegetation variance and/or the SWIF in place, and describe how they would address impacts to special status species, such as salmonids and Swainson's hawk.

W-5

Other recent USACE flood-risk reduction feasibility studies/plan, including the Sacramento River Bank Protection Project and the Lower San Joaquin River Project Integrated Interim Feasibility Report, also involve substantial removal or degradation of riparian and shaded riverine aquatic habitat within the Delta. We recommend that, as the USACE develops the CVIFMS, the cumulative impacts of levee improvement and maintenance projects on riparian and shaded riverine aquatic habitat be assessed. The study should analyze whether the collective loss of those habitat types will adversely affect the achievement of the coequal goal of ecosystem restoration of the Delta. Additionally, we recommend that the CVIFMS assess the cumulative impacts that proposed placement of miles of rock revetment along salmonid migration corridors for levee bank erosion control measures will have on juvenile salmonid rearing and outmigration success.

W-6

According to the draft GRR, the Benefit-Cost (B/C) ratio of the TSP is 4.3 and the TSP is also the Local Preferred Plan (LPP). If additional funding is available, the project team should reconsider including additional alternatives or objectives with lower but acceptable B/C ratios, given the planning constraints. These alternatives could include additional project features that may restore and improve shaded riverine aquatic habitat for the study area, since the riparian habitat along the Sacramento River and the American River is important for native terrestrial and aquatic wildlife. For example, the project can evaluate the use of setback levees as a part of the alternatives, where feasible, to increase floodplains and riparian habitats. The Delta Plan recommends areas of the Delta for evaluating the feasibility of using setback levees for levee projects within the Sacramento River watershed, including urban levee improvement projects in Sacramento.

W-7

Next Steps

We look forward to continuing to work with your agency on this project. I encourage you to contact You Chen (Tim) Chao (916-445-0143) at YouChen.Chao@deltacouncil.ca.gov or Daniel Huang at Daniel.Huang@deltacouncil.ca.gov with your questions, comments, or concerns. We look forward to working with you to ensure consistency of the American River Watershed Common Features General Reevaluation Report Project with the Delta Plan while

also avoiding, minimizing, or mitigating potential environmental impacts. We also look forward to continued discussions with the USACE and the CVFPB regarding this proposed project as well as the development of the CVFIMS and how these activities can be incorporated into the updated Delta levees investment strategy.

Sincerely,

Cindy Messer

Cindy Messer
Deputy Executive Officer
Delta Stewardship Council

cc: Ms. Erin Brehmer, California Department of Water Resources

X

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May 4, 2015

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RE: Draft American River Watershed Common Features General Reevaluation Report Project Environmental Impact Statement/Environmental Impact Report, SCH #2005072046

Dear Ms. Brehmer:

Thank you for the opportunity to comment on the draft American River Watershed Common Features General Reevaluation Report (GRR) Project Environmental Impact Statement/Environmental Impact Report (EIS/EIR), prepared by the U.S. Army Corps of Engineers (USACE). The Delta Stewardship Council (Council) staff is pleased to see that this project is being proposed to improve the regional levee system and its existing conditions to reduce flood risk in the Sacramento area.

The Council has a legally enforceable management framework for the Delta and Suisun Marsh called the Delta Plan. The Delta Plan applies a common sense approach based on the best available science to restore habitat, increase the diversity and efficiency of California's water supplies, enhance floodplains, improve the Delta's levee system, and preserve the Delta's agricultural values. In many cases, the Delta Plan calls for balancing competing needs in the Delta, e.g., protecting and restoring habitat while reducing flood risk. Since part of the proposed GRR project activities lie within the Legal Delta and play an important role in maintaining the integrity of the Delta levee system, it is essential that our agencies continue to coordinate closely on these types of efforts.

Delta Plan Covered Actions and Certification of Consistency

Through the Delta Reform Act, the Council was granted specific regulatory and appellate authority over certain actions that take place in whole or in part in the Delta and Suisun Marsh. The Council exercises that authority through development and implementation of the Delta

Plan. State and local agencies are required to comply with the set of 14 regulatory policies contained within the Delta Plan.
According to the Delta Reform Act, it is the state or local agency approving, funding, or carrying out the project that must determine if a project is a "covered action" subject to regulations of the Delta Plan, and if so, certify consistency of the project with Delta Plan policies (Water Code Section 85225). Generally, the California Environmental Quality Act (CEQA) lead agency makes the determination if a project is a covered action, which in the case of this project is the Central Valley Flood Protection Board (CVFPB). If it is determined that the project is a covered action, CVFPB will need to complete a certification of consistency that demonstrates that the project is consistent with the regulatory policies of the Delta Plan. (Please refer to our website at http://deltacouncil.ca.gov/covered-actions for more information about the covered action process.) Information and analysis needed to support a consistency certification could be taken directly from the EIS/EIR.

X-1

Council staff has reviewed the draft EIS/EIR and has found that several of the proposed risk reduction measures are within the legal Delta and this proposed project may be a "covered action" and, therefore, subject to Delta Plan regulations, although that determination ultimately resides with CVFPB. Consequently, we have identified the issues below that we believe you should consider, for the purposes of compliance with both the Delta Reform Act and CEQA.

Comments on the Draft EIS/EIR

For this letter, our comments are organized by subject area. Within each subject area we have included information on the Delta Plan policy (or policies) possibly implicated by this project and the requirements of these policies, as well as specific comments on the draft EIS/EIR. Where appropriate, we have also provided information on mitigation measures from the Delta Plan's EIR that should be considered for this project if it is deemed a covered action. In a separate but related letter to the USACE on the draft GRR, we provide comments specifically on the process of identifying the federal interest in the project. A copy of this letter will be provided to your agency as well.

Delta Plan EIR Mitigation Measures

Delta Plan Policy **G P1** (23 CCR Section 5002) requires that actions not exempt from CEQA and subject to Delta Plan regulations must include applicable feasible mitigation measures consistent with or more effective than those identified in the Delta Plan Environmental Impact Report (EIR). The Delta Plan's Program EIR provides a list of mitigation measures to address, including those to address impacts to biological resources and agricultural resources. (Mitigation measures can be found in the Delta Plan Mitigation and Monitoring Reporting Program document, http://deltacouncil.ca.gov/sites/default/files/documents/files/Agenda%20Item%206a_attach%202.pdf.) The Delta Plan mitigation measures most relevant to this project are discussed under the relevant subject area headings below.

Risk Reduction

Delta Plan Policy **RR P1** (23 CCR Section 5012) calls for the prioritization of State investments in Delta flood risk management, including levee operation, maintenance and improvements. This policy includes interim priorities categorized as specific goals to guide budget and funding allocation for levee improvements and to assist California Department of Water Resources (DWR) and the CVFPB in achieving a balance in funding the various goals. In consultation with DWR, CVFPB, Delta Protection Commission, and other state and local agencies, the Council is currently updating this investment strategy to better define the State's interests. The updated strategy should incorporate information on proposed projects such as the one described in this draft document.

The draft EIS/EIR states that the purpose of the proposed action under CEQA is to reduce flood risk to the Sacramento area by improving the levees that surround the study area. The draft GRR further states that the objective of the non-federal sponsors, the State of California and Sacramento Area Flood Control Agency (SAFCA), is to meet the requirements of California Senate Bill (SB) 5 and the Central Valley Flood Protection Act to achieve an urban level of protection. The non-federal sponsors' goal is consistent with one of the goals contained in Delta Plan Policy RR P1: to "Protect existing urban and adjacent urbanizing areas by providing 200-year level flood protection."

The Sacramento area, according to the draft EIS/EIR, is one of the most at risk areas for flooding in the United States, and there is a high probability of levee failure when flood waters flow in either the American or Sacramento Rivers, which stress the network of levees protecting the study area. Based on our review of the draft GRR, it is unclear if the proposed project can effectively reduce the flood risk for the region and assist local communities in achieving the urban level of flood protection as required by the State. According to USACE's risk analyses from the draft GRR, the results of the risk analyses for the American River South Reach concluded that the Annual Exceedance Probability (AEP) for the American River South (ARS) Reach as a whole is 1 in 147. These results demonstrate that the flood risk for the ARS region would be reduced with the Tentatively Selected Plan (TSP) in place, but this information is insufficient for concluding that the proposed project can achieve the non-federal sponsors' goal.

X-2

In the final EIS/EIR, the results of risk analyses of multiple alternatives should be included and clearly presented according to the USACE standards and State's urban level of flood protection criteria. This information will be essential for assessing consistency with Delta Plan Policy RR P1. Also, the final EIS/EIR should include the potential effects on existing conditions or adjacent upstream and downstream flood control systems. These additional analyses will not only enhance the environmental impact assessments for the proposed alternatives but may also be beneficial to USACE's ongoing Central Valley Integrated Flood Management Study, DWR's 2017 Central Valley Flood Protection Plan update, and the Council's development of the Delta Levees Investment Strategy.

The draft EIS/EIR states that the operation and maintenance (O&M) of the improved levee segments and the modified Sacramento Weir/Bypass are the responsibility of the local maintaining agencies, including the American River Flood Control District, DWR's Maintenance Area 9, and the City of Sacramento. The final EIS/EIR, or subsequent environmental evaluation documents, should include the details of the O&M plan, along with mitigation measures, for each levee improvement site and the modified Sacramento Weir/Bypass with well-defined measurable performance standards. This should be included in addition to the Standard Operation and Maintenance Manual for the Sacramento River Flood Control Project.

X-3

Habitat Restoration

The comments regarding habitat restoration pertain to the Sacramento River East Levee work and proposed associated off-site mitigation sites, since these areas are located within the legal Delta. There are two regulatory policies in the Delta Plan related to ecosystem restoration actions. Delta Plan Policy **ER P2** (23 CCR Section 5006) states that habitat restoration must be consistent with Appendix 3 of the Delta Plan regulations, which is an excerpt from the 2011 Draft Ecosystem Restoration Program Conservation Strategy. Delta Plan Policy **ER P4** (23 CCR Section 5008) calls for levee projects to evaluate and where feasible incorporate alternatives, including the use of setback levees, to increase floodplains and riparian habitats. The policy also calls for the evaluation of setback levees of certain areas of the Delta, including the urban levees addressed in this EIS/EIR.

The proposed project will involve extensive levee improvement work along the east bank of the Sacramento River and the American River. The TSP includes a suite of erosion protection measures for identified levee segments which include placement of rock fill above and below the low summer/fall waterline, placement of a launchable rock trench, and substantial removal of levee vegetation.

According to the draft EIS/EIR, the Local Maintaining Agency would address vegetation issues under the System Wide Improvement Framework (SWIF) agreement, with the assumption that the USACE would approve a variance for USACE Engineer Technical Letter (ETL) 1110-2-583 Vegetation Free Zone requirements. Even with a USACE approved vegetation variance, the proposed vegetation removal under the TSP could result in the loss of 750 riparian trees along the main stem of the Sacramento River, as well as extensive removal of shaded riverine aquatic habitat associated with placement of rock fill along nine miles of river channel. The impacts to these habitats are expected to have adverse effects on the special status species that depend upon them, including Chinook salmon and Swainson's hawk. CVFPB should work with USACE to obtain a vegetation variance and include the status of the variance application process in the final GRR and associated final EIS/EIR.

X-4

As acknowledged in the draft EIR under Impact AG-2, the project proposed in the GRR is expected to have potentially significant impacts on riparian habitat. This would be due to removing established riparian vegetation and shaded riverine aquatic habitat through placement of rock fill and its vegetation management plan to remove trees and shrubs it

considers detrimental to maintaining levee integrity. The Delta Plan's EIR Biological Resources Mitigation Measure 4-3 calls for proponents to design projects that avoid impacts that would lead to substantial loss of fish and wildlife habitat. If there will be a loss of habitat for fish and wildlife species from a project, Mitigation Measure 4-3 calls for proponents to replace, restore, or enhance habitats for those species and preserve in-kind habitat.

Given the tremendous investment by State, federal, and local agencies, as well as nonprofits, to promote recovery of salmonids and other threatened and endangered species that use the Sacramento and American Rivers as migratory corridors, it is essential to make every effort to avoid or minimize impacts to these riparian and channel margin habitat. The benefits to special status species provided by the proposed mitigation measures in the draft EIS/EIR are unclear. We recommend that, to the maximum extent feasible, any impacts to the channel margin habitat along important salmonid migratory corridors should be mitigated on-site. In the event that off-site mitigation is necessary, we also suggest that any off-site mitigation occurs in close proximity and along the same waterway as where the impacts would occur to demonstrate that the mitigation is restoring equivalent, in-kind habitat.

X-5

X-6 In the final draft EIS/EIR or additional environmental evaluations, please identify and include the details of the mitigation measures with or without the USACE vegetation variance and/or the SWIF in place, and describe how they would address impacts to special status species, such as salmonids and Swainson's hawk. If additional funding is available, and a lower benefit-cost ratio of the project is acceptable to USACE and non-federal sponsors, additional alternatives that offer opportunities to restore and improve shaded riverine aquatic habitat important for native terrestrial and aquatic wildlife should be considered.

X-7

Invasive Species

Delta Plan Policy **ER P5** (23 CCR Section 5009) calls for avoiding introductions and habitat improvements for invasive nonnative species. This policy states, "The potential for new introductions of or improved habitat conditions for nonnative invasive species, striped bass, or bass must be fully considered and avoided or mitigated in a way that appropriately protects the ecosystem." Analysis on this matter should address both nonnative wildlife species (e.g., introduced sport fish species), as well as nonnative vegetation, including both aquatic and terrestrial weeds. In-water rock fill often provides cover for nonnative predators like striped bass, but is often negatively associated with native fish species like Chinook salmon. In the final EIR, please describe how the project will avoid or mitigate permanent impacts associated with in-water rock fill, including the creation of habitat conducive to invasive fish predators which could impact listed native fish.

X-8

X-9 Delta Plan Biological Resources Mitigation Measure 4-1 includes a requirement that an invasive species management plan shall be developed and implemented for any projects where construction or operation could lead to introduction or facilitation of invasive species establishment. Based on the concerns raised above regarding invasive species, we believe that such a plan is necessary and should be developed soon to help guide site-specific levee

X-9 (Cont.)

improvement designs. This plan is to be developed in consultation with Department of Fish and Wildlife (DFW), U.S. Fish and Wildlife Service, National Marine Fisheries Service, and local experts. The invasive species management plan is to include the following elements: nonnative species eradication methods, nonnative species management methods, early detection methods, notification requirements, best management practices for preconstruction, construction, and post construction periods, monitoring, remedial actions and report requirements; and provisions for updating the target species list over the lifetime of the project as new invasive species become potential threats to the integrity of the local ecosystems.

Best Available Science and Adaptive Management

X-10

Delta Plan Policy **G P1** (23 CCR Section 5002) also states that actions subject to Delta Plan regulations must document use of best available science, as defined by Appendix 1A of the Delta Plan (refer to http://deltacouncil.ca.gov/sites/default/files/documents/files/AppB_Combined_2013.pdf). Additionally, this policy calls for water management and ecosystem restoration projects to include adequate provisions for continued implementation of adaptive management, appropriate to the scope of the action. This requirement can be satisfied through the development of an adaptive management plan that is consistent with the framework described in Appendix 1B of the Delta Plan (refer to http://deltacouncil.ca.gov/sites/default/files/documents/files/AppB_Combined_2013.pdf), along with documentation of adequate resources to implement the proposed adaptive management process. This policy is most applicable to the habitat restoration planned as mitigation for the environmental impacts of the levee projects.

Based on the draft GRR and the draft EIS/EIR, we understand that no monitoring or adaptive management plans have been developed related to the proposed habitat mitigation and enhancement activities. Prior to implementation of these habitat related actions, USACE, CVFPB, and potential local levee maintaining partners should develop adaptive management plans consistent with the Delta Plan; particularly the Plan's Appendix C. The uncertainty of whether the proposed habitat mitigation and enhancement measures are able to offset the impacts of the project and provide net benefits for native fish and wildlife species highlights the need for an effective adaptive management strategy and associated monitoring framework. Council staff is available to assist you in developing an adaptive management plan as part of early consultation to promote consistency with the Delta Plan. We suggest including documentation of best available science and an adaptive management plan as an appendix to the final EIS/EIR in order to have it available for use in a consistency certification.

Inconsistencies with the Delta Plan

X-11

The final EIS/EIR should discuss any inconsistencies between the proposed plan and the Delta Plan, as required by 15125(d) of the CEQA Guidelines. Please note that the CEQA guidelines' Appendix G states that a project that is inconsistent with any applicable land use plan, policy, or regulations may result in a finding of significant impact on biological resources.

X-11 (Cont.) Based on our initial review of the project, we have found potential inconsistencies with Delta Plan Policies **RR P1, ER P5**, and **G P1,** as described above.

Early Consultation

The Council strongly encourages all agencies who propose to approve, fund, or carry out an action in the Delta, as early in the project's development as possible, to consult with the Council and ensure the project (whether it is a covered action or not) is consistent with the Delta Plan. If CVFPB staff chooses to engage in early consultation, the Council staff will meet with you and offer guidance on determining whether the project meets the definition of a covered action, provided that the ultimate determination in this regard must be made by your agency. Council staff will also work with you to ensure consistency between the project and the Delta Plan's policies and recommendations. We also can help guide you through the certification process.

As mentioned above, Delta Plan Policy **G P1** requires that water management projects document use of best available science and include an adaptive management plan when filing a certification of consistency with the Delta Plan. We recommend that adaptive management for this project incorporate a monitoring, evaluation and reporting program that evaluates whether the project is successfully achieving the goals and objectives for the project. Delta Stewardship Council staff, including staff from the Delta Science Program, can provide early consultation to help in your preparation of documentation of use of best available science and adaptive management.

Next Steps

We look forward to continuing to work with your agency and other local, state, and federal agencies on this project. I encourage you to contact You Chen (Tim) Chao (916-445-0143) at YouChen.Chao@deltacouncil.ca.gov or Daniel Huang at Daniel.Huang@deltacouncil.ca.gov with your questions, comments, or concerns. We look forward to working with you to ensure consistency of the GRR Project with the Delta Plan while also avoiding, minimizing, or mitigating potential environmental impacts.

Sincerely,

Cindy Messer
Deputy Executive Officer
Delta Stewardship Council

cc: Ms. Anne Baker, U.S. Army Corps of Engineers, Sacramento District

STATE OF CALIFORNIA – NATURAL RESOURCES AGENCY EDMUND G. BROWN, JR., *Governor*

DELTA PROTECTION COMMISSION
2101 Stone Blvd., Suite 210
West Sacramento, CA 95691
Phone (916) 375-4800 / FAX (916) 376-3962
Home Page: www.delta.ca.gov

Contra Costa County Board of Supervisors

Sacramento County Board of Supervisors

San Joaquin County Board of Supervisors

Solano County Board of Supervisors

Yolo County Board of Supervisors

Cities of Contra Costa and Solano Counties

Cities of Sacramento and Yolo Counties

Cities of San Joaquin County

Central Delta Reclamation Districts

North Delta Reclamation Districts

South Delta Reclamation Districts

CA State Transportation Agency

CA Department of Food and Agriculture

CA Natural Resources Agency

CA State Lands Commission

May 4, 2015

Anne Baker
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, CA 95814

Erin Brehmer
Department of Water Resources
3464 El Camino Avenue, Room 200
Sacramento, CA 95821

Re: American River Common Features General Reevaluation Report Draft Environmental Impact Statement/Environmental Impact Report (SCH # 2005072046)

Dear Ms. Baker and Ms. Brehmer:

Thank you for providing the Delta Protection Commission (Commission) the opportunity to review the Draft Environmental Impact Statement/Environmental Impact Report for the American River Common Features General Reevaluation Report Project (Project).

The Commission is charged with ensuring orderly, balanced conservation and development of Delta land resources and improved flood protection. Proposed local government projects within the Primary Zone of the Legal Delta must be consistent with the Commission's Land Use and Resource Management Plan (LURMP). The Commission also provides comments on proposed projects in the Secondary Zone that have the potential to affect the resources of the Primary Zone. Portions of the Project are located within the Primary and Secondary Zones of the Legal Delta.

Proposed USACE and CVFPB actions are not subject to consistency requirements with the LURMP since the Project is sponsored by a federal and state agency. However, the Commission reviewed the EIS/EIR for possible impacts on the resources of the Primary Zone. We find that the Project provides necessary improvements to the Delta's levees and flood management system that promote the protection of life and property. We urge the U.S. Army Corps of Engineers (USACE), Central Valley Flood Protection Board (CVFPB), and Sacramento Area Flood Control Agency to minimize potential impacts to aesthetic, biological, cultural, and recreational resources where feasible. Y-1

In addition, the Great California Delta Trail Act (Chapter 839, statutes of 2006) directed the Commission to develop and adopt a plan and implementation program for a continuous regional recreational corridor extending throughout the five Delta Counties linking to the San Francisco Bay Trail and Sacramento

River Trail. In support of this objective, the Commission approved a resolution that encourages the incorporation of improved bicycle lanes as Delta levees are designed, engineered, and upgraded, taking into account the concerns of local residents and the viability of the Delta economy. Please consider incorporating improvements to accommodate bike lanes along the Sacramento River.

Y-2

Thank you for the opportunity to provide input. Please contact Blake Roberts, Associate Environmental Planner, at 916-375-4237 for any questions regarding the comments provided.

Sincerely,

Erik Vink
Executive Director

cc: Don Nottoli, Sacramento County Board of Supervisors

Z

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Office of the General Manager

May 4, 2015

VIA EMAIL AND U.S. MAIL

U.S. Army Corps of Engineers
Attention: Anne E. Baker
1325 J Street
Sacramento, CA 95814-2922
Anne.E.Baker@usace.army.mil

Dear Ms. Baker:

Comments on the Draft Environmental Impact Statement/Environmental Impact Report: American River Watershed Common Features Project-General Reevaluation Report (SCH No. 2005072046)

The Metropolitan Water District of Southern California (Metropolitan) has reviewed the Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) prepared by the two lead agencies, U.S. Army Corps of Engineers and Central Valley Flood Protection Board, to comply with the National Environmental Policy Act and the California Environmental Quality Act, respectively. As proposed, the subject project would provide flood risk management to the city of Sacramento by improving the levees that surround the city. This letter contains Metropolitan's comments on the EIS/EIR as a stakeholder in the State Water Project (SWP) and the Sacramento-San Joaquin Delta (Delta).

Southern California has an important stake in the Delta region and its existing infrastructure. As a SWP contractor, Metropolitan has invested and will continue to invest significantly in the SWP, efforts to restore sensitive fish populations in the Delta watershed, and scientific research into the causes of decline in fish native to the Delta. Even with the diversification of its supply sources and water use efficiency and conservation efforts, the SWP will remain a critical source of water supply for Metropolitan's service area. Hence, strategic levee protection measures are vital in protecting lives, infrastructure, and water quality in the Delta. However, should Alternative 2 of the subject project become the preferred alternative, then additional analyses should be conducted in support of the Folsom Dam Water Control Manual Update. These evaluations should consider flow frequency, duration, rate, and stage of American River Common Feature Project and Folsom Dam operations as they effect the Sacramento River, Yolo Bypass and related Delta water operations. Such analyses would ensure that habitat restoration opportunities in the Yolo Bypass, including the Cache Slough area, are not potentially compromised.

Z-1

We appreciate the opportunity to provide input to your planning process and we look forward to receiving future information concerning this proposed project. If we can be of further assistance, or if you would like to discuss Metropolitan's comments, please contact me at sarakawa@mwdh2o.com or Mr. Randall Neudeck at rneudeck@mwdh2o.com.

Very truly yours,

Stephen N. Arakawa
Manager, Bay-Delta Initiatives

DWS:rrw

cc: Ms. Erin Brehmer
California Department of Water Resources
3464 El Camino Avenue, Suite 200
Sacramento, CA 95821
Erin.Brehmer@water.ca.gov

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

May 4, 2015

U.S. Army Corps of Engineers
Sacramento District
Attention: Anne Baker
1325 J Street
Sacramento, California 95814-2922

Subject: American River Watershed Common Features General Reevaluation Report Draft Environmental Impact Statement/Environmental Impact Report, Sacramento and Yolo Counties, California [CEQ #20150071]

Dear Ms. Baker:

The U.S. Environmental Protection Agency has reviewed the above referenced document. Our review and comments are provided pursuant to the National Environmental Policy Act, the Council on Environmental Quality's NEPA Implementation Regulations at 40 CFR 1500 - 1508, and our review authority under Section 309 of the Clean Air Act.

The Draft Environmental Impact Statement evaluates alternatives to provide flood risk management to the city of Sacramento by improving the levees that surround the city. The Tentatively Selected Plan -- Alternative 2-Sacramento Bypass and Improve Levees -- appears to be the least environmentally damaging alternative as it results in less riparian habitat removal along the Sacramento River and creates additional floodplain acreage. EPA has rated the Tentatively Selected Plan and the Draft EIS as EC-2 -- Environmental Concerns-Insufficient Information" (see Enclosure 1: "Summary of EPA Rating Definitions").

Our concerns are based on the need for remediation of the Old Bryte Landfill in the proposed Sacramento Bypass expansion area, as well as the potential for construction emissions to contribute to violations of the National Ambient Air Quality Standard for oxides of nitrogen (NOx). We recommend that the Final EIS include additional information on cleanup plans for the landfill. We also recommend that, if NOx emissions would exceed the *de minimis* threshold under the Tentatively Selected Plan, the Final EIS demonstrate that the project would conform to the State Implementation Plan and include a draft conformity determination. Furthermore, we recommend that the Final EIS include additional information regarding wetlands and riparian habitat, climate change, mitigation measures, and the project's ability to meet flood protection levels required by California Senate Bill 5. Please see the enclosed detailed comments (Enclosure 2) for additional concerns and recommendations.

We appreciate the opportunity to review this Draft EIS. Please send one hard copy and one CD of the Final EIS to this office (mailcode ENF-4-2) when it is officially filed with EPA's *e-NEPA*. If you have

any questions, please call me at (415) 972-3521 or contact Jeanne Geselbracht, our lead NEPA reviewer for this project, at geselbracht.jeanne@epa.gov or (415) 972-3853.

Sincerely,

Kathleen Martyn Goforth, Manager
Environmental Review Section

Enclosures:
(1) Summary of EPA Rating Definitions
(2) EPA's detailed comments on the American River Watershed Common Features Draft EIS

cc: Erin Brehmer, Central Valley Flood Protection Board
Peter Buck, Sacramento Area Flood Control Agency
Howard Hold, Central Valley Regional Water Quality Control Board

SUMMARY OF EPA RATING DEFINITIONS

This rating system was developed as a means to summarize EPA's level of concern with a proposed action. The ratings are a combination of alphabetical categories for evaluation of the environmental impacts of the proposal and numerical categories for evaluation of the adequacy of the EIS.

ENVIRONMENTAL IMPACT OF THE ACTION

"LO" (Lack of Objections)
The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

"EC" (Environmental Concerns)
The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

"EO" (Environmental Objections)
The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

"EU" (Environmentally Unsatisfactory)
The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potentially unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

ADEQUACY OF THE IMPACT STATEMENT

Category 1" (Adequate)
EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

"Category 2" (Insufficient Information)
The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analysed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

"Category 3" (Inadequate)
EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analysed in the draft EIS, which should be analysed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

*From EPA Manual 1640, "Policy and Procedures for the Review of Federal Actions Impacting the Environment

Hazardous Materials

The Old Bryte Landfill is located immediately adjacent to the land side of the northern levee of the Sacramento Bypass and the eastern levee of the Yolo Bypass Flood Channel. This landfill area would become part of the expanded Sacramento Bypass floodway when the existing northern Sacramento Bypass levee is removed and relocated 1,200 feet farther north. The Draft Environmental Impact Statement (p. 272) states that the landfill would be completely remediated in accordance with Federal, State, and local laws by the non-federal partner prior to construction.

The Old Bryte Landfill is the subject of a Preliminary Assessment Report prepared for the EPA in February 2012. According to the Preliminary Assessment Report (p. 8), sampling results showed the presence of elevated levels of lead, zinc, dioxins, and polychlorinated biphenyls (PCB). Lead was detected in all samples at concentrations ranging from 13 milligrams per kilogram (mg/kg) to 22,000 mg/kg. The average lead concentration of 4,285 mg/kg exceeded the Total Threshold Limit Concentration (TTLC) of 1,000 mg/kg. The average Waste Extraction Test (WET) concentration for lead of 64 milligrams per liter (mg/L) exceeded the Soluble Threshold Limit Concentration (STLC) of 5.0 mg/L. Zinc was detected in one soil sample at 17,000 mg/kg, exceeding the TTLC of 5,000 mg/kg. PCBs were detected in five soil samples ranging from 0.50 to 0.98 mg/kg. Dioxins were detected in one soil sample at 0.14 mg/kg. TTLC and STLC are used for hazardous waste characterization under California State regulations. Trench logs indicate an overall waste depth from ground surface to 13 feet with an average waste depth ranging from 5.9 to 7.2 feet, and the estimated volume of the waste is approximately 127,107 cubic yards. In 2001, the California Integrated Waste Management Board concluded that the burn ash material would likely be classified as a California hazardous waste if it were to be excavated for disposal.

AA-1 The Draft EIS neither describes how the landfill would be remediated and the materials disposed, nor identifies applicable cleanup standards, confirmation testing, or agencies responsible for overseeing the remediation before the weir construction and bypass expansion can be completed.

Recommendation: Include the above information in the Final EIS.

Air Quality

EPA's guidance on General Conformity applicability analyses states, "the Federal agency can take measures to reduce its emissions from the proposed action to in fact below *de minimis* levels and, thus, the rule would not apply. The changes must be State or Federally enforceable to guarantee that emissions would be below *de minimis* in the future."[1] The Draft EIS is unclear regarding the assumptions, including the enforceability of emissions controls, that were factored into the emissions estimates for the truck delivery scenario and the barge delivery scenario under the project alternatives.

Table 31 of the Draft EIS indicates that Year 2 total oxides of nitrogen (NOx) emissions would exceed the *de minimis* General Conformity threshold for the Sacramento Area under the barge delivery scenario. In addition, Table 30 indicates that, under the truck delivery scenario, NOx emissions would

[1] General Conformity Guidance: Questions and Answers (Response to Question 29), July 13, 1994 http://www.epa.gov/air/genconform/documents/gcgqa_940713.pdf

be less than, but quite close to, the *de minimis* threshold. The Draft EIS (pp. 196 and 199) states that, with the implementation of the Sacramento Metropolitan Air Quality Management District's Enhanced Exhaust Control Practices for off-road equipment and using only on-road heavy-duty diesel trucks or equipment that comply with EPA 2007 on-road emission standards, annual construction emissions would be reduced to below *de minimis* thresholds. It appears, however, that the emissions estimates in tables 30 and 31 already account for emission reductions from these measures, since the methodology section (Draft EIS, p. 188) indicates that the air quality emissions analysis was based, in part, on an assumption that "all project plans and specifications will require that construction contractors use only off-road equipment that implements the SMAQMD Enhanced Exhaust Control Practices and only use on-road hauling equipment that was manufactured in 2010, or later."

In addition, the Draft EIS implies that a 20 percent reduction in NOx from off-road equipment, relative to the emissions provided in tables 30 and 31, would be applied to the project. The SMAQMD Enhanced Exhaust Control Practices for off-road equipment require demonstrating that the heavy-duty off-road vehicles will achieve a project wide fleet-average 20 percent NOx reduction and 45 percent particulate reduction *compared to the most recent California Air Resources Board fleet average*. It is unclear what assumptions for fleet averages were used in the emissions analyses, and whether the 20 percent NOx reduction mentioned on pp. 194 and 198 is in reference to, or in addition to, this Enhanced Exhaust Control Practice.

The Draft EIS (p. 202) states that the use of Tier 3 and Tier 4 standards for newly built marine engines would be encouraged under the barge delivery scenario. The Draft EIS (p. 202) also states that, under the barge delivery scenario, off-road diesel-powered construction equipment greater than 50 horsepower shall meet Tier 4 off-road emission standards at a minimum, and on-road heavy-duty diesel trucks or equipment with a GVWR of 19,500 pounds or greater shall comply with EPA 2007 on-road emission standards for PM and NOx.

Recommendations:

AA-2
- In preparing the Final EIS, please consult with Tom Kelly, EPA Region 9 Air Division, on the requirements of EPA's General Conformity Rule. He can be reached at (415) 972-3856 or kelly.thomasp@epa.gov.

AA-3
- Clarify in the Final EIS the measures and assumptions that were factored into the emissions estimates in tables 30 and 31, and provide any recalculations if needed.

AA-4
- Clarify the mechanisms that would be used to ensure that emissions reductions are enforceable (e.g., included in contract specifications?) and achievable.

AA-5
- Estimate in the Final EIS the additional emission reductions that would accrue to each scenario with application of all enforceable mitigation measures. If NOx emissions would exceed the *de minimis* threshold under the Tentatively Selected Plan, we recommend that the Final EIS include a draft conformity determination and demonstrate that the project would conform to the State Implementation Plan.

AA-6
- We encourage the use of marine engines meeting EPA's Tier 4 emissions standards for the barge delivery scenario, on-road trucks meeting EPA's 2007 emission standards for the truck delivery scenario, and off-road construction equipment meeting EPA's 2014 emissions standards, to the extent possible for both of these scenarios.

AA-7
- In the Final EIS, correct the following informational errors that appear in the Air Quality sections of the Draft EIS:

AA-7 (Cont.)

- Table 25 identifies a 24-hour sulfur dioxide National Ambient Air Quality Standard. On August 23, 2010, EPA revoked the 24-hour sulfur dioxide standard.
- Table 26 and p. 185, bullet 2: On October 28, 2013, the Sacramento PM10 nonattainment area was redesignated as an attainment area with an EPA-approved maintenance plan.
- Tables 28 and 31: The *de minimis* threshold for volatile organic compounds in the Bay Area Air Basin is 100 tons per year rather than 50 tons per year.

Flood Protection Level

The General Reevaluation Report (GRR, p. 2-3) identifies the California Senate Bill 5 requirement for urban areas to achieve a 200-year level of flood protection, and notes concern that improvements under the Federal plan might not achieve this standard. Table 3-19 of the GRR indicates that the American River South portion of the project would not meet this standard under the Tentatively Selected Alternative. We were unable to find a discussion in the Draft EIS of the requirements of SB 5 or of whether and how each alternative would meet its requirements. We also note that the list of significance thresholds for hydrology and hydraulics impacts (Draft EIS, p. 78), which is based on the environmental checklist in the California Environmental Quality Act Guidelines, does not include the project's ability to meet SB 5. The Council on Environmental Quality's regulations for implementing the National Environmental Policy Act require that EISs address possible conflicts between the proposed action and the objectives of Federal, regional, State, and local land use plans, policies and controls for the area concerned.

AA-8

Recommendation: We recommend that the Final EIS discuss whether and how each alternative would meet SB 5, including a description of any additional measures that would be needed to meet the standard and identification of the parties responsible for implementing and funding them.

According to the Draft EIS (p. 102), operation of the new weir and Sacramento Bypass will be determined after construction is complete. It is unclear what this information would entail and why it is not described in the EIS.

AA-9

Recommendation: We recommend that the Final EIS describe operation of the new weir and expanded Sacramento Bypass, and any potential additional impacts associated with operations not already discussed in the Draft EIS.

Vegetation

The Draft EIS (p. 49) states that lands within the extended Sacramento Bypass could be used to compensate for some of the trees being removed from the levees, and that a hydraulic analysis would need to be done to determine to what extent planting could occur. Elsewhere (p. 97), the Draft EIS states that detailed wetland surveys in the bypass will be done prior to construction. These analyses are also needed for determination and disclosure of the anticipated effectiveness of mitigation opportunities in the bypass and whether additional offsite mitigation sites may be necessary to compensate for project-related losses of riparian and wetland habitat.

AA-10

Recommendation: We recommend that the Final EIS discuss the results of the hydraulic evaluation and wetland survey in the expanded Sacramento Bypass area, including available

AA-10 (Cont.)

resources and opportunities to compensate for riparian and wetland habitat losses there, and the effectiveness of such compensation. If additional compensation areas would be needed, the Final EIS should identify those areas and the acreages needed.

Climate Change

The Draft EIS (p. 213) states, "project-wide GHG emissions would be well below the BAAQMD's GHG threshold of 10,000 MT CO2e per year, indicating that project-generated GHG emissions would not contribute to climate change." While the project-generated greenhouse gas emissions of approximately 3,400 metric tons of carbon dioxide equivalent emissions per year (Draft EIS, Table 34) are well below the Bay Area Air Quality Management District's GHG threshold, it is not accurate to indicate that the project-generated GHG emissions would not contribute to climate change, as all GHG emissions do contribute to climate change. Please note that, on December 18, 2014, the Council on Environmental Quality (CEQ) released revised draft guidance for public comment, which describes how Federal departments and agencies should consider the effects of greenhouse gas emissions and climate change in their NEPA reviews, and specifically addresses incremental contributions to climate change. As noted in the draft guidance,

AA-11

> "CEQ recognizes that many agency NEPA analyses to date have concluded that GHG emissions from an individual agency action will have small, if any, potential climate change effects. Government action occurs incrementally, program-by-program and step-by-step, and climate impacts are not attributable to any single action, but are exacerbated by a series of smaller decisions, including decisions made by the government."

Recommendation: We recommend that the conclusion regarding the project's contribution to climate change be revised to indicate that all GHG emissions contribute to climate change.

BB

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

Central Valley Regional Water Quality Control Board

29 April 2015

Erin Brehmer
Central Valley Flood Protection Board
3464 El Camino Avenue, Room 200
Sacramento, CA 95821

CERTIFIED MAIL
7014 2870 0000 7535 8331

COMMENTS TO REQUEST FOR REVIEW FOR THE DRAFT ENVIRONMENTAL IMPACT REPORT, AMERICAN RIVER COMMON FEATURES GENERAL REEVALUATION REPORT PROJECT, SCH# 2005072046, SACRAMENTO AND YOLO COUNTIES

Pursuant to the State Clearinghouse's 20 March 2015 request, the Central Valley Regional Water Quality Control Board (Central Valley Water Board) has reviewed the *Request for Review for the Draft Environment Impact Report* for the American River Common Features General Reevaluation Report Project, located in Sacramento and Yolo Counties.

Our agency is delegated with the responsibility of protecting the quality of surface and groundwaters of the state; therefore our comments will address concerns surrounding those issues.

Construction Storm Water General Permit

BB-1 Dischargers whose project disturb one or more acres of soil or where projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres, are required to obtain coverage under the General Permit for Storm Water Discharges Associated with Construction Activities (Construction General Permit), Construction General Permit Order No. 2009-009-DWQ. Construction activity subject to this permit includes clearing, grading, grubbing, disturbances to the ground, such as stockpiling, or excavation, but does not include regular maintenance activities performed to restore the original line, grade, or capacity of the facility. The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP).

For more information on the Construction General Permit, visit the State Water Resources Control Board website at:
http://www.waterboards.ca.gov/water_issues/programs/stormwater/constpermits.shtml.

Phase I and II Municipal Separate Storm Sewer System (MS4) Permits[1]

BB-2 The Phase I and II MS4 permits require the Permittees reduce pollutants and runoff flows from new development and redevelopment using Best Management Practices (BMPs) to the maximum extent practicable (MEP). MS4 Permittees have their own development standards, also known as Low Impact Development (LID)/post-construction standards that include a hydromodification component. The MS4 permits also require specific design concepts for LID/post-construction BMPs in the early stages of a project during the entitlement and CEQA process and the development plan review process.

For more information on which Phase I MS4 Permit this project applies to, visit the Central Valley Water Board website at:
http://www.waterboards.ca.gov/centralvalley/water_issues/storm_water/municipal_permits/.

For more information on the Phase II MS4 permit and who it applies to, visit the State Water Resources Control Board at:
http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml

Industrial Storm Water General Permit

BB-3 Storm water discharges associated with industrial sites must comply with the regulations contained in the Industrial Storm Water General Permit Order No. 97-03-DWQ.

For more information on the Industrial Storm Water General Permit, visit the Central Valley Water Board website at:
http://www.waterboards.ca.gov/centralvalley/water_issues/storm_water/industrial_general_permits/index.shtml.

Clean Water Act Section 404 Permit

BB-4 If the project will involve the discharge of dredged or fill material in navigable waters or wetlands, a permit pursuant to Section 404 of the Clean Water Act may be needed from the United States Army Corps of Engineers (USACOE). If a Section 404 permit is required by the USACOE, the Central Valley Water Board will review the permit application to ensure that discharge will not violate water quality standards. If the project requires surface water drainage realignment, the applicant is advised to contact the Department of Fish and Game for information on Streambed Alteration Permit requirements.

If you have any questions regarding the Clean Water Act Section 404 permits, please contact the Regulatory Division of the Sacramento District of USACOE at (916) 557-5250.

[1] Municipal Permits = The Phase I Municipal Separate Storm Water System (MS4) Permit covers medium sized Municipalities (serving between 100,000 and 250,000 people) and large sized municipalities (serving over 250,000 people). The Phase II MS4 provides coverage for small municipalities, including non-traditional Small MS4s, which include military bases, public campuses, prisons and hospitals.

Clean Water Act Section 401 Permit – Water Quality Certification

BB-6 If an USACOE permit (e.g., Non-Reporting Nationwide Permit, Nationwide Permit, Letter of Permission, Individual Permit, Regional General Permit, Programmatic General Permit), or any other federal permit (e.g., Section 9 from the United States Coast Guard), is required for this project due to the disturbance of waters of the United States (such as streams and wetlands), then a Water Quality Certification must be obtained from the Central Valley Water Board prior to initiation of project activities. There are no waivers for 401 Water Quality Certifications.

Waste Discharge Requirements

BB-7 If USACOE determines that only non-jurisdictional waters of the State (i.e., "non-federal" waters of the State) are present in the proposed project area, the proposed project will require a Waste Discharge Requirement (WDR) permit to be issued by Central Valley Water Board. Under the California Porter-Cologne Water Quality Control Act, discharges to all waters of the State, including all wetlands and other waters of the State including, but not limited to, isolated wetlands, are subject to State regulation.

For more information on the Water Quality Certification and WDR processes, visit the Central Valley Water Board website at:
http://www.waterboards.ca.gov/centralvalley/help/business_help/permit2.shtml.

Regulatory Compliance for Commercially Irrigated Agriculture

If the property will be used for commercial irrigated agricultural, the discharger will be required to obtain regulatory coverage under the Irrigated Lands Regulatory Program.
There are two options to comply:

BB-8

1. **Obtain Coverage Under a Coalition Group.** Join the local Coalition Group that supports land owners with the implementation of the Irrigated Lands Regulatory Program. The Coalition Group conducts water quality monitoring and reporting to the Central Valley Water Board on behalf of its growers. The Coalition Groups charge an annual membership fee, which varies by Coalition Group. To find the Coalition Group in your area, visit the Central Valley Water Board's website at: http://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/app_approval/index.shtml; or contact water board staff at (916) 464-4611 or via email at IrrLands@waterboards.ca.gov.

2. **Obtain Coverage Under the General Waste Discharge Requirements for Individual Growers, General Order R5-2013-0100**. Dischargers not participating in a third-party group (Coalition) are regulated individually. Depending on the specific site conditions, growers may be required to monitor runoff from their property, install monitoring wells, and submit a notice of intent, farm plan, and other action plans regarding their actions to comply with their General Order. Yearly costs would include State administrative fees (for example, annual fees for farm sizes from 10-100 acres are currently $1,084 + $6.70/Acre); the cost to prepare annual monitoring reports; and water quality monitoring costs. To enroll as an Individual Discharger under the Irrigated Lands Regulatory

Program, call the Central Valley Water Board phone line at (916) 464-4611 or e-mail board staff at IrrLands@waterboards.ca.gov.

Low or Limited Threat General NPDES Permit

BB-9

If the proposed project includes construction dewatering and it is necessary to discharge the groundwater to waters of the United States, the proposed project will require coverage under a National Pollutant Discharge Elimination System (NPDES) permit. Dewatering discharges are typically considered a low or limited threat to water quality and may be covered under the General Order for *Dewatering and Other Low Threat Discharges to Surface Waters* (Low Threat General Order) or the General Order for *Limited Threat Discharges of Treated/Untreated Groundwater from Cleanup Sites, Wastewater from Superchlorination Projects, and Other Limited Threat Wastewaters to Surface Water* (Limited Threat General Order). A complete application must be submitted to the Central Valley Water Board to obtain coverage under these General NPDES permits.

For more information regarding the Low Threat General Order and the application process, visit the Central Valley Water Board website at:
http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2013-0074.pdf

For more information regarding the Limited Threat General Order and the application process, visit the Central Valley Water Board website at:
http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2013-0073.pdf

If you have questions regarding these comments, please contact me at (916) 464-4684 or tcleak@waterboards.ca.gov.

Trevor Cleak
Environmental Scientist

cc: State Clearinghouse unit, Governor's Office of Planning and Research, Sacramento

CC

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May 7, 2015

Ms. Anne Baker
U.S. Army Corps of Engineers – Sacramento District
1325 J Street – 11th Floor
Sacramento, CA 95814

Subject: **American River Common Features General Reevaluation Report – Draft Environmental Impact Report**

Dear Ms. Baker:

Sacramento Regional County Sanitation District (Regional San) has reviewed the subject report and has the following comments.

Regional San has numerous pipeline crossings of the American River that could potentially be impacted by the proposed erosion control work referenced within the subject report. The launchable rock trench, which is described as up to 10' in depth, may be in conflict with some of these facilities.

CC-1 Regional San requests that all design submittals for the proposed erosion control effort be reviewed and approved by Regional San for any reach of work that may potentially impact Regional San facilities.

If you have any questions or concerns regarding this letter, please feel free to contact me at (916) 876-6104.

Sincerely,

Robb Armstrong
Regional San Development Services & Plan Check

cc: Sarenna Moore – Regional San Long Range Planning

Joseph E. O'Connor Jr.
[redacted]

14 May 2015

U. S. Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, CA 95814

Subject: Draft Report, American River Watershed, Common Features, General Reevaluation Report, March 2015

I am submitting a response to the subject Draft Report for consideration regarding overtopping concerns at the east end of the south-side of the American River levee. More specifically, it's the east end of the levee section known as the Mayhew Levee. When the entire Mayhew levee section was raised and upgraded it was noted that it did not tie into high ground at the east end, but instead left nearly a two-foot gap between the high levee top and lower adjacent ground to the rear where rising river water could prematurely pass. Members of our community, including myself, reported this to the Sacramento Area Flood Control Agency and the Corps of Engineers and requested a repair.

DD-1

This past November, the Corps of Engineers completed what they considered a repair; however, this minor repair, while reducing some of the shortfall, still falls short of tying the east end into high ground equal to the levee top. To address the shortfall in an emergency, the Corps of Engineers has introduced a plan involving adding a wall of sandbags to fill the low area around the rear of the levee's east end. This would involve removing homeowner fences and building the sandbag wall across back yards. In such a dire emergency, flood control officials shouldn't be concerning themselves with something that's so easy to fix long before hand. The east end of the Mayhew Levee should tie into high ground equal to the top of the levee. A project to do this should be added to this General Reevaluation Report.

Sincerely,

Joseph E. O'Connor Jr.

U.S. Army Corps of Engineers, Sacramento District
Attention: Ms Anne Baker
1325 J Street, Sacramento, CA 95814
and Central Valley Flood Protection Board
c/o U.S. Army Corps of Engineers, Sacramento District
1325 J Street, Sacramento, CA 95814

May 18, 2015

Re: American River Watershed, Common Features, General Reevaluation Report, Draft Report, March 2015.

This was an important document to read, with the key new element to the traditional Common Features Project, the expansion of the Sacramento River bypass, apparently well supported in the tentatively selected alternative. The other new elements, additional work on tributaries to the Natomas East Main Drain, was somewhat surprising, but this should have been expected since private-citizen forums for reviewing the detailed work of this lengthy draft General Reevaluation Report (GRR or Report) before the release of the draft GRR have been somewhat limited.

Regrettably, the short comment period for this GRR limits the scope of these comments. But before going to the meat of our comments on the Report, we'd like to highlight an important issue:

The GRR does and should recognize that bank protection and other land and river-edge and riparian-forest disturbing projects within the American River Parkway are of significant concern to the public. The GRR suggests that the project sponsors will work to address these concerns. However, the new Corps feasibility review process for submitting to Congress for authorization does not develop enough site-specific project detail for the public to engage effectively at this level of project characterization. The public and the authorizing bodies (including the Congress) are being asked to trust project sponsors that the final as-constructed projects will be good ones for the Parkway as well as community safety. An argument can be made that this trust has been earned. Perhaps this is correct. Perhaps not.

In these circumstances, assurances that the project sponsors can make that they will abide by relevant laws protecting the American River Parkway and wild & scenic river are important. We hope that you take our specific suggestions seriously. Accepting them

may or may not require recirculation, but the Final GRR needs to successfully address the deficiencies of the draft.

EE-1 Our comments here address a few themes: (1) Let's get the history of the Sacramento River Basin and area floodwater-management projects right. These documents live on, so it's important to write carefully and communicate accurately at all the important levels. To do so, let's meet to discuss our offered comments. We want to avoid misunderstandings so that your responses to comments are on target. Don't bury any needed corrections to the GRR in the Response to Comments appendixes. We want to make sure if you don't get the words right in the draft Report, get them right in the final Report that people actually will read in the future (2) Make sure that you don't ignore or

EE-2 downplay your environmental responsibilities. Make it clear what they are, and tell us that you will abide by them.

EE-3 These comments cannot contain sufficient expert subject matter comments on the reach-by-reach vulnerability of river and creek levees affected by the project, or the project designs to avoid or robustly mitigate adverse impacts, as much as we would like to have delivered these comments. The GRR is not detailed enough and the comment period too short to review these critical project assumptions. The consequence may have to be that preconstruction engineering and design will need to be the robust "formal and informal" processes that the GRR commits to engage in. As you know, previous bank-protection projects on the Lower American River had and have been thoroughly vetted in the Lower American River Task Force formed in 1993. The setting of the GRR is now a wider one, but the Task Force is certainly a good place to start. In fact, starting this review early is a good idea. Failing a quick authorization by the Congress (their record does not inspire confidence), one or more than one of the project sponsors may wish to or should find the resources to engage in a collaborative advanced site design process.

With that admonition, let's move on to the page-by-page comments on the Report.

EE-4 GRR p. PAC-18: The description of the purpose of the 1986 release from Folsom Dam above the objective release is misleading. It is true that "rapid inflow" was part of the decision to make the 134,000 cfs release, but the status of the reservoir and antecedant operational decisions were the real reasons for the departure from the objective release. As noted in the National Research Council (NRC) report referenced below, there would have been no reason to surcharge the reservoir and make a release in excess of the objective release if the Reservoir Water Control Manual had been followed. Of course the nerves of the dam operators were also tested by the failure to revise the Manual to account for the likely failure of the Auburn Coffer Dam at the halted construction site (suddenly releasing enough water to fill more than a quarter of Folsom's flood reservation) in an already significant high-water event. We excerpt some of the conclusions from the NRC here:

> On February 13 and 14 the California Department of Water Resources (CDWR) began preparations for a full flood fight, given computer projections of a[n] extraordinary storm

approaching the state from across the Pacific (CDWR, 1986). The American River flood flows began in earnest on February 15, with inflows rising to over 60,000 cfs early the next day, but Figure 2.1 shows that Folsom operators did not begin to evacuate the flood control storage volume, nor did releases from Folsom match the inflows to the lake. Operators expressed a major concern for the effect of large Folsom releases on recreational facilities in the lower American River floodway; releases were held to 20,000 cfs for 36 hours. This is inconsistent with the 1977 USACE flood control diagram in force at the time; the diagram states that when Folsom storage is in the flood control reservation the water "shall be released as rapidly as possible" subject to ramping limits. Even after increased releases from Folsom began on February 16, and before they reached the 115,000-cfs limit, Folsom releases continued to lag behind inflows into Folsom Lake by 30,000 cfs or more. USACE-prescribed ramping limits of "15,000 cfs during any 2-hour period" do not appear to have limited the rate of increase of Folsom releases during the 1986 flood, nor were physical release rate limits at Folsom Dam a constraint given the initial elevation of the reservoir.

Lesson: Procedures need to be adopted to ensure that flood releases are made as required by operating regulations if intended flood risk reduction is to be achieved.

EE-4
(Cont.)

Folsom operations were primarily based on the actual inflow to Folsom Reservoir calculated from lake level changes (Figure 2.1). This calculation ignored the accumulation of water in the cofferdam near the Auburn dam site above Folsom. Written operating procedures do not mention this accumulation of water. Because this cofferdam was designed to breach with the 30-year flood flow, its accumulation distorted the effective inflow to the Folsom-cofferdam system and the accumulated storage in the two reservoirs, which ended up in Folsom Reservoir when the cofferdam finally breached.

Lesson: Plans need to be updated to reflect changes in facilities in basins and "temporary" structures.

If the Bureau of Reclamation had been able to more closely match outflow to inflows while inflows were less than 115,000 cfs, then releases into the American River would not have exceeded 115,000 cfs during the 1986 flood using the nominal storage capacity of the reservoir, even without anticipation of the Auburn cofferdam failure. Fortunately, disaster was averted by the use of extra surcharge storage in Folsom and by the ability of the downstream channel and levee system to handle releases of 130,000 cfs. Lessons drawn from the 1986 experience should not be forgotten. (See National Research Council Committee on *Flood Control Alternatives in the American River Basin,* National Academy Press, Washington, D.C., 1995, pp. 44–48. We'd be happy to make these pages available if the planning team does not have them.)

Resuming our thoughts, the History of Project (PAC-18) implies that "rapid inflow"[1] was responsible for the 1986 release in excess of Folsom Reservoir's objective release. To the extent that readers draw the conclusion that the 1986 high water exceeded Folsom Dam's reservoir design flood, the project sponsors are rewriting the history of the 1986

[1] The instanteous peak inflow in 1986 was reported to be 900,000 cfs when 120,000 acre feet were released with the failure of the Auburn coffer dam. *Corps of Engineers. Sacramento District, Folsom Dam and Lake, American River, California, Water Control Manual*, Appendix VIII to Master Water Control Manual, Sacramento River Basin, California, 1987, pp. iv, IV-7–8.

EE-4 (Cont.)

American River flood event and failing to abide by the admonition of the NRC not to forget these lessons.[2]

EE-5

GRR p. 1-18: The history of Folsom Dam's design is slightly over-simplified when it is reported that it was designed to meet the Standard Project Flood in existence at that time: instead, it was designed to handle the predecessor method to the Standard Project Flood. Here's the more detailed history as told by the U.S. Bureau of Reclamation (Reclamation):

> "In the design of Folsom Reservoir, the Corps of Engineers recognized the need to provide protection against a very large winter rain flood. The flood of January 1862 was thought to be the largest experienced flood for which estimates could be made, and those estimates[3] were initially considered by the local Corps of Engineers' staff for the Folsom flood control design operation plan. Objections raised by higher echelons of the Corps of Engineers, based on flood control experience throughout the United States resulted in discarding the estimated 1862 flood hydrograph and preparing a revision of the design flood to assure that a higher or "project design" degree of protection would be provided by the flood control operation under consideration, when allowance for unforseen contingencies was included." (Corps of Engineers Comments on Draft of USBR 'Amendment to the Final Environmental Statement and Supplement on Auburn-Folsom South Unit,' " July 11, 1974, *Amendment to the Final Environmental Statement and Supplement on Auburn-Folsom South Unit, American River*

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[2] Reservoir design floods are the volume of water in a reservoir-specific hydrograph that can be safely stored and released downstream under a given set of initial-state conditions. Flood hydrographs with routings that, for example, cause a reservoir to surcharge or cause releases above a dam's objective release or downstream conveyance capacity would exceed the reservoir design flood. In practice, no American River flood has caused surcharge or release of more than the objective release with the exception of 1986, and this was because of operational irregularities described by the NRC. Folsom Dam's reservoir design-flood hydrograph is represented in a number of Corps documents, including *Corps of Engineers. Sacramento District, Folsom Dam and Lake, American River, California, Water Control Manual*, Appendix VIII to Master Water Control Manual, Sacramento River Basin, California, 1987, sheet 2 of 8, Plate 19. The hydrograph is a partially reregulated inflow into Folsom Reservoir. The peak of the design hydrograph is 340,000 cfs, which no unregulated (unimpaired) historic flood has approached. In recent decades, three-day unregulated inflow volumes have been the customary way to describe actual flood magnitudes experienced by section-7 reservoirs in this region. Three-day design floods have never been developed for the existing Folsom Dam and the various reservoir-regulation manuals that described its operations from 1955 to 1986 (a six-day volume and a peak inflow were developed), a period where the SMUD UARP and PCWA Middle Fork Projects were constructed. If a three-day volume (regulated or not) has been developed for Folsom's design flood for this period, the following period 1987–95, and the current variable storage period, we would appreciate it if this data and supporting assumptions could be shared with us. The estimate of the peak of the variable-storage Folsom Dam design hydrograph, 360,000 cfs, is from MBK, personal communication, 2006.

[3] We have the Corps of Engineers 1941 and 1943 Leslie E. Bossen American River 1862 flood-estimate memos. They are an interesting and valuable read, and a written review is under preparation, but the Bossen memos suffer from a lack of a hydrograph and documentation of the stage-discharge routings. We can share the Bossen memos with the GRR team if they have passed from collective memory of the Sacramento District. If the Corps or the Central Valley Flood Protection Board has additional library documentation of the 1862 flood or the detailed history of the design of Folsom Dam's reservoir design flood, please contact us. They belong in our library as well and would be of interest to academic researchers as well.

Division, Central Valley Project-California, Volume 2, Department of the Interior, USBR, p. 248)

A complementary take on the design flood comes from the California Department of Water Resources (DWR): the reservoir design flood for Folsom Dam was developed from statistically centering the 1937 large regional flood over the American River Basin and computing its outflow—developing a peak inflow of 340,000 cfs at the design hydrograph used at the time. (*A Preliminary Study of Flood Control Alternatives on the Lower American River*, California Department of Water Resources, Central District, September 1982, p. 7). The GRR should note that Folsom Dam's reservoir design flood peak flow or the crucial three-day volume has not been exceeded by recorded flows.

EE-5 (Cont.)

GRR p. 1-18's characterization of the SPF event frequency ("between the 250- and 500-year event") is perhaps a simplification of the annual flood frequency often found in (but not assigned to) modern SPFs, although the SPF is now a fairly unused concept.[4] Regardless as noted above, this frequency was not the statistical characterization of the "project design" flood hydrograph at the time that Folsom Dam was designed. In fact, as the authors of the GRR must know, probability characterizations of the SPF are not relevant to the creation of SPFs. Instead, particularly in the early years, SPFs were based on transposition of the historic regional flood hydrology over the basin of interest. In recent years, SPFs have tended to be scaled PMFs. Neither methodology bases its determinations on a statistical probability range for a hydrologic event.

For example, statistical analysis to characterize the Folsom Dam's design flood (the pre-SPF, but similar "project design" flood) at the time of initial design suggested that the dam and levee system could contain the modeled 1000-year flood (*A Preliminary Study of Flood Control Alternatives on the Lower American River*, California Dept. of Water Resources 1982, p. 7). When Folsom Dam was built, it was expected to provide 250-year protection (*ARWI Feasibility Report, Main Report*, Corps of Engineers, Sacramento District, 1992, p. III-5). But soon after the dam was constructed, a 120-year level of protection was modeled, an annual flooding risk of 0.7%.[5] Of course, as new statistical treatments resulting from high water in 1986 and 1997, along with new deterministic engineering criteria for levee competence, became incorporated, the modeled frequency of Folsom Dam's design flood has bounced around, something that continued as more

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[4] The standard project flood methodology was the subject of a Corps engineering manual: *USACE, ER 1105-2-101, 1952 revised 1965.* It has been updated subsequently.

[5] *A Preliminary Study of Flood Control Alternatives on the Lower American River*, California Dept. of Water Resources 1982, p. 7. The reports of this post-construction-era assessment varied. In the 1962 Letter From the Secretary of the Interior Transmitting a Report on the Auburn-Folsom South Unit Proposing Expansion of the Central Valley project in California, Pursuant to Section 9(a) of the Reclamation Act of 1939 (53 Stat. 1187), and Section 2 of the American River Basin Development Act of October 14, 1949 (63 Stat. 852), House Document #305, 87th Congress, 2nd Session, p. 16, the Department estimated the modeled level of protection at that time to be 200 years. (January 18, 1962)

annual flood records affected the statistical analysis and Common Features and reoperation projects came on line.

This should be expected. Unlike design floods (which are expressed in relevant volumes or peak discharges of the design hydrograph—and only change when topography or the flood-control facilities change), statistical characterizations of the "level of protection" or "return frequencies" or "annual exceedances" of this and other project design floods vary widely, depending on statistical methodologies and the underlying hydrology data set and engineering assumptions, which evolve with time. This should be particularly true for statistical estimates for the probability distribution of hypothetical flood magnitudes—which, after all, have never been experienced and the "true" probability distribution of which is speculative—but in practice is driven by the chosen statistical methodology, adopted skew, and even the low flow record events.

EE-5 (Cont.)

Again on page 1-18, there is another error: that the emergency release for Folsom Dam is 152,000 cfs. It is not. It is most simply characterized as 160,000 cfs (See Corps of Engineers. Sacramento District, *Folsom Dam and Lake, American River, California, Water Control Manual*, *Appendix VIII to Master Water Control Manual, Sacramento River Basin, California,* 1987, chart A-9, Emergency Spillway Release Diagram, Operating Instructions). The 152,000 cfs number comes from the flows assigned to the original design minimum freeboard of the levees along the lower American River: 3 feet for 152,000 cfs or 5 feet at 115,000cfs.[6]

EE-6

P-1-19. It's an exaggeration to suggest that the 1986 134,000 cfs release was made "to manage the risk of dam failure" (the release was made to avoid higher regulated releases that might cause greater strain on the American River levees and banks) and that conditions "came dangerously close to requiring operation of the [three] emergency flood gates at flows in excess of 152,000 [sic] cfs." With a full or nearly full reservoir, the five operational gates can make a release considerably in excess of the 152,000 cfs, nor does the diagram contemplate making releases higher than the emergency release target of 160,000 cfs until circumstances become noticeably more dire than what occurred in 1986 (inflows were declining sharply during most of the 134,000 cfs release according to Figure 2.1 on page 48 of the NRC report and sheet 8 of 8, plate 19 of the Folsom Dam Water Control Manual).[7]

EE-7

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[6] For a simple but informative discussion of American River design levee height and flow relationships, see pages 3-17–18 of the *Folsom Dam Raise & Auxilliary Spillway Alternative Project Alternative Solutions Study (Pass) II, Final Report*, June 2006, ACE, Rec Board, DWR, USBR, SAFCA.

[7] The U.S.A.C.E. Sacramento District, *Folsom Dam and Lake, American River, California, Water Control Manual, Appendix VIII to Master Water Control Manual, Sacramento River Basin, California,* 1987. Chart A-9, "Indicated Release for the Next Hour" diagram, displays the maintaining-no-more-than-160,000 cfs "rule" until there is four feet of surcharge (in 1986, Folsom Reservoir surcharged 1.56 feet according to the *Sacramento and San Joaquin River Basins, California, Post-Flood Assessment*, March 1999, U.S. Army Corps of Engineers p. 5-18), and chart A-5, Spillway Total Capacity Curve [without emergency gates], displays a gross-pool discharge capacity as approximately 280,000–300,000 cfs. Note

EE-8 GRR p. 1-29: The Central Valley Flood Protection Plan (CVFPP) 200-year standard for reduced floodplain management and proposed improvements for urban levees need not be based on Corps of Engineers statistical and engineering methodologies. The statute provides that DWR, not the Corps, determines the statistical and engineering-criteria methodologies to assess performance against a state 200-year standard for floodplain management restrictions under California state law, SB-5, state legislation passed in 2007 (Cal GC 65300.2(a)). The CVFPP echoes this.

EE-9 GRR p. 2-4: It's true to say that in 1986 the Sacramento River flood-control system was near or somewhat above capacity, which perhaps could be translated to the "Sacramento River flood control system was overloaded" statement contained in the report. But with the exception of the left-bank Yuba River levees, the project levees along the major rivers held[8], and the Yuba River levee on the descending limb of the flood hydrograph at 60% of design flow. We have not previously seen estimates that 1986 actual flows were meaningfully larger than design floodway capacities in this area until this report (650,000 cfs combined in the Yolo Bypass and Sacramento River in the GRR, against 600,000 cfs nominal and the 1991 Corps bypass-near-Lisbon and Sacramento-River-near-Freeport estimate of 605,000–614,000 cfs[9]). We are not aware of any releases in excess of tributary floodway capacity for any of the section-7 reservoir[10] tributaries to the Sacramento River, although the objective release was exceeded at Folsom Dam because of the previously mentioned operational irregularities.

It's barely correct to say that reservoirs in the Sacramento system "were filled beyond their design capacity" in 1986. Only one large reservoir was: Folsom Dam because of departures from operations prescribed in the Reservoir Regulation Manual. In fact, there were no exceedances of normal pools in the San Joaquin Valley section-7 reservoirs either.[11] It may be misleading and certainly vague to talk of "reservoirs

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that the emergency (auxiliary) spillway with its flip-bucket energy dissipater instead of a large stilling basin is "intended for use only during extreme flood periods." (*Folsom Water Control Manual, 1987*, II-2)

[8] *Sacramento and San Joaquin River Basins, California, Post-Flood Assessment*, March 1999, U.S. Army Corps of Engineers, table 5-15.

[9] *Draft Feasibility Report, American River Watershed Investigation, California, Documentation Report,* Volume 2 - Appendix K, p. K-8. Table 8 here is a comparison of design flows and stages and peak flows and stages during February 1986 flood event. It would be interesting to see if, how, and why these figures would differ from estimates in 2015.

[10] Section-7 of the Flood Control Act of 1947. Flood control operations of these reservoirs are regulated by the Army Corps of Engineers' Water Control Manuals.

[11] In 1986, the small Sacramento Valley coast-range reservoir, Black Butte Reservoir, exceeded its gross pool of 144,000 acre feet by 24,000 acre-feet. It made a spillway release of 3,900 cfs (presumably augmenting its 15,000 cfs objective release by that amount) *Black Butte Dam and Lake, Stony Creek, California Water Control Manual*, U.S. Army Corps of Engineers, Sacramento District, May 1987, p. III-6 and *Post-Flood Assessment*, March 1999, U.S. Army Corps of Engineers, p. 5-18, table 5-14. Comanche

produc[ing] river flows that exceeded the design capacity of downstream levees: water came within inches of overtopping levees protecting Sacramento" if Common Features riverside levees are being referred to, although the new Common Features flow estimate in the Yolo Bypass/Sacramento River would put the 1986 combined flow at more than eight percent above the design flow.

Turning back to the American River, post-flood descriptions of design freeboard for these levees and the 1986 freeboard/flow relationships were published in the January 1995 *Proceedings of Phase Two, The Lower American River Task Force*. The Proceedings assessed then-existing Project levee freeboard conditions at various flows along the American river and concluded the following:

> For a release of 115,000 cfs, the existing minimum [freeboard] is the same for both left and right bank [project] levees (about 6 feet). The 130,000 cfs release condition also has about the same freeboard at the lowest point (interpolated to about 5.5 feet). (p. L-2, L-3)

EE-9
(Cont.)

This is not inches. It seems difficult to see how the current Common Features GRR could differ so significantly from the *Proceedings*. We suspect that the *Proceedings*' more detailed and documented descriptions are more accurate than these undocumented assertions in the draft GRR, but look forward to reviewing these conclusions with the GRR team.

The "inches" description could refer to a different problem involving what are now Common Features levees but not the river levees. The 1986 flood did show a freeboard/discharge/backwater problem with the Natomas East Main Drainage Canal (NEMDC) levee, which failed to have the freeboard envisioned by their designers in 1986 (remaining freeboard on the NEMDC near Main Avenue and the Natomas Cross Canal was 0.5 foot to 2 feet[12]). The drainage canal also had a problem with its upstream-levee creek collectors system, which failed to extend far enough upstream. It was this condition that caused localized severe flooding behind the outflanked NEMDC (Steelhead Creek) levee (Strawberry Manor). These deficiencies were largely remedied by the Sacramento Area Flood Control Agency (SAFCA) North Area Project of the early 1990s, which had a design philosophy to achieve sufficient freeboard for a stage associated with a 180,000 cfs flow in the American River and the design flow in the Sacramento River. The SAFCA North Area Project Feasibility studies characterize the problem and their solution. Although SAFCA's projects were largely completed, the

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Reservoir (not included in either the Sacramento or San Joaquin Valleys) exceeded its gross pool of 430,000 acre-feet by 9,000 acre-feet. We have not seen documentation that Comanche Reservoir released more than its objective release as a result of this small surcharge. *Post-Flood Assessment*, March 1999, U.S. Army Corps of Engineers, p. 5-18, table 5-14.

[12] *Draft Feasibility Report, American River Watershed Investigation, California, Documentation Report,* Corps of Engineers, Part 1, April, 1991, p. III-14.

EE-9 (Cont.) Common Elements GRR recommends additional levee work in these upstream tributaries to the drain.

EE-10 GRR p. 2-8: The Sacramento River Flood Control Project may have been "designed to pass the known flood of record," 1909, but since that time some major section-7 reservoirs have been constructed, allowing the 1909 Sacramento River flood system footprint to accommodate later high-flow events. It could be misleading to not mention these later additions to the floodwater-management system. It can also be misleading to state that "[t]he floods of 1986 and 1997 delivered much more water to the leveed reaches than they were designed to carry, resulting in levee failures." The connotations of the word "much" and perhaps "leveed reaches" are the issues here. Floodway design flows and design stages along major Project rivers and bypasses were not materially exceeded[13], however some tributary creek levees were overtopped or outflanked.[14] River levee failures here did occur, but at stages below design, such as the 1986 Peach Tree Mall Yuba River levee break, or estimated to be at the design stage, such as the 1997 Country Club Road Feather River levee break. We think it is undisputed that the 1986 and 1997 Sacramento Valley levee failures along major rivers or bypasses were because of engineering deficiencies associated with their original construction, foundation problems, or because of the consequences of nearby levee failures, not because their design stages were dangerously exceeded by flood-corridor river stages.

EE-11 GRR p. 2-9: Far more than "the 200-year event design storm can be safely conveyed past the dam" once the Joint Federal Project (JFP) is completed; after all, Reclamation's goal is for Folsom Dam to pass the PMF without major damage to the Dam. A PMF is a highly improbable flood event that is the traditional standard for sizing spillways to avoid dam failure. A little more careful writing is warranted here since we suspect that the sought-for objective is to pass the GRR design storm without downstream levee failure or outflanking of tributary streams, not whether the flows can be conveyed safely past the dam.

EE-12 GRR p. 2-13: Again we have the misleading at best and undocumented "inches from overtopping" statement for Sacramento area levees. It makes for dramatic reading, but engineers should strive for precision in language and avoid inaccurate or misleading statements. See above our comments on GRR p. 2-4 above.

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[13] *Draft Feasibility Report, American River Watershed Investigation, California,* Corps of Engineers, Volume 2 - Appendix K, April 1991, p. K-8. Table 8 here is a comparison of design flows and stages and peak flows and stages during February 1986 flood event. Design stages in parts of the project area river and bypass system were exceeded to some degree in half the table locations, but none of these representative locations, nor the locations they were surrogates for, experienced failure or risk of overtopping.

[14] Levees along two Sacramento Valley creeks were overtopped in 1997, and one was outflanked/ "overtopped" in 1986. The west levee of the Sutter Bypass failed in 1997. See tables 5-15 and 5-34 of the *Post Flood Assessment,* March 1999, U.S. Army Corps of Engineers.

EE-13

GRR p. 2-18–19: Modeling the Campus-Commons/Sacramento State University "raceway" section of the Lower American River does show high velocities in this, the most narrow reach of the Lower American River. We have not yet been able to review the velocity contour analysis for the more typical reaches. Since additional erosion protection is being advocated for more than just the "raceway" reach, it would be appropriate for the GRR to characterize the wider and presumably lower-velocity reaches of river that it is seeking bank-protection authority for. We understand that bank vulnerability analysis and the resulting project recommendation would be to have the subject of discussions during post-authorization preconstruction engineering and design (PED) but remain uneasy about the potential scope of the authorization.

EE-14

GRR p. 2-30: The Report identifies a single planning constraint: not violating FAA restrictions on providing additional bird habitat around the Sacramento International Airport, which we believe in the past has been used to argue (whether meritoriously or unmeritoriously) against levee setbacks and more extensive riparian forests along the Sacramento and American Rivers. The Report appears to be silent on the Corps of Engineer's responsibility to comply with the National Wild & Scenic Rivers Act (WSRA), which states that federal agencies shall not undertake any of a wide range of water-resources-project actions that would have "a direct and adverse effect on the values for which the river was established" (§7a, WSRA).

The Lower American River is a state and federal wild & scenic river. According to the introduction on §7 of the federal act in the *Wild & Scenic Rivers Reference Guide* of the Interagency Wild & Scenic Rivers Coordinating Council, "[T]his key provision directs federal agencies to protect the free-flowing condition and other values of designated rivers and congressionally authorized study rivers." According to §16b of WSRA, "Free-flowing, as applied to any river or section of a river, means existing or flowing in natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the waterway." The *Reference Guide* adopts the definition of water resources project published in regulations developed by the Secretary of Agriculture (36 CFR 297) as "construction of developments which would affect the free-flowing characteristics of a wild and scenic or congressionally authorized study river."[15]

Because the bank protection projects that are envisioned in the Common Features draft GRR are water resources projects as defined by statute, regulation, and federal agency guidance, the project should be expected to comply with the National Wild & Scenic Rivers Act. Specifically, it should meet the §7 standards as determined by the federal wild & scenic river manager, the National Park Service. These "no direct and adverse impact on the values for which the river was established" as measured in §7 are again defined in the *Guide* consistent with 36 CFR 297 and §1b of the Act: "as the river's free-flowing condition, water quality, and outstandingly remarkable values (ORVs)." The outstandingly remarkable values on the Lower American River are anadromous

[15] *The Reference Guide* has now been broken up into a series of sub-publications from the Council that continue to be found at http://www.rivers.gov/publications.php.

fisheries and recreation (*American River Parkway Plan* 2008, Sacramento County, p. 90).

EE-14 (Cont.)

Section 2(a)(ii) national wild and scenic rivers such as the Lower American River are, in general, to be managed by the state or its political subdivisions. The most recent state plan is the *Lower American River Parkway Plan* adopted by the legislature in 2009 (AB-889). Although the federal manager has an independent duty to determine whether specific projects comply with federal WSRA law, the adopted state plan is intended to provide guidance to the federal manager, as well as the state manager, Sacramento County, (*American River Parkway Plan* 2008, Sacramento County, pp. 89–92). This plan contemplates additional floodwater-management works and contains detailed flood-control policies (pp. 82–83), later discussed and displayed in the GRR draft EIS, to avoid or mitigate adverse impacts to wild & scenic river values and Parkway resources. It should also be noted that State agencies such as the Central Valley Flood Protection Board (the non-federal sponsor) and political subdivisions of the state such as Sacramento County or the Sacramento Flood Control Agency, have a duty to comply with the provisions of the California Wild & Scenic Rivers Act (See California Public Resources Code §5093.56, §5093.61, and see §5093.50 for some relevant provisions).

We do not argue here that the 2015 Common Elements Project cannot comply with these statutes, only that the state and federal agency sponsors must shape the projects to comply with their obligations under their respective statutes. It is important the GRR acknowledge those responsibilities, and since the GRR does not contain specific site designs, the GRR should acknowledge that specific site designs will be subject to compliance with state and federal WSRAs. Projects along the lower American River have done so in the past; they can do so in the future. But their design must reflect the obligations of the GRR sponsors, both state and federal.

EE-15

GRR p. 2-32: This could be a subtle point, but it's not apparent to us that the JFP is aimed at having the ability to pass an *objective* release of 160,000 cfs. That certainly is currently the traditional emergency release, and it's fair to say that the Long-Term Study (see references below) envisioned that releases above 115,000 cfs would be included in measures of project performance, but we would characterize the releases above 115,000 cfs as contingency releases to be made when conditions require them. The Long Term Study envisioned that a new Emergency Spillway Release Diagram (ESRD) (figure 4, p. B-20) would determine operations in this range, proposed a new diagram, and stated the following:

> "Before adoption of a new ESRD, the proposed ESRD will undergo refinement and thorough analysis to ensure that the procedures are well defined to assist in the precise operational decisions necessary to make the selected plan function effectively for a range of events near design magnitude through extreme floods." *Volume III: Appendix C, Engineering, American River Watershed, California, Long-Term Study, Final Supplemental Plan Formulation Report/EIS/EIR*, Corps of Engineers, SAFCA, California Reclamation Board, Feb 2002, p. B-6."

EE-15 (Cont.)

The revision to Folsom Dam's Water Control Manual is underway. We assume that it will be the mechanism to tackle how these releases are characterized and will, therefore, contain the definitive terms and accompanying definitions needed to describe Folsom Dam's future operations. We offer up our characterization here for use by the Corps reservoir regulation manual update team.

EE-16

GRR p. 3-2: The yield of Reclamation's Auburn Dam is characterized in the Report as 270,000 acre-feet per year. The latest update from Reclamation, in 2006, estimated average yield at 208,000 acre feet per year.[16] The Report characterizes the energy production at the authorized Auburn Dam as 600 megawatt hours per year. This is confirmed by DWR and Reclamation sources. DWR characterized the annual energy production of the original Auburn dam as 600 GWhs (*Auburn Dam, Reconnaissance Appraisal of Construction Under State Sponsorship*, DWR Division of Planning, 1987 p. 8). This was echoed by Reclamation in a report published the same year with a 607.8 GWh estimate, arguably an estimate with too many significant figures (*Auburn Dam Report, Auburn Dam Alternative Study*, Bureau of Reclamation, Mid-Pacific Region, 1987, table 11).[17]

EE-17

GRR p. 3-5: The Report states that the section-7 reservoirs in the Sacramento River Basin "were completed prior to the largest flood in Sacramento; therefore, their designs are based on hydrology that does not take these large floods into account." In addition to being somewhat off the mark[18], this statement can mislead: as discussed earlier, the

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[16] Reclamation made some sub-estimates as well: (1) American River deliveries, an increase of 21,000 acre feet or a 3% change, (2) CVP total deliveries, an increase of 138,000 acre feet or a 3% change, (3) SWP total deliveries, 70,000 acre feet or a 2% change, (4) CVP dry and critical year deliveries, 229,000 acre feet or a 5% change, and SWP dry and critical year deliveries, 114,000 acre feet or an increase in 4%. (*Auburn-Folsom South Unit Special Report, Benefits and Cost Update*, Central Valley Project California, U.S. Department of Interior, Bureau of Reclamation, Mid Pacific Region, December 2006, pp. TS-3, Table III-2).

[17] We do note parenthetically that Reclamation's 2006 report appears to upsize the generation plants and develop a range of estimates for a number of re-envisioned hypothetical unit number and configurations, making comparisons with the authorized project difficult. Moreover, Reclamation's 2006 Special Report was unable to firmly identify average annual energy production saying the following:

> [t]he power generation potential at a hydropower plant is unique to each facility. Extensive analysis is required to develop power generation equations for a specific facility. This type of analysis has not been completed for the proposed Auburn Reservoir power plant.

The 2006 Reclamation report demonstrated a re-envisioned annual power generation potential ranging from 1,667 to 3,618 GWhs but fails to explain this considerable departure from earlier estimates. (*Auburn-Folsom South Unit Special Report, Benefits and Cost Update, Central Valley Project California,* U.S. Department of Interior, Bureau of Reclamation, Mid Pacific Region, December 2006, pp. III-15–17).

[18] A review of the Sacramento Valley reservoir water control manuals suggests that neither the early twentieth century storms magnitudes nor the latter twentieth century storms were the controlling factors in the design of most of their reservoir design floods. As noted earlier, Folsom Dam's design flood was initially based on 1862-flood estimates, then upsized. Review of the other respective reservoir regulation

EE-17
(Cont.)

record does not show any inflow events to these section-7 reservoirs that would have required releases in excess of dam objective releases or surcharged these reservoirs.[19] Of course, the original reservoir design floods, spillway design floods, SPFs, & PMFs would now be assigned a more probable "return frequency," which is probably what the GRR authors intended to say. The Report then states that "reoperation of these upstream reservoirs would not substantially reduce the flood risk to the Sacramento area," implying that this is because "flood storage is a small component of these dams' storage, since they are water supply reservoirs." Again, in spite of the "*small* component" of reservoir storage dedicated to a flood-control reservation, since their construction, these dams have been able, or should have been able, to maintain regulated releases to within their objective releases, which are usually keyed to leveed river-corridor capacity, indicating the dams' importance to the current floodwater-management system.

The real reasons why reoperation of upstream section-7 dams does not materially affect the performance of the Common Features floodwater-management systems are more varied. (1) Folsom Dam is already being "reoperated," reserving in some conditions more than two thirds of the reservoir for flood space, (2) the effectiveness of Common

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manuals is instructive. New Bullards Bar Dam's flood reservation was designed, in concert with the authorized but still unconstructed Marysville Dam, to provide SPF protection to Marysville-Yuba City (p. 24, ¶27, 1972). Oroville Dam's flood space was designed to provide SPF protection to the Feather River basin (p. 15, ¶14, 1970). "Shasta Reservoir does not have a reservoir design flood," although the 1977 manual does note, in this case, that the dam could contain a 100-year flood within its flood space and not exceed nearby downstream flow objectives. The 1940s-era hydrologic basis for its design was to be a multipurpose reservoir and meet its authorized purposes and priorities (p. 9, ¶18 & p. 25, ¶24). The smaller Black Butte Project was authorized because "the required flood protection could be provided more effectively and economically" than downstream levee or channel improvement projects or small upstream reservoirs (p. III-1). Project objectives include protecting "the city of Orland from all reasonably probable rain floods," protecting downstream agricultural areas "during all but very large floods," and restricting releases from the dam to 15,000 cfs "insofar as possible" (p. VII-1, 1987). The 1970s-era Indian Valley Reservoir on the NF Cache Creek seems to be the only Sacramento Valley section-7 reservoir with a hydrologic basis for design based on a probability frequency that could be affected by more recent flood experience. Its small flood-space reservation of 40,000 acre-feet was based on "adequately contain[ing] all Indian Valley inflow for floods up to the 50-year flood until flows at Rumsey have returned to existing channel capacity of 20 cfs" (p. 9 ¶17, 1977).

[19] In the 1997 event, Oroville Dam operators made a release of 160,000 cfs, 10,000 cfs above the dam's objective release out of concern that pass-through operations were imminent. However, 1997 reservoir operations peaked with 206,000 acre feet of the standard 750,000 acre-feet flood control reservation and 150,000 acre-feet of objective-release-requiring surcharge operational space defined in the Water Control Manual still untouched. That's a 350,000 acre-feet cushion. Oroville Dam did not experience a reservoir design flood, and pass-through operations were not imminent. For a careful analysis of the Oroville Dam operations, see Motion to Intervene of Friends of the River, South Yuba Citizens League, and Sierra Club, Federal Energy Regulatory Commission, Project No 2100-52, October 17, 2005. Of course, two San Joaquin River Basin section-7 reservoirs filled and spilled in 1997, but given floodway constraints, this should not have been unexpected. Sacramento River Basin floodway capacities are an order of magnitude greater their southern neighbors. For a handy record of 1997 major section-7 reservoir operations, see the *Final Report, Governor's Flood Emergency Action Team*, The Resources Agency, May 10, 1997, Appendix B.

EE-17 (Cont.)

Features facilities is buffered from potential exceedances from dams upstream of the American River because these exceedances may be temporarily stored in upstream flood-deposition basins due to levee breaks or Butte Basin upstream weir operations, or mostly diverted into the Fremont and even Sacramento Weir and into the Yolo Bypass. (3) Shasta Dam and Oroville Dam have large flood reservations and substantial early-release capabilities now. The most deficient dam is New Bullards Bar Dam. It has the smallest flood-space reservation, even in percentage terms of any of these dams. It's early-release capabilities are limited enough that Yuba County Water Agency, the dam's owner, has undertaken preliminary design investigations to enlarge its low-level release capabilities to better enable the dam to conduct floodwater-management operations and benefit from a forecast-based reoperation. Physical modification to this dam and a modified Water Control Manual is a foreseeable circumstance, but their major benefits would mostly be improving regulation of flood stages along the Yuba and Feather Rivers for some floods and produce only attenuated benefits downstream, in part because most of these flows are diverted into the Yolo Bypass.

EE-18

GRR p. 3-6: As we recall the Corps 1991 ARWI alternative analysis, another reason the Corps did not carry forward the proposed Deer Creek offstream storage project was simple: the downstream channels needed to evacuate Deer Creek dam storage of antecedant flood events were too small. As a result, the Corps could not be confident that flood space there could be considered reliable during flood seasons like 1862 when large flows were experienced in multiple very large flood waves throughout the months of December and January. Sacramento River Basin flood corridors are a lot larger than more southerly corridors. That makes a huge difference in flood-space recovery times.

EE-19

GRR p. 3-7: The report notes "that some [study area] flood events were larger than those for which the flood control system was sized (1955, 1964, 1986, and 1997)." As noted earlier, Folsom Dam has never experienced a flood larger than its reservoir design flood (see attachments).[20] The JFP is designed to increase the Folsom Dam reservoir design flood in case flows larger than record or greater than reservoir-design-flood inflows occur. Common Features projects are designed to increase levee reliability at objective releases up to the emergency release target flow of 160,000 cfs (which may become a conditional release as well). Of course if the focus is on the Common Elements collector streams, these projects did not perform well during the 1986 flood and have been the focus of non-federal sponsor activity and this GRR to prevent the leveed corridors of upstream creeks from being outflanked or overtopped or failing during high-flow events, especially when high backwater conditions prevail. Nevertheless, these general

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[20] We suspect that the metrics used to establish this assertion are six-day volumes. As noted earlier, the actual hydrograph may be best representation of a reservoir design flood. Failing that, three-day volumes have become the *lingua franca* of contemporary measures of reservoir flood-operations performance in this region. Design hydrographs that are challenged by three-day numbers are typically not very challenged by six-day flows given the large floodway capacities of Sacramento Valley reservoirs and typical runnoff patterns of the areas's great floods. In effect, the center-of-storm runnoff (3-day) metrics challenge flood space and timely reservoir operations, while long storm-sequence (6- or 14-day) metrics challenge downstream release and floodway capacities.

EE-19 (Cont.) statements should be made with more precision. Otherwise, they are subject to misinterpretation.

EE-20 GRR p. 3-20: Vegetation on or near levees can also reduce the probability of system failure by reducing water velocities at the bank or levee interface and by increasing levee or bank/berm cohesion. As noted in other areas of the Report, levee and near-levee vegetation-removal policies are a significant issue of public concern. That concern has resulted in a stand-down of enforcement of some of the Corps policies as a result of Congressional Action (WRRDA §3013) with a conforming court order (*Friends of the River v. U.S. Army Corps of Engineers,* Case 2:11-cv-01650-JAM-AC (E.D.Cal. Sept. 12, 2014). It would be helpful if the Project sponsor GRR presentations on this subject area were more balanced given the obvious local, state agency, and federal natural resources agency sensitivities to this issue while the Corps is reformulating its vegetation policies as discussed in WRRDA and the conforming court order.

EE-21 GRR p. 3-23: We concur with Table 3-6's assessment that the later not-carried-forward Upstream Storage on American River (Auburn Dam) alternative has demonstrated a lack of Congressional and public support. It's probably also true that there is no non-federal sponsor for this alternative. We are, therefore, curious why the same poor acceptability rating does not occur with the also not-carried-forward Maximum Plan alternative. It, too, also features the same upstream storage element as the previous (above) alternative and lacks any realistic potential non-federal sponsors.

EE-22 GRR p. 3-28: Regarding your Focused Alternative 5: Maximum Plan (later not carried forward) it would be helpful if the GRR discussion could include a caveat or two regarding the statistical meaningfulness of assigning apparently precise and therefore accurate probabilities to hypothetical never-before-experienced, particularly events considerably larger than recorded events. For example, the American River rain flood frequency analysis by the Corps of Engineers prepared with the advice of the National Research Council's Committee on American River Flood Frequencies does not extrapolate the frequency curve beyond 1 in 200.[21] While the Committee and we understand that assigning these rare probabilities to some hypothetical flows for some purposes is necessary, it would be appropriate to include the NRC's caution when discussing analyses concerning events modeled to be less probable than 1 in 200 in this watershed.

EE-23 GRR p. 3-38: The Vegetation and Access discussion of vegetation on and near levees begun here and carried through much of the rest of the Report seems curiously uninformed by WRRDA §3013 and the conforming court order. There are two relevant provisions neatly summarized by the order:

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[21] U.S.A.C.E. Sacramento District, *American River, California, Adopted Rain Flood Flow Frequency Analysis*, April 1999, plate 1 and presumably subsequent successor analyses.

> The Corps will proceed to conduct the review of the guidelines and take the actions required by WRRDA § 3013. In accordance with § 3013(g) until the date on which revisions to the guidelines are adopted, the Corps will not require the removal of existing vegetation as a condition or requirement for any approval or funding of a project, or any other action, unless the specific vegetation has been demonstrated to present an unacceptable safety risk (*Friends of the River v. U.S. Army Corps of Engineers,* Case 2:11-cv-01650-JAM-AC (E.D.Cal. Sept. 12, 2014) ¶6).

EE-23
(Cont.)

To date, the review has not been concluded, nor have any revisions to the guidelines contemplated in the court order been adopted. Instead, the representations of how vegetation on and near levees will be treated by the Common Elements projects appear to be consistent with the current Corps Vegetation Engineering Technical Letter (ETL), SWIF, and variance policies, apparently prejudging the results of the review and release from the court order. It is therefore troubling that the Report fails to note that some vegetation-removal actions are not consistent with current federal law or the court order. Nor does the Report note that it has been required by the Congress to review the ETL with the expectation that a revised ETL will then be issued. We appreciate that the project sponsors need to be able to describe the environmental impacts of the successor ETL as the projects in the Common Elements GRR are constructed, but the range of potential of future Corps (and state) levee- and near-levee vegetation policy alternatives are not included in your descriptions.

In fact, it is impossible not to note that the Report and draft EIS/EIR fail to develop any alternatives to implementation of the meat and substance of the current ETL and related vegetation policies. Instead, the GRR apparently assumes that variances will be given. We appreciated that the Sacramento District will seek a variance to the ETL (*Appendix C, Engineering,* 2.4.2) and hope that they receive a variance. However, there could be severe consequences if the existing ETL or similar successor ETL (apparently assumed here) is required to be implemented because variances are not granted. Given the proximity to wild & scenic rivers and the potential to take actions that may violate federal laws meant to protect the environment, this is a deficiency in the project formulation and assurances that needs to be addressed in the Final Report and environmental documents or challenges could arise.[22]

The Central Valley Flood Control Board's adoption resolution for its levee vegetation policy in the Central Valley Flood Protection Plan (CVFPP) also contemplated a state review of the adopted levee-vegetation elements of the CVFPP, which were not consistent with the ETL. Again the possibility of revisions to the state plan elements, particularly the Life Cycle Management Policy (which would gradually result in absence of woody vegetation from most of the levee profile and all of the landside near-levee area) or of the DWR Urban Levee Design Criteria vegetation requirements, are not contemplated in the Report. DWR is also reviewing how their vegetation policy squares

[22] See NEPA Regulations: 1508.27(b) ("severity" "intensity"); 1508.27(b)(3) ("proximity to. . .wild and scenic rivers"); and 1508.27(b)(10) ("Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.").

with the Draft Conservation Strategy being prepared for adoption before or at the 2017 update to the CVFPP.

A little humility is necessary here. It's O.K. to recognize and report that the federal and state policies are under review but this is how it would work with the existing, but in the federal circumstance, stood-down policy and the state policy that is supposed to be under review. But you have to make it abundantly clear that these policies may change or be refined as a result of future review and discuss the implications of various alternatives.

EE-23 (Cont.)

And speaking of humility, consider the lowly California Poppy *(Eschscholzia californica, E. caespitosa, or E. lobbi)*. The Report assumes that hydroseeding perennial grass seeds on the otherwise barren or mowed or burnt levees envisioned in the Report will be successful in keeping wildflowers and annual grasses of the Sacramento Valley from invading the slopes of the levees in violation of the ETL. It is probably worth some real inquiry on the track record of this technique to achieving mowable perennial grasses that can successfully exclude vegetation inconsistent with the ETL such as forbs and annual grasses. And if the Corps intends to revise the ETL, don't declare war again on California's native wildflowers. They aren't the enemy.

GRR p. 4-8: We were pleased to read the following commitment:

> An initial assessment with regards to the method of bank stabilization has been made for this document. During detailed design, the Corps will coordinate closely with the county, state, and federal agencies responsible for managing the resources of the parkway in selecting which method of bank stabilization should be deployed. In carrying out this effort, the Corps will coordinate through the formal and informal processes that have been created to facilitate management of the parkway in application of the above criteria. Where erosion protection is needed to meet established flood risk reduction objectives, the selection of the method of protection will be based on a determination of which method would do the most to protect valuable parkway land, fish and wildlife resources, and recreational facilities considering both the short term impacts of construction and the long term effects of any mitigation measures included in the design of the project.

EE-24

As you know, one of these groups is the now twenty-two-year-old Lower American River Task Force. This is so important that if necessary the Corps may be well-advised to seek specific authorization to do this if and when an authorization proposal is submitted to the Congress.

GRR p. 4-36: It is perhaps premature to specify that the expanded portion of the Sacramento Weir will never be operated "for events up to and including the 1/100 ACE event." By implication, this is either an inflow-into-Folsom Dam or a Folsom Dam outflow statistic (the text is not clear). It should be noted that the current 1/100 ACE inflow into Folsom Reservoir has never been experienced in the period of hydrological record. And no Water Control Manual operation would have required outflows greater than 115,000 cfs in the same period routed through the existing system of dams. It is,

EE-25

thus, not out of the question that the expanded Sacramento Weir would never be used under this policy.

EE-25 (Cont.) The California Department of Water Resources, along with local governments, is also developing a project to expand the Sacramento Weir, which it probably intends to marry with the Corps Common Features tentatively selected alternative. It is premature to judge what project operational criteria they will develop for weir operations. It is certainly possible that DWR et. al. would conclude that opening the weir could be important in circumstances not within the criteria put forward in GRR p. 4-36.

EE-26 GRR p. 4-37–40: Again, the State and National Wild & Scenic Rivers Act §7 standards are not mentioned as avoidance or mitigation objectives. They belong here.

EE-27 GRR p. 7-1–4: In the list of recommendations a number of project-related relevant statutes are referenced for the purposes of a pledge of compliance. There are at least two relevant ones that we do not see: (1) WRRDA §3013 and the conforming District Court order (*Friends of the River v. U.S. Army Corps of Engineers*, Case 2:11-cv-01650-JAM-AC (E.D.Cal. Sept. 12, 2014) as applicable, and (2) the National Wild and Scenic Rivers Act (16 U.S.C. 1271-1287) as set forth herein consists of Public Law 90-542 (October 2, 1968) and amendments thereto.

EE-28 dEIS/EIR p. 56: We suspect that the conclusion, "[i]f a large regional earthquake occurred during a major flood event, these potential [structural degredation] effects would be magnified, and potential for levee breach would be increased," is true, especially for the American River and upstream levees, which rarely experience high stages. But the Sacramento River does experience high stages for weeks and longer during relatively routine rainy periods even in the absence of "a major flood event." Since the GRR project area includes the Sacramento River, the conclusion there that "the potential for failure or significant damage of project structures is low" because, in part, of the "small likelihood of coincidence [of a] flood event and a major earthquake." Given the large populations and ongoing land-use and floodplain-management decisions within the protected reaches of the GRR, more detailed discussion of this issue is in the public interest, even if the project may not change the relative risk of this failure mode in comparison to the without-project condition. Some discussion is also warranted of how sensitive the liquefaction risk is to stage since deeper foundation wetness conditions may not be as sensitive to stage as shallow foundation wetness may be.

EE-29 dEIS/EIR p. 59: The lower American River is not classified as a "Recreation" river within the state and federal wild & scenic river systems. It is classified as a "Recreational" river. "Recreation" is one of two identified extraordinary values of the lower American River wild and scenic river, the other being anadromous fishery.

EE-30 dEIS/EIR p. 60: Thank you for quoting the American River Parkway Plan flood-control policies. As you note on page 59, the parkway plan acts as the management plan for the

EE-30 (Cont.) state and federal wild and scenic rivers acts. It also should be noted that the parkway managers and state and federal agencies need to comply with the statutes in their exercise of discretion when implementing the policies of the management plan.

EE-31 dEIS/EIR p. 63: Although the likely erosion of waterside berms is a basic assumption of the GRR, this hypothesis on a reach-by-reach basis will and should be demonstrated (preferably pre-authorization but failing that, during preconstruction engineering and design). We'll all have to spend more time with GRR Appendix C, Attachments C & E.

EE-32 dEIS/EIR p. 64: The following statement is so important, that we repeat it full:

> The American River Parkway Plan policies address flood risk reduction and levee protection activities with the overall aim of facilitating these activities as necessary to achieve established flood risk reduction objectives in a manner which provides optimum protection to the open space, recreation, and fish and wildlife resources of the Parkway. Consistent with these policies, bank protection improvements and to a lesser extent launchable rock trench improvements have been constructed at various locations in the Parkway over the past 20 years. In selecting which of these methods of protection should be deployed, the Corps will coordinate closely with the Sacramento County Department of Parks and Recreation, the National Park Service, the other Federal and State agencies responsible for managing the resources of the Parkway, and non-governmental stakeholders. In carrying out this effort, the Corps will coordinate through the formal and informal processes that have been created to facilitate management of the Parkway. Where erosion protection is needed to meet established flood risk reduction objectives, the selection of the method of protection will be based on a determination of which method would do the most to protect valuable Parkway land, fish and wildlife resources, and recreational facilities considering both the short term impacts of construction and the long term effects of any mitigation measures included in the design of the project.

We would add that the vegetation and aesthetic resources of the parkway should not be unnecessarily sacrificed, that they contribute to the parkway's extraordinary and outstandingly remarkable values, and that we believe that the above coordination commitment applies here as well.[23] Moreover, we expect that project decisions along the Sacramento River and tributary creeks to the American River will be well coordinated as

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[23] See §10(a) of the National Wild & Scenic Rivers Act. "Each component of the national wild and scenic rivers system shall be administered in such manner as to protect and enhance the values which caused it to be included in said system without, insofar as is consistent therewith, limiting other uses that do not substantially interfere with public use and enjoyment of these values. In such administration primary emphasis shall be given to protecting its esthetic, scenic, historic, archaeologic, and scientific features." *(emphasis added)*

EE-32 (Cont.) well, recognizing, of course, that authorities and responsibilities along these waterways may differ.

EE-33 dEIS/EIR p. 69: The "Regulatory Setting" bullet points here and in other portions of the dEIS/EIR should give more careful consideration of whether to include the state and federal wild and scenic river acts. Water resources projects including bank protection projects need to get WSRA §7 sign offs from the National Park Service. Under the California WSRA, each agency makes its own determination of consistency (PRC 5093.61), although the Resources Agency is responsible for coordinating state agency actions and decisions (PRC 5093.60).

EE-34 dEIS/EIR p. 70: The document notes that "[t]he project area is divided into two basins—American River North and American River South." These may be congruent with the pre-leveed natural flood-deposition basins on either side of the American River: the American Basin to the north, and the Sacramento Basin to the south. Since professional and academic use will be made of the GRR, it may be helpful to explain their equivalence or how the terms differ. For example, the portion of the American Basin surrounded by levees in Natomas is often called the Natomas Basin. These three basins are nicely displayed in GRR Appendix E, but the relationships between geomorphic forms could use better discussion.

EE-35 dEIS/EIR p. 75: Table 8 compares pre and post Joint Federal Project (JFP) outflows for modeled year frequency events. We were unaware that the operational rules for the JFP had been completed, presumably a prerequisite for making these predictions. We would be interesting in learning what rule assumptions were made to construct Table 8 and Figure 7 on the following page.

EE-36 dEIS/EIR p. 81: Will the trigger for the use of the expanded Sacramento Weir and Bypass be when a Folsom Release of greater than 115,000 cfs is made or will it be tied to a hydrology analysis of higher inflow into or outflow from Folsom Reservoir than the modeled 1/100 ACE event (as it exists now or in the future)? See our remarks above about the wisdom of making this commitment at this time.

EE-37 dEIS/EIR p. 102, 2nd ¶, 1st sentence: Substitute "effect" for "affect."

EE-38 dEIS/EIR p. 103: Vegetation, both temporary and long-term, are clearly one of the big potential adverse impacts of the Project and revegetation, whether natural or artificial, is a major potential mitigation for the GRR. It is critical, as noted at this page, that [d]uring the design refinement phase, plans will be evaluated to reduce the impacts on vegetation and wildlife to the extent practicable." This is a high-visibility parkway. This commitment needs to be serious and meaningful and that the words "extent practicable" are not misused.

EE-39 dEIS/EIR p. 111: The hypothesis that "high flows in the American River would have a large impact on the American River Parkway as the berms disappear from continued

EE-39 (Cont.) high flows against erodible material" has yet to be thoroughly and in detail reviewed outside of the GRR team and consultants. As noted earlier, a wider, more public technical reach-by-reach discussion is warranted. We'll all have to spend more time with GRR Appendix C, Attachments C & E.

EE-40 dEIS/EIR p. 116: As noted earlier, there needs to be a review of the Regulatory Setting sections in the dEIS/EIR on whether the state and federal wild and scenic river acts belong in the bulleted list of regulatory statutes. They certainly do here. Anadromous fisheries are listed outstandingly remarkable or extraordinary values.

EE-41 dEIS/EIR p. 148: Please see our earlier remarks regarding the status of the levee ACE vegetation policy. This policy is supposed to be under review.

If the existing ETL is not changed and is still enforced, in addition to the infeasible forb and annual grass prohibition, a variance of more than the lower waterside vegetation would be required. Corps policy is also to prohibit plantings of woody plants that may throw roots into levee critical features, regardless of distance from the levee.

The premise of a SWIF is to eventually comply with the Corps' vegetation policy. This slow deforestation of the landside woody, forb, and annual vegetation (and some levee vegetation?) and the planting prohibition where roots may reach the levee or levee foundation is controversial and not fully accepted by state and federal natural resources agencies. We certainly agree that "collaborative intergovernmental framework[s]" in "complex situations" "will take time," particularly as the Corps and the State of California and federal resource agencies review existing vegetation management policies.

EE-42 dEIS/EIR p. 149: Please list the NPS among the agencies from which to obtain "necessary permits and authorizations." We are pleased that "[t]he Corps would adhere to all applicable…laws…during implementation."

EE-43 dEIS/EIR p. 149: The Bay Delta Conservation Plan with its focus of an HCP and NCCP to recover listed species and co-equal goals appears to have been abandoned, replaced by an effort to construct tunnels under the Delta to deliver Sacramento River water to the export pumps and to mitigate their impact.

EE-44 dEIS/EIR p. 291: We hope that the project, as implemented, will not have significant environmental impacts from loss of vegetation and wildlife habitat and loss of aesthetic and visual resources. In other words, we note that Project proponents have described the environmental documents supporting the potential Corps and Assistant Secretary for Civil Works recommendations for this GRR reauthorization as describing the maximum project adverse impacts. Project proponents hope to avoid some of the described project impacts during preconstruction engineering and design. That is our hope and expectation as well.

Comment Attachments

EE-45 The first two one-page attachments (appended to this PDF) document historic American River floods as measured by flood peaks of hydrographs by estimation method. If you have different estimates and more detailed references, let's discuss this. The second attachment (also appended to this PDF) compares estimated flood peaks and compares them with current and contemplated reservoir design floods. Your assistance in better referencing this document would also be appreciated.

EE-46 The last attachment is an outline of the GRR and dEIS/EIR with questions and comments in italics prepared by a consultant with considerable experience on the American River based on a preliminary initial review. It is in an accompanying docx file. Hopefully, these questions can be addressed in the Response to Comments and the "formal and informal processes that have been created to facilitate management of the Parkway" that project sponsors have committed to engage in.

Sincerely,

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AMERICAN RIVER RECORD HIGH FLOWS (Rain Floods) (Top 11) Unregulated Conditions at Fair Oaks (in cubic feet per second)				
Year	Peak Flow	1-Day Mean	3-Day Mean Measure of Design Flow for ARWP Alternatives	Other Mean Flows
February 1986	259,000 cfs Personal Communication w/ ACE, MBK, & USBR	171,000 cfs 1998 ACE (American River Rain Flood Frequency Analysis)	166,000 cfs 1998 ACE	204,000 cfs, 1-Day Mean, 255,000 cfs peak 1987 Folsom Dam Water Control Manual (WCM).
January 1997	298,000 cfs Personal Communication w/, ACE, MBK, & USBR 255,000 cfs FEAT Report	248,921 cfs 1998 ACE	164,252 cfs 1998 ACE	120,106 cfs, 5-Day Mean, 1998 ACE
December, 1964	260,000 cfs 1987 Folsom WCM	183,240 cfs 1998 ACE	140,339 cfs 1998 ACE	106,436 cfs, 5-Day Mean, 1998 ACE
January, 1862 **(flow estimates)**	~320, 000 cfs, unpublished USBR 1998; 265,000 cfs 1941, ACE; ~280,000 cfs COE 1974 USBR 1983		~147,000 cfs 1999 NRC	
December 1955	219,000 cfs 1987 Folsom WCM	189,070 cfs 1998 ACE	127,449 cfs 1998 ACE	89,784 cfs, 5-Day Mean, 1998 ACE
January, 2006	201,000 cfs est. MBK			
November, 1950	180,000 cfs 1987 Folsom WCM	132,000 cfs 1998 ACE	107,500 cfs 1998 ACE	80,940 cfs, 5-Day Mean, 1998 ACE
March, 1928	163,000 cfs 1987 Folsom WCM	119,000 cfs 1998 ACE	98,167 cfs 1998 ACE	73,340 cfs, 5-Day Mean, 1998 ACE
February, 1963	240,000 cfs 1987 Folsom WCM	152,813 cfs 1998 ACE	93,881 cfs 1998 ACE	64,030 cfs, 5-Day Mean, 1998 ACE
March, 1907	156,000 cfs 1987 Folsom WCM	105,000 cfs 1998 ACE	87,833 cfs 1998 ACE	78,500 cfs, 5-Day Mean, 1998 ACE
January, 1909	119,000 cfs 1987 Folsom WCM	98,000 cfs 1998 ACE	87,167 cfs 1998 ACE	70,300 cfs, 5-Day Mean, 1998 ACE

Historic High Flow Table References

American River Project, Rain Flood Flow Frequency Analysis, American River at Fair Oaks, (Unregulated Conditions), ACE, February 3, 1998. (draft)

American River Watershed Project, California, (ARWP), ACE, The Reclamation Board, SAFCA, March, 1996.

Auburn-Folsom South Unit American River Division Central Valley Project, Information Pertaining to Unit Reauthorization Legislation Presently Before the Congress (H.R. 2219), Bureau of Reclamation, July 1983.

Discharge Rating Curves of American River at Fair Oaks and at Folsom, Leslie Bossen, ACE, August, 1941.

Final Report, Governor's Flood Emergency Action Team, (*FEAT Report*) May 10, 1997.

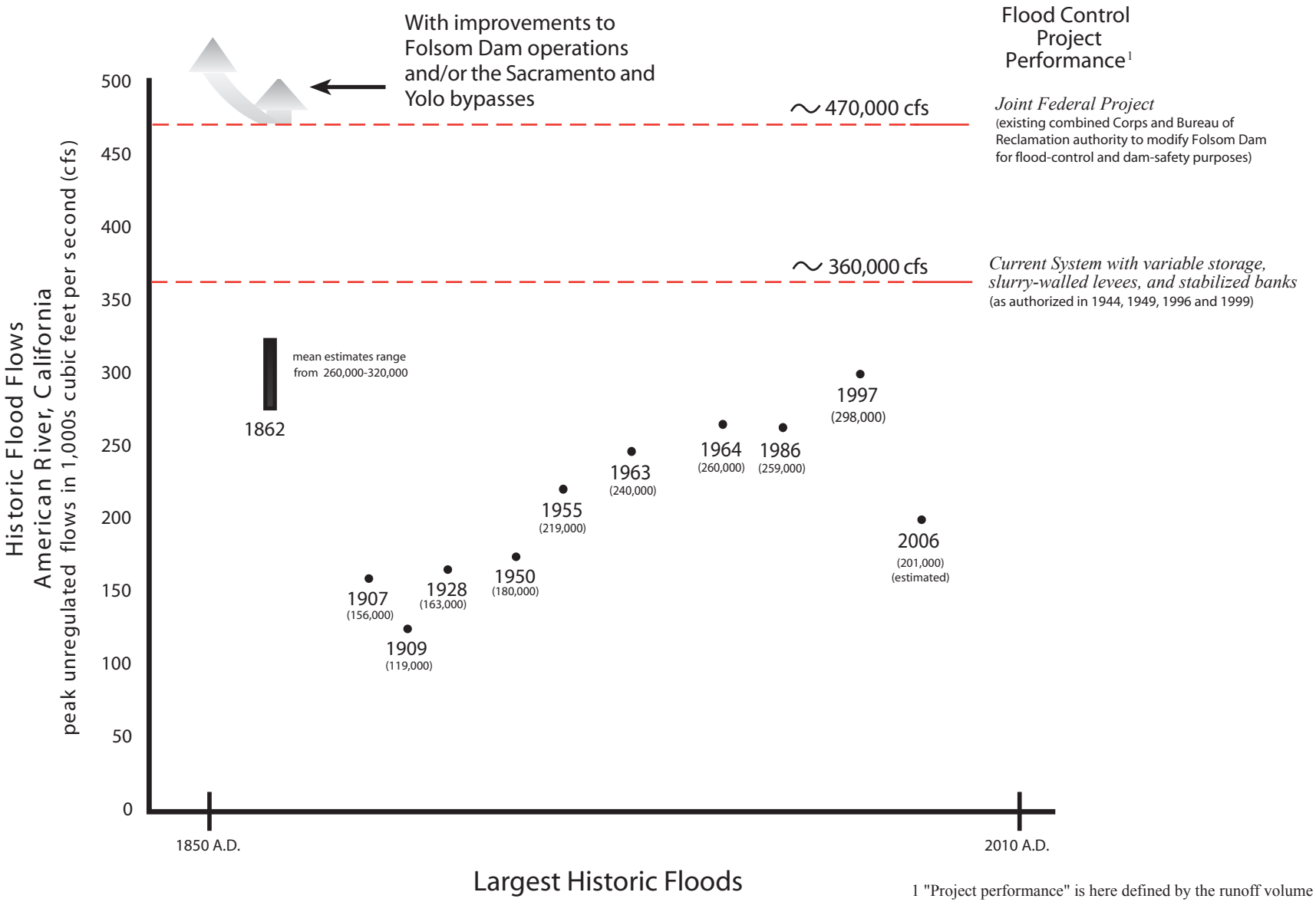
Auburn-Folsom South Unit, Amendment to the Final EIS and Supplement, Vol. 2, ACE comments, Sept., 1974.

Folsom Dam and Lake, American River, California, Water Control Manual, Plate 21, Appendix VII to Master Water Control Manual, Sacramento River Basin, California, ACE Sacramento District, December 1987.

MBK — MBK Consulting Civil Engineers, Sacramento, California.

FOR, August 7, 2006

Record American River Floods, Existing and Authorized Flood Control Project Performance



1 "Project performance" is here defined by the runoff volume (as measured by the flood peak of the unregulated "design flood" hydrograph) that a particular flood-control system can reliably accommodate. In dam-controlled watersheds, use of unregulated (total flow into rivers and storage) runoff-volume hydrographs allows planners to easily compare the performance of past, existing, and planned flood-control projects against historic, modern, and hypothetical storm-runoff events.

June 12, 2006

Draft 5/8/15

DRAFT General Reevaluation Report - EIS/EIR (March 2015).

- **Executive summary:**
  - Introduction (1):
  - Purpose and intended uses of this EIS/EIR (1):
  - Study area (2):
  - Project background (2-4):
  - Need of action (4-5):
  - Alternatives (5-7):
    - No action alternative (5):
    - Alternative 1 – improve levees (5):
    - Alternative 2 – improve levees and widen Sacto. weir and bypass (TSP) (6-7):
  - Environmental effects and mitigation measures (7-8):
    - TABLE ES.2: Environmental impacts and proposed mitigation/compensation for the ARCF GRR: (8)
    - TABLE ES.3: Summary of environmental effects and mitigation measures: (10-16)
  - Cumulative impacts (8):
  - Areas of controversy and unresolved issues (8):
  - Public involvement (9):
  - Tentatively selected plan (TSP) (9

- **1.0 Introduction (1-19):**
  - 1.1 Scope of the environmental analysis (1-3):
  - 1.2 Project location and study area (2):
    - 1.2.1 Location (2):
    - 1.2.2 Study area (2-3):
  - 1.3 Background an history of the Amer. R. Common Features Project (3-7):
  - 1.4 Project purpose and need for action (8-14):
    - 1.4.1 Seepage and underseepage (9):
    - 1.4.2 Levee erosion (910):
    - 1.4.3 Levee stability (10):
    - 1.4.4 Levee overtopping (10-11):
    - 1.4.5 Vegetation and encroachment compliance (11-13):
      - System Wide Improvements Framework (SWIF) (12):
        - An agreement between the Corps and the non-federal sponsor that
          - Allows the local maintenance agency (LMA) to defer compliance with ETL 1110-2-583.
          - Provides that the LMA would address **landside** vegetation and encroachment issues through
            - Implementation of their standard O&M actions over time.
          - Vegetation not impacted by construction would be addressed
            - By the LMA in accordance with
              - State's Levee Vegetation Management Strategy in the CVFPP
                - Over the next 20-40 years.
        - Will be planned and implemented by the non-federal sponsor
          - Will include the flowing criteria.
            - List and short discussion.
      - Vegetation variance (13):
        - Will be sought by the Sacto District to comply with
          - ETL 1110-2-583
            - On the **waterside** of levees.
        - The request required the Corps to show that the
            - Safety
            - Structural integrity
            - Functionality
          - Of the levees would be retained
            - If vegetation were to remain in place.
        - An evaluation of
              - Underseepage
              - Waterside embankment slope stability
            - Was completed by Corps geotechnical engineers.
          - For a Sacto River location (Levee Mile 5.92)
            - As representative of the most critical
                - Channel and levee geometry
                - Underseepage
                - Slope stability
                - Vegetation

- Conditions.
- Results showed that
  - Tree fall and scour did not significantly affect levee performance
  - The levee meets Corps seepage and slope stability criteria
    - Considering that
      - Seepage
      - Slope stability
    - "With-project" improvement measures are in place.
  - It is reasonable to conclude that by
    - Allowing vegetation to remain
      - Safety
      - Structural; integrity
      - Functionality
    - Of Sacto. River levees would be retained.
    - *What about American River issues?*

EE-47

- Vegetation variance request would be developed
  - During design phase
    - To allow for vegetation to remain on the lower portion of waterside levees.
    - Vegetation on the upper waterside slope would be removed as part of project construction.
- If a variance is not approved
  - Recommendations for this portion of the project
    - Will be reformulated
      - Further environmental compliance efforts would be required.
      - *If this variance is to apply to the American River, and if it is not approved; what additional vegetation impacts will occur on the LAR?*

EE-48

- 1.4.6 Releases from Folsom Dam (13-14):
- 1.4.7 Flood management system (14):

- 1.5 Environmental regulatory framework and authority (14-16):
  - 1.5.1 NEPA (14):
  - 1.5.2 CEQA (14-15):
  - 1.5.3 State and local planning (15):
  - 1.5.4 Study authority (15-16):
- 1.6 Intended use of this document (16):
- 1.7 Related documents and resources relied on in preparation of this DEIS/DEIR (16- 17):
- 1.8 Application of NEPA and CEQA principle and terminology (17-18):
- 1.9 Organization of the DEIS/DEIR (18-19):

- **2.0 Alternatives (20-53):**
  - 2.1 Introduction (20-25):
    - 2.2.1 Alternative formulation and screening (20-22):
      - Future without Project condition (21-22):
    - 2.2.2 Measures and alternative considered, but eliminated from future consideration (22-25):
      - Upstream storage on the American River (Auburn Dam) (22):
      - Transitory storage in upstream basins (23):
      - Yolo bypass improvements (23):
      - Reoperation of upstream reservoirs (24):
      - Sacramento River I St. bridge diversion structure (24-25:
      - Non-structural measures (25):
  - 2.2 Non action alternative (25-26):
  - 2.3 Alternative 1 – improved levees (26-42):
    - 2.3.1 American River (30- 31):
      - Levees would require improvements to address erosion.
        - Consisting of waterside armoring to prevent erosion
          - Of banks and levees
            - If unaddressed <u>could potentially</u> undermine levee foundations.
            - *What level of uncertainty/certainty does this "could potentially" imply?*

EE-49

      - Bank protection (30):
        - Consists in placing rock on
          - Banks and in some cases levees
        - <u>When necessary</u> eroded portion of banks would be filled and compacted prior to rock placement.
            - *What conditions make this "necessary"?*

EE-50

        - Sites would be prepared by
          - Clearing and stripping prior to construction
            - <u>Small vegetation</u> and loose material would be removed
        - In most cases
          - <u>Large vegetation</u> would be left in place.
            - *What size criteria are to be used for small/large?*

EE-51

            - *If large trees are left in place will the amount be specified by hydraulic modeling of conveyance?*

EE-52

            - *If large trees are left in place, when they die will they be replaced; will natural revegetation be allowed or even possible with the rocked surface?*

EE-53

            - *If these trees are expected to die and not be replaced how should these trees be counted for impact/mitigation purposes?*

EE-54

EE-55

- *Because of these questions/issues, should the recreation and visual impact assessment be based on no trees at all on these banks?*

- Temporary access ramps would be developed
  - If needed

EE-56

    - *In what conditions would access ramps not be needed?*

- Hauled revetment rock will be stored on-site immediately near the construction site.
  - A loader will move rock to the staging area.
- An excavator will place a large rock berm
  - In the water to an elevation slightly above mean summer flow elevation

EE-57

    - *A berm using large rock or a large berm using rock?*

EE-58

    - *This berm is not indicated on Figure 1.*
  - A planting trench would be established on this rock surface
    - For revegetation.
- The excavator would work to place rock either
  - From the top of bank
  - From the constructed berm
- On levees
  - Rock placement will be from the top of levees.
- On banks
  - The revetment would be placed at slopes of
    - 2V:1H to 3V:1H

EE-59

      - Depending on site conditions.
      - *This must be a typo – 2:1 and 3:1 slopes (2H:1V and 3H:1V).*
  - After placing revetment
    - A small planting berm would be constructed in the rock
      - Where feasible

EE-60

      - To allow some revegetation of the site
      - Outside the vegetation free zone as required by ETL 1110-2-583
      - *This planting berm is not indicated on Figure 1.*
    - This vegetation will be designed on a site specific basis to
      - Minimize O&M
      - Not impact the channel conveyance.

- Launchable rock trench (31):
  - Designed to deploy revetment once erosion has removed the bank material beneath it.
    - Will be placed outside the channel.
  - Vegetation would be removed from the trench footprint and levee slopes

        - Prior to trench excavation.
    - Trench will be located at the toe of existing levees
        - Will have a
            - River-side slope of 1:1
            - Levee-side slope of 2:1
        - The bottom of the trench would be constructed to an elevation near the summer mean water surface.
            - In order to reduce the;
                - Rock launching distance
                - Amount of rock required
                - *With the design depth and slopes, this configuration seems to maximize the amount of rock required?*

EE-61

    - Trench rock will be covered with a minimum of 3 ft. of stockpiled soil.
    - Rock placed on levee surfaces would be covered with stockpiled soil.

EE-62

                - *Will soil be placed with the launchable rock in the trench to prevent progressive infiltration of surface soil into rock voids and prevent surface subsidence?*

EE-63

                - *Could the excess excavated soils be used to in-fill mine tailings at restoration sites? This would require the restoration sites to have working plans and to have the cobbles pre-graded.*
    - All disturbed areas would be reseeded with
                - Native grasses
                - Small shrubs
                    - Where appropriate.

EE-64

                - *What conditions make it inappropriate?*
        - Some vegetation could be permitted over the trench
                - If planted outside the specified vegetation free zone required by ETL 1110-2-581.
            - This vegetation would likely be limited to
                - Native grasses
                - Shrubs
                - Trees with shallow root systems
                    - To ensure the functionality of the launchable rock trench.
            - This vegetation would only be permitted;
                - If it does not put undue burden on maintaining agencies
                - If it is in locations that do not interfere with channel conveyance capacity.

EE-65

                - *These limitations seem to prohibit the use of the trench sites for riparian restoration.*

- 2.3.2 Sacramento River (31-36):
- 2.3.3 East side tributaries (37-39):
- 2.3.4 O&M (40-42):

        - ARFCD (41)
        - Maintenance Area #9 (41):
        - City of Sacramento (41-42):
- 2.4 Alternative 2 – Sacramento bypass and improve levees (TSP) (41-47):
    - 2.4.1 Sacramento weir and bypass (44):
    - 2.4.2 American River (44):
    - 2.4.3 Sacramento River (45):
    - 2.4.4 East side tributaries (45):
    - 2.4.5 O&M (47):
        - DWR (47):
- 2.5 Comparison of alternatives (47-53):

- **3.0 Affected environment and environmental consequences (54-277):**
  - **3.1 Introduction (54):**
  - **3.2 Geological resources (54-58):**
    - Regulatory setting (54-55):
      - Federal
      - State
    - Existing conditions (55-58):
      - Geology (55-56):
      - Seismicity (56-57):
      - Soils (57):
      - Minerals (57):
  - **3.3 Land use (58-69):**
    - 3.3.1 Environmental setting (58-61):
      - Regulatory setting (58):
        - ARPP
        - Sacto. Co. General plan
        - Sacto. City General Plan
        - Yolo Co, General Plan
        - SAFCA Join Powers Agreement
      - Existing conditions (59-61):
        - General discussion of region
        - ARN (59-61):
          - Includes the ARP
          - ARPP;
            - Defines the ARP land uses
            - Acts as the management plan for the federal and state W&SR Acts.
            - Goal is to
              - Provide
              - Protect
              - Enhance
            - The ARP
              - For public uses.
            - Human developments and facilities
              - Are prohibited in “Open Space Preserve Areas”
                - Except as necessary to protect
                - Public health
                - Safety
                - Welfare
                - Habitat restoration.
            - Flood control-related polices include;
              - Flood control agencies should continue to maintain, and improve, where required, the reliability of the existing public flood control system along the LAR to meet the need to provide a high level of flood protection to the heavily urbanized

floodplain along the LAR consistent with other major urban areas. This effort is expected to include raising and strengthening the levees as necessary to safely contain very high flows (up to 160,000 cfs) for a sustained period.

- Flood control projects, including levee protection projects and vegetation removal for flood control purposes, shall be designed to avoid or minimize adverse impacts on he ARP, including impacts to wildlife and wildlife corridors. To the extent that adverse impacts are unavoidable, appropriate feasible compensatory mitigation shall be part of the project. Such mitigation should be close to the site of the adverse impact, unless such mitigation creates other undesirable impacts.
- Where feasible, multi-use buffers should be created on the landside of levees, including additional access points from public streets that enhance levee O&M activities, improve flood fight capabilities, provide opportunities to relocate or expand levees or supporting stability berms, if required, and support recreational opportunities.
- Vegetation in the ARP should be appropriately managed to maintain the structural integrity and conveyance capacity of the flood control system, consistent with the need to provide a high level of flood protection to the heavily urbanized floodplain along the LAR and in a manner that preserves the environmental, aesthetic, and recreation quality of the ARP.
- Flood control berms, leeves and other facilities should be, to the extent consistent with proper O&M of these facilities, open to the public for approved uses, such as hiking biking and other recreational activities.
- Public facilities and private encroachments that inappropriately constrain the operation and maintenance of the flood-control system should be redesigned or relocated.
- The flood control system should be maintained in a condition that ensures adequate flood fighting capability, consistent with demands of protecting a heavily developed floodplain.

        - Bank scour and erosion shall be proactively managed to protect public levees and infrastructure, such as bridges, piers, power lines, habitat and recreational resources. These erosion control projects, which may include efforts to anchor berms and banks with rock revetment, shall be designed to minimize damage to riparian vegetation and wildlife habitat, and should include a revegetation program that screens the project from public view, provides for a naturalistic appearance to the site, and restores affected wildlife habitat values.
        - Project to address bank stabilization and erosion that are threatening privately-owned structures shall; secure appropriate permits. The engineering of these projects should give preference to biotechnical or non-structural alternative, where feasible, over alternatives involving revetments, bank re-grading, or installation of river training structures. Use of rubble, gunnite, bulkheads, or similar material in these projects is prohibited.
        - It is recognized that flood control agencies have the authority to take actions(s) to prevent or respond to flood emergencies occurring in or adjacent to the ARP. In the event that these actions(s) have an adverse impact on biological resources in excess of the estimated impacts of the projected flood damage to such resources, the agency(ies) undertaking the emergency work will implement feasible compensatory mitigation measures pursuant to Policies. Nothing in the Policy shall be construed to interfere with the existing authority of flood control agencies to prevent or respond to an emergency situation occurring in or adjacent to the ARP.
    - ARS (61):
    - Sacramento bypass (61):
- 3.3.2 Methodology and basis of significance (62):
    - Methodology (62):
        - Determine the effects of the project on land use plans
            - Including;
                - ARPP
                - Sacto. Co. General Plan and zoning code
                - Sacto. City General Plan and zoning code

- Yolo Co, General Plan and zoning code
- Basis of significance (62):
  - Effect are considered significant if any one of the following results;
    - Conflict with any land use plan, policy, regulation.
    - Conflict with approved Habitat Conservation Plans or Natural Community Conservation Plan.
    - Physically divide an established community
    - Displace substantial numbers of people,
      - Necessitating the construction or replacement housing elsewhere.

- 3.3.3 No action alternative (62-63):
  - The waterside berm in the ARP would erode overtime
    - Resulting in the loss of ARP lands.
    - Timing is unknown
      - *Is there a Corps' estimate of potential land, habitat, and recreational facility losses that will be due to the No Action Alt.?*

EE-66

  - The ARPP designated most of the lands within the project area for
    - Natural
    - Recreational
    - Habitat enhanced
    - Uses.
  - Alt. is inconsistent with the ARPP
    - Would be considered a significant effect.
- 3.3.4. Alternative 1 – improved levees (63-67):
  - Barrow sites (63-64):
  - American River (64):
    - Approximately 11 mi of erosion protection needs has been identified.
      - Erosion protection approaches could be
        - Luanchable rock trench
        - Bank protection
  - ARPP policies address flood risk reduction
    - Overall aim of facilitating flood risk reduction activities in a manner that
      - Provide optimum protection to ARP resources;
        - Open space
        - Recreation
        - Fish and wildlife
    - Consistent with these policies
      - Bank protection improvements
      - Some launchable rock trench improvements
    - Have been constructed over the past 20 years
      - At various locations.
  - To select improvement methods (bank protection//launchable rock trench) to be used
    - The Corps will coordinate closely with

- SCRP
- NPS
- Other state and federal agencies
  - Responsible for resource management
- NGO stakeholders

- Will coordinate through
  - Formal processes
  - Informal processes
- That have been created to facilitate ARP management.

- Where erosion protection is needed
  - To meet established flood risk reduction objectives

- Selection of improvement methods to be used
  - Will be based on
    - Which most protects ARP resource values
      - ARP lands
      - Fish and wildlife
      - Recreational facilities
    - Considering
      - Short-term construction impacts
      - Long-term effects of mitigation measures.

- Launchable rock trench (65):
  - Would minimize land use changes
    - For the 11 mi of erosion protection proposed.
  - Construction activities;
    - Could cause temporary LU changes
      - Within the levee structure
      - Adjacent waterside berm
      - Channel bank
    - Changes include lands for
      - Staging areas
      - Construction footprint
    - As construction progresses along the levee
      - Completed areas will be returned to their prior use.
      - Except;
        - A 15 ft. vegetation free zone on the waterside of the levee.
  - With a maximum trench <u>width of 70 ft</u>.
    - <u>65 ac will be disturbed</u>.
      - *At design trench slopes (2:1 and 1:1) (p31), a 70 ft. wide trench would be 23 ft. deep (70/3=23.3), if it has no bottom width. Design specifications (Figure 1) indicate varying trench bottom widths so*

EE-67

EE-67
(Cont.)

independently estimating trench top-widths is not possible here. However I'm thinking that most of the levee toe elevations are about 20 ft above with lowflow water surface which indicates that, if there is to be any bottom-trench width at all, maximum trench surfaces may be in excess of 70 ft. It is possible that 70 ft. could be the average trench surface width.

EE-68

- *Does this exclude staging areas, temporary ramps and access/construction roads?*

- These areas are presently
  - A 15 ft. wide maintenance road
  - Additional lands containing
    - Riparian habitat
      - Intermixed with
      - Recreation facilities
      - Open space
- Post-construction
  - The maintenance road at the toe of the levee will be replace to original condition
  - Some construction ramps may remain for maintenance access
    - In coordination with
      - SCRP
      - ARFCD
  - Construction roads not needed for maintenance
    - Would be returned to original condition
  - The <u>riparian areas would be replanted with vegetation</u>.
  - Re-establishing <u>riparian habitat would take many years</u>

EE-69

- *Replanting requirements and limitation (p 31) seem to severely limit the types and amount of revegetation.*

EE-70

- *Riparian re-establishment on or off-site? If on-site, planting requirements/limitations imply that no deep-rooted trees would be involved so why would on-site re-establishment take so long?*

  - Recreation facilities will be replaced to original condition
    - In coordination with SCRP
- <u>No LU changes</u>,
  - Except;
    - 15 ft. maintenance road
    - Vegetation free zone
- Alt 1. is in compliance with ARPP

- LU impacts are considered less than significant
    - No mitigation is required.
    - ***In the No Action Alt. the Corps attribute land and resource losses due to ongoing erosion as a significant LU impact that is not consistent with ARPP. The proper functioning of the launchable rock trenches anticipates (and depends on) ongoing bank erosion and retreat to launch the rocks. When the rocks are launched there will be a continuous revetment slope from the levee toe to the eroded channel margin. This slope will be absent of habitat and recreation values. Why are these impacts, which are implicit to the expected proper functioning of the project as designed, not counted as project impacts?***

EE-71

- Bank protection (65-66):
    - Bank protection may be used
        - Instead of launchable rock trenches
            - To reduce riparian habitat impacts.
    - Construction stage;
        - Access would be
            - From existing maintenance roads and ramps
            - Additional roads and ramps could be required
                - To the bank for rock placement.
        - Staging areas required to store rock.
        - Construction site locations are presently unknown
            - However new access roads will be designed to
                - Minimize natural resource impacts.
    - Design would not change existing LU designations
        - Therefore effects to LU are considered less than significant
            - No mitigation would be required.
        - (Riparian habitat loss mitigation is discussed in Veg & Wildlife Section)
- Sacramento River (66):
- East side tributaries (66-67):

- 3.3.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (67-68):
- 3.3.6. Avoidance, maintenance, and mitigation measures (68-69):
    - American River (68-69):
        - ARPP Flood Control Polices include;
            - Mitigation is defined as any project-related action taken to minimize or avoid an impact to the physical environment, or

any action designed to replace, repair, or restore a resource that was physically affected by a project.
        - Construction projects on the ARP should be designed to first, avoid adverse environmental impacts; second, minimize adverse environmental impacts; and, third replace, repair, or restore adversely impacts resource as close as feasibly in time and place to the impact.
        - Impacts are defined as any physical change to the environment, including but not limited to aesthetics, recreational facilities, and access points, water quality, soils, and all biological resources, such as native and non-native vegetation, aquatic habitat, fisheries, and special-status species. Noise, air quality (including fugitive dust), artificial lighting, and other impacts associated with construction activities are also considered to be impacts to avoid, minimize, and mitigate.
    - ARPP states in the Flood Control Policy section;
        - Flood control project, including levee protection projects and vegetation removed for flood control purposes, shall be designed to avoids or minimize adverse ARP impacts, including impacts to wildlife and wildlife corridors. To the extent that adverse impacts are unavoidable, appropriate feasible compensatory mitigation shall be part of the project. Such mitigation should be close to the site of the adverse impact, unless such mitigation creates other undesirable impacts.
    - Mitigation for <u>lands converted from Parkway</u> lands
        - <u>To flood control uses</u>
            - Will be mitigated
                - With fees to the Sacto. Co. under the Habitat Restoration Program Fees'
                    - To be used for natural resource protection or enhancement and for land acquisition.
                - *Under either Alternative and for either the bank protection of the launchable rock trench approach, how are these land areas to be computed? Is the Corps talking about land as land area, or land under changing uses and LU designations?*

EE-72

    - Sacramento River (69):
    - East site tributaries (69):
- **3.4 Hydrology and hydraulics (69-82):**
    - 3.4.1 Environmental setting (69-76):
        - Regulatory setting (69):
            - Federal:
                - Clean water act 1972
                - Safe drinking act 1974
                - National flood insurance program

- State:
  - Porter-Cologne water quality control act 1970.
- Existing conditions (70-76):
  - Geomorphic conditions (70-71):
    - A short and somewhat strange discussion w/o importance.
  - Sedimentation (71-73):
    - As a result of SN hydraulic mining in the late 1800's
      - The Sacto R. and major tributaries aggraded 10-15 ft.
      - Since then they have gradually incised into residual mining debris.
    - Transport of SN mining debris into and through the Delta
      - probably continued into the mid 1900's
    - Many researchers believe
      - The present sediment loading of the Sacto. R. is approaching pre-gold rush levels.
    - A sediment analysis was not completed for this study
    - A Sacto. basin wide sediment study was conducted under the
      - Sacramento River Bank Protection Project (NHC, 2012).
        - Objectives were to
          - Investigate sediment transport processes in the Sacrto R. and major tributaries/distributaries.
        - HEC-6T sediment transport 1-D model
          - For the Sacto, American, Feather Rivers.
          - Computes streambed profile aggradation and degradation
          - Over the course of a hydrologic event.
    - Long-term simulation of the LAR
      - Most of the 22 mile LAR is actively degrading.
      - RM 22-12
        - 9-10 ft. of degradation
          - For both the 50 and 100 year periods
      - RM 11-12
        - 3-4 ft. of aggradation
        - (Timeframe not specified)
      - RM 0-11
        - Max of 15-16 ft. of degradation
          - 50 year period
        - Max of 19-20 ft. of degradation
          - 100 year period
      - <u>Average LAR degradation</u>
        - 50 year period
          - Thalweg – 5.39 ft.
          - Average channel bed- 4.83 ft.

- 100 year period;
  - Thalweg - 6.42 ft.
  - Average channel bed- 5.84 ft.
- *These modelling results are non-sensible – at least w/o further discussion and explanation.*
  - *Were the cemented/indurated clay channel bed nick points considered and what influence would they have on channel degradation upstream of their locations over these timelines? Can very deep channel sections be expected to develop and survive upstream of the several clay-channel bed nick points?*
  - *What is the volume of sediment predicted by this modelling to be lost in the LAR over these timelines?*
  - *Where does this sediment go?*
  - *Have they overlooked that the LAR channel is drowned downstream of RM 5 (due to geologic timescale sea level rise) and that now and in the future (increasing rates of sea level rise), out-fluxing of coarse sediment past this point is not likely. What are the implications of this sea-level rise process on long-term degradation/aggradation in the RM 5-7 reach?*
  - *Does the 15-20 ft. of degradation in RM 0-11 reach imply that over these timelines (50-100 yrs.) the SN mining debris sand in the LAR system has become exhausted?*

EE-73

EE-74

EE-75

EE-76

EE-77

EE-78

- Irregular channel reaches may not be adequately represented by this model
  - Especially in braided reaches above RM 8.
- *There are no really braided channel plan forms on the LAR upstream of RM 8 except possibly a 0.5 mi section at about RM 14/15 (this is really just a short reach recently experiencing over-loaded sediment influx in conjunction with erodible banks – local widening and the development of multiple channels. This "braided" feature is in the process of change and could develop into a*

EE-79

EE-79
(cont.)

single thread channel with time). The complex channel in the RM 11-12 reach is the result of the breaching of off-channel gravel pits – not channel braiding. The complex channel configuration at RM 9 downstream of the Watt bridge is due to a natural process of sediment deposition and channel re-configuring resulting from late-date gravel bar mining and the resulting over-widened channel – this is not channel braiding. The source of the sediment that is being deposited downstream of the Watt bridge is most likely due to ongoing scour in the 0.5 mi of channel upstream of the Watt bridge. At about RM 6 there is a 0.5 mi braided reach that is due to coarse sediment deposition at the head of the drowned LAR channel reach (RM 0-5) (due to geologic time-scale sea level rise). This is the expected final location of all coarse sediment transported through the LAR.

- Application of generalized results in irregular reaches may be subject to errors.
- Further site-specific analysis could potentially reduce the error.
- In general the mode results conform to records of channel degradation at the Fair Oaks Gage.

- Potential implications of model results;
  - Degraded bed can
    - Increase stress on
    - Levee toes
    - Berm toes
    - Can increase scour in unrevetted reaches.
  - Aggraded bed can
    - Increase floodflow water surface elevations
    - Reduce flood conveyance

- American River channel stability (73-74):
  - "LAR – Erosion Susceptibility Analysis for Infrequent Events (Ayers 2012)
    - 2-D hydraulic model
      - 115.000 cfs
      - 140,000 cfs
      - 160,000 cfs

- Analyses have been completed;
  - Many more are still underway

        - To understand overall channel stability.
- Additional information in Civil Design and Geotechnical appendices.
- Pending result will not affect the following conclusions:
    - The LAR is degrading under present operational conditions
    - LAR is sediment starved.
        - Bedrock has been reached as far downstream as Guy West Bridge which is slowing further degradation.
        - Without significant bed slope reduction, it will now tend to erode laterally to satisfy need for sediment.

EE-80

    - *This conclusion seems to contradict the predictions of significant channel degradation noted above.*
    - Hydraulic modeling shows areas of bank and levees where allowable velocities for vegetation cover are exceeded
        - These site need to be evaluated in more detail to determine is a levee failure is likely to occur.
    - Field review verified that erosion of the bank is occurring at RM 9.0 RR, even at lowflow of 7,000 cfs.
        - Erosion of the LAR is continually occurring.
        - Leaving the banks sacred and susceptible to future erosion, especially at high flow events.
        - Further reducing the amount of berm separating the channel from the levees
        - Loss of vegetation is leaving the bare soil, which is susceptible to erosion at a lower velocity

EE-81

    - *All of these statements about "erosion" appear to be true when applied only to the field-verified erosion at "RM 9.0 RR."*
        - *However this site of erosion is not characteristic of the LAR: It is due to local-scale natural channel adjustments underway in response to channel over-widening that occurred in the 1960-70's when the*

EE-82

EE-82

(Cont.)

EE-83

EE-84

EE-85

RL attached longitudinal gravel bar was removed for gravel mining purposes. With reduced stream power at this location a medial bar developed which is now morphing into a diagonal bar attached to the RL bank at the bridge. The process has progressively forced more flow and power to the RR bank causing the Corps' "field-verified" erosion. At the location of the original attached bar, the channel is aggrading to a significant degree making the existing boat ramp dysfunctional.

- *This condition in not representative of the LAR in general, nor of the critical RM 6-11 reach but is a local phenomenon, with local symptoms and local causal factors.*
- *Which could be corrected with proper channel restoration actions.*
- *The real long-term erosion issue in this critical reach is the sewer main undercrossing at about RM 7. The line was installed as an inverted syphon with one limb at the edge of the RR active channel bank, with revetment armoring on this bank slope. This constitutes a critical channel impingement and constraint which resulted in severe RR bank erosion upstream of the line due to progressive erosive eddy development during the 1986 flood event. Without that armored nick point on the RR bank (and with the inverted syphon limb set back from the channel bank edge), it is most likely that bank erosion along the RR bank at that location during the 1986 event would have been very modest. The presence of this sewer undercrossing in its present configuration limits intelligent channel reconfigure alternatives for dealing with this critical flood conveyance reach.*

EE-86

- *The Corps' flood conveyance actions in this critical reach should be focused on the modification of the existing inverted syphon such that stream channel, channel bank, and riparian setting reconfiguration and restoration options are maximized not minimized.*

- Climate (74):
  - Short unimportant discussion.
- Surface water storage (74-75):
  - Short discussion.
  - For details on hydrologic inputs and storm centering see,
    - Hydrology appendix
- Existing and future without project condition assumptions (75-76):
  - Existing condition assumptions include;
    - Existing releases from Folsom Dam
    - USBR/SAFCA reservoir operations agreement
      - Allowing greater flood storage compared to the original operations manual.
  - Future without project condition assumptions include;
    - Construction and operation of all previously authorized on the LAR
      - WRDA 1996, 1999 Common Features authorizations
      - Levee repairs as described in the Natoma PACR authorized in WRRDA 1014
      - The new JFP spillway at Folsom Dam
      - Future planned raise of Folsom Dam
  - Future with project condition assumptions include;
    - The work proposed as part of the GRR.
  - Implications of the future with project conditions
    - Were developed on the basis of
      - Future without project conditions
  - TABLE 8: comparison of existing and future w/o project releases from Folsom Dam (75)

Freq (yr).	Existing	Future w/o project (Alt 1)
10	43,000	72,000
25	100,000	115,000
50	115,000	115,000
100	145,000	115,000
200	320,000	160,000
500	520,000	530,000

  - FIGURE 7: Comparison of existing and future w/o project (Alt 1) Folsom Dam releases.

- 3.4.2 Methodology and basis of significance (77-78):

- Methodology (77-78):
- Basis of significance (78):
  - Alternatives were determined to have significant impacts if they result in any of the following;
    - Substantially alter the existing drainage pattern of the site or area, including through the alteration of a stream course in a manner that would result in;
      - Substantial erosion of siltation on- or off-site
      - Substantial increase in the rate or amount of surface runoff in a manner that would result in flooding on- or off-site.
    - Create if contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional source of polluted runoff.
    - Place housing within a 100-year flood hazard area.
    - Place within a 100-year flood hazard area structures which would impede or redirect flood flows.
    - Expose people or structures to a significant risk of loss, injury, or death involving flooding.

- 3.4.3 No action alternative (79):
  - Continued risk of levee failures
    - Continued flood flight regime.
      - Possibly placement of rocks at levee failure site
        - Emergency repair activities
          - Could result in
            - Loss of channel capacity
            - Alteration of present geomorphic processes.
          - *Not sure why these either of these conditions should occur*.

EE-87

- 3.4.4. Alternative 1 – improved levees (79-80):
  - Levee remediation measures to address deficiencies such as;
    - Seepage
    - Slope instability
    - Overtopping
    - Erosion
    - Lack of vegetation compliance
    - Lack of O&M access
  - Along;
    - American R.
    - Sacto. R.
    - NEMDC
    - Arcade C.
    - Dry C.
    - Robla C.
    - Magpie C.
  - Combines
    - Construction of improvement

- While maintaining present levee alignments.

- Purpose is to,
  - Improve the flood risk management system to
    - Safely convey flows up to a level that
      - Maximizes net benefits.
  - Project work primarily includes landside levee fixes,
    - That do not change in-channel geometry or characteristics.
  - Therefore would not:
    - Substantially alter erosion or siltation in the system
    - Increase surface RO in a manner that would result in any flooding.
    - Impact stormwater drainage systems or create additional RO.
      - *Can this be said of the proposed 11-12 miles of bank protection and launchable rock trench work in the LAR/ARP?*

EE-88

  - Water surface elevations for
    - Baseline,
    - Alt 1 (which is the "future without-project")
    - Alt 2
    - For the
      - 2-yr event
      - 100-yrevent
  - Is in the Engineering appendix
  - TABLE 12: Comparison or 10, 100 and 200 year events under various conditions (LAR only) (81):

Freq.	Existing (Baseline?)	Future w/o project (Alt 1)	Future w/ project (Alt 2)
10	43,000	72,000	72,000
100	145,000	115,000	115,000
200	320,000	115,000	115,000

  - The 200-yr flows in the LAR
    - Are tied to the changes on Folsom Dam operations
      - Which will be analyzed as part of the ongoing
        - Folsom Dam Water Control Manual Update.
    - Effects of these flows including cumulative effects
      - Will be addressed by
        - The Manual Update EIS/EIR.
        - *Does this mean that the 200-yr LAR flows may not be 115,000?*
        - *Does this mean that the impacts of changing the floodflow regime on the LAR will be assessed at a later time? That the possible channel implications of the GRR w/o or w/ project conditions do not consider the change in floodflow regime? And that they have not yet been assessed?*

EE-89

EE-90

EE-91

- *When will the Manual Update EIS/EIR be undertaken?*
- Alt 1 would not alter flows
  - There would be no significant change or effect on hydrology and hydraulics
    - With the project in place
      - No mitigation would be required.

EE-92

- *If the launchable rock trench method is used, the expected project functionality depends on progress bank erosion/retreat to launch the rocks. Under this post-launched condition, what would be the impacts on the hydraulic conditions of the channel?*

- 3.4.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (80-82):
- 3.4.6. Avoidance, maintenance, and mitigation measures (82):
  - Flows are not increased
    - Effect to hydrology/hydraulics are less than significant
      - No mitigation is required.

EE-93

- *If the launchable rock trench method is used, the expected project functionality depends on progress bank erosion/retreat to launch the rocks. Under this post-launched condition, what would be the impacts on the hydraulic conditions of the channel?*

- **3.5 Water quality and groundwater resources (82-93):**
  - 3.5.1 Environmental setting (82-88):
    - Regulatory setting (82):
    - Existing conditions (83-88):
      - American River (83):
      - Sacramento River (84);
      - East side tributaries (84):
      - Sacramento bypass (84):
      - Surface water quality (84-88):
  - 3.5.2 Methodology and basis of significance (88):
    - Methodology (88):
    - Basis of significance (88):
  - 3.5.3 No action alternative (88-89):
  - 3.5.4. Alternative 1 – improved levees (89-91):
    - American River (90):
    - Sacramento River (90-91):
    - East side tributaries (91):
  - 3.5.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (91):
  - 3.5.6. Avoidance, maintenance, and mitigation measures (92-93):
- **3.6 Vegetation and wildlife (94-106):**
  - 3.6.1 Environmental setting (94-97):
    - Regulatory setting (94):
      - Sacramento County Ordinance, Chapter 19.12, Tree Preservation and Protection (Tree Preservation Ordinance).

- City of Sacramento Protection of Trees Ordinance (City of Sacramento Municipal Code 12.56.060).
- City of Sacramento Heritage Tree Ordinance (Code 12.64.020)

- Existing conditions (94-97):
  - Addresses areas within potential construction footprint.
    - These are the areas where potential impacts to vegetation and wildlife could occur.
  - Conducted a survey (2011) of levee trees
    - Within 30 ft. of waterside
    - Within 15 ft. of landside
    - Included;
      - Species
      - Diameter
      - Location
- American River (94-95):
  - Along the channel vegetation is primarily SRA habitat.
    - *Were the USFS criteria used in this survey/result?*
    - *Is this survey information available?*

EE-94

  - Trees adjacent to the channel are mainly
    - Oaks
    - Cottonwoods
      - With a thick understory of vines, berry bushes, willows.
  - The ARPP details
    - How vegetation should be managed and expanded
      - Where appropriate
    - Recognizes the primary purpose of the system is for flood control
      - Attempts to manage the natural setting of vegetation and wildlife
      - While meeting the goals of the flood control system.
  - Protected areas contain tracts of naturally occurring vegetation and wildlife
    - Although capable of sustaining <u>light to moderate use</u>
      - With minimal alteration to the natural landscape
    - Would be easily disturbed by <u>heavy use</u>.
      - *Where does this judgment come from?*

EE-95

  - <u>Emphasis is on</u> protection an restoration of large portion of relatively natural areas
    - Which stands a better chance of preservation
      - And provide better sup[port for wildlife
        - Than smaller pieces.

EE-96

- *Where does this statement/judgement come from?*
  - Several areas have been used as
    - Mitigation sites for Corps and other agencies for endangered species
    - Compensation for loss of riparian habitat or oak woodlands from other projects.

EE-97

- *What is the difference between sites used as "mitigation" and "compensation?"*
  - Example list of wildlife species in the ARP.
- Sacramento River (95-96);
- East side tributaries (96-97):
- Sacramento weir and bypass (97):

- 3.6.2 Methodology and basis of significance (97-98):
  - Methodology (97-98):
    - Impacts are evaluated based on data collected from
      - Tree surveys
      - Site visits
      - Google Earth
      - ARPP
    - Which provide a comprehensive overview of vegetation conditions
    - Were used to evaluate impacts.
    - ARPP goals and objectives were considered for
      - The impact analysis
      - How construction would impact those goals and objectives.
    - Impacts to wildlife were evaluated based on
      - Construction activities
      - Changes in habitat types after construction.
    - Assumed the Corps would receive a variance to address waterside vegetation
      - Under the requirements of ETL 1110-2-583
    - A System Wide Improvement Framework (SWIF) agreement is being sought by the non-federal sponsor
      - Which would allow the local maintenance agency (LMA) to defer ETL 1110-2-582 compliance of landside vegetation encroachments
        - To be addresses by the LMA at a later time.
        - Details on the SWIF are **presented in 1.4.5**.
    - Effects to vegetation and encroachments are assumed to occur
      - In the footprint of all proposed construction activities.
  - Basis of significance (98):
    - Effect are considered significant if any one of the following results;
      - Substantial loss, degradation, or fragmentation of any natural communities or wildlife habitat.

- Substantial effects of a sensitive natural community, including;
  - Federal protected wetlands
  - Other wetlands of the US
    - As defined in Section 404.
- Substantial reduction in quality or quantity of important habitat
  - Or access to such habitat for wildlife species
- Conflict with
  - ARPP
  - Sacto. Co. Tree Preservation Ordinance
  - City of Sacto. Protection of Trees Ordinance.
- Substantial adverse effects of native wood habitats in the ARP
  - Resulting in the loss of vegetation and wildlife.
    - *What parameters were used to assess "substantial" and "conflict?"*

EE-98

- 3.6.3 No action alternative (98-99):
  - Over time the berms would erode
    - Vegetation would be lost
      - Wildlife would relocate
    - Trails would be lost that provide to access for
      - Wildlife observation
      - Fishing
      - Other recreational activities
  - Does not comply with the ARRP
    - Which states;
      - "Bank scour and erosion shall be proactively managed to protect public levees and infrastructure, such as bridged, piers, power lines, habitat and recreation resource."
        - ***Where is this statement – what context?***

EE-99

  - The loss of
    - Vegetation and wildlife habitat
      - Would be considered a significant impact.
        - *The Corps does not specify or estimate the amount of vegetation and wildlife habitat that would be lost in the ARP.*

EE-100

- 3.6.4. Alternative 1 – improved levees (99-101):
  - A vegetation variance would be obtained to
    - Reduce the impacts to vegetation and wildlife.
    - Allowing most trees on the lower ½ of the waterside slope to remain in place
      - Details on the vegetation variance **are in 1.4.5**.
      - *The discussion of the vegetation variance (p 13) specifies the Sacramento River levees. Will the variance include American River levees?*

EE-101

EE-102

- *What would be the ARP vegetation and wildlife habitat impact implications should the vegetation variance not be approved and/ot not really apply to the LAR?*

- A System Wide Improvement Framework agreement would allow vegetation and encroachment compliance on the landside of the levees to be deferred.
  - Details on SWIF **<u>are in 1.4.5</u>**.

- American River (99-100):
  - Construction of launchable rock trench;
    - Removal <u>of 65 ac of riparian habitat</u> in the ARP
    - Calculated by
      - <u>Overlaying the largest possible footprint onto aerial photos</u>

EE-103

        - *Will this overly be available during the NRMP process?*
      - Calculating the riparian habitat within the footprint.

EE-104

        - ***In Section ____ (p__) the Corps states that 65 ac of land would be disturbed; not 65 ac of riparian habitat. Which is correct?***
    - Is located in areas designated in the ARPP as
      - Protected Areas
      - Nature Study Areas
      - However, the ARPP allows for flood control activities to be conducted
        - In order to pass 160,000 cfs
      - ARPP Section 4.10 states;
        - "Flood control projects, including levee protection projects and vegetation removal for flood control purposes, shall be designed to avoid or minimize adverse impacts on the ARP, including impacts to wildlife and wildlife corridors. To the extent that adverse impacts are unavoidable, appropriate feasible compensatory mitigation shall be part of the project. Such mitigation should be close to the site of adverse impacts, unless such mitigation creates other undesirable impacts."
    - This impact is considered as significant because
      - The temporal loss of trees between the time of removal and their growth to a condition that provides original values.
      - Cannot be mitigated to less than significant.
        - *Impacts and determination of significance seems to be based on construction and time delays for construction impacts. This seems to ignore the impacts of properly functions*

EE-105

EE-105
(Cont.)

designed approach should the launchable rock trench approach be used. The proper functioning of this approach depends of the progressive loss of banks and berms that provide the locations of vegetation and wildlife habitat and the launchable rocks can only be launched once these ARP values are lost. Why shouldn't these proper operational impacts of the launchable rock trench approach be addressed in the same light as the No Action Alternative, that entail the same resource values loses, and over the same timeframe, as the launchable rock trench approach?

- Construction would likely by May-October
  - When birds are likely to be nesting.
- **Once the project is authorized and funded**
  - **Surveys would occur to determine**
    - If nesting birds are present which may be impacted during construction.
  - If nesting birds are located adjacent to the project area
    - Coordination with resource agencies would occur.

- Other additional construction;
  - Would occur on another 135 ac of the ARP
    - Primarily
      - Levees
      - Patrol roads
      - Open lands with no trees.
- 11 miles of intermittent erosion repair
      - Bank protection
      - Launchable rock trench
    - Would occur over a 7 year period.
  - Trees would be removed as the trench is constructed
    - Over multiple years
  - Trees outside the construction footprint
    - Would be covered by the <u>vegetation variance</u>
      - Would therefore remain in place.
      - *Unless the variance is not approved!*
      - *Section 1.4.5 (p 13) specifies that the vegetation variance was for Sacramento River levees. Is this an incorrect interpretation of the text? Would it also apply to LAR levees?*

EE-106

EE-107

      - ***Impacts addressed for this alternative are exclusively construction related. What would be the impacts of expected and***

EE-107

(Cont.)

proper functioning of the launchable rock trench approach?

- Sacramento River (100-101):
- East side tributaries (101):

- 3.6.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (102-103):
  - Sacramento River (102):
  - Sacramento weir and bypass (102-103):
- 3.6.6. Avoidance, maintenance, and mitigation measures (103-106):
  - Estimates of compensation measures are based on
    - The largest potential footprint
    - Worst case scenario
      - For the purposes of NEPA compliance

EE-108

Does this include the possibility that the vegetation variance will not apply to the LAR or that it will not be approved??

  - If design refinements result in reduced impacts to vegetation
    - Compensation would be coordinated with the appropriate resource agencies and adjust accordingly.

EE-109

As well as increased impacts??

  - American River (103-104):
  - Design-refinement plans will evaluate reductions to vegetation and wildlife impacts including;
    - Reduced footprint
    - Constructing bank protection rather than launchable rock trench
      - Whenever feasible

EE-110

This implies that bank protection is the preferred approach unless not feasible.

    - Designing planting berms in areas where significant riparian habitat exists adjacent to the levee toe
      - When no hydraulic impacts would occur.

EE-111

Could the NRMP be used to assess overall-ARP impacts and implications of mitigation to include greater (short-term) impacts in the construction area with greater long-term mitigation values with restoration/mitigation projects in the Arden/Sacto Bar/Sailor Bar areas??

    - Trees would remain in locations where
      - Bank protection
      - Planting berms
      - Can be constructed
        - Since this area is 15 ft. from levee toes
        - Complies with Corps vegetation policy.

EE-112

In Section 2.3.1, the Corps said that for bank protection work, large trees may be left in place. However, if these trees live for a while they will die and will leave a bare

EE-112 (Cont.)

rock slope because revegetation success on revetments is very poor. Shouldn't this mean that long-term impacts should count these slopes as unvegetated?

- Trees would be protected in place along the natural channel bank
  - During placement of rock
    - Would anchor trees to reduce risk of falling during high flow events.
    - *In Section 2.3.1, the Corps said that for bank protection work, large trees may be left in place. However, if these trees live for a while they will die and will leave a bare rock slope because revegetation success on revetments is very poor. Shouldn't this mean that long-term impacts should count these slopes as unvegetated?*

EE-113

- Additional plantings would be installed on
  - Newly constructed berms
    - To provide habitat for
      - Fish species
      - Avian species
  - Planting berms would be used to minimize impacts to fish and wildlife species,
    - However impact to riparian habitat would still be significant.
    - *These planting berms are not discussed specifically in Section 2.3.1 nor are indicated on Figure 1.*

EE-114

EE-115

- *Were these "minimized impacts" used to reduce the amount of mitigation obligation?*
- *Would these "newly constructed berms" extend into the channel from the present bank, reducing active channel widths?*

EE-116

- Compensation for 65 ac of riparian habitat
  - 130 ac of replacement habitat would be created.
- Species selected to compensate for riparian corridor removal
  - Would be consistent with approved native plant species list for the ARP.
- The 130 ac would
  - Create
    - Habitat connectivity
    - Wildlife migratory corridors
      - That provide for the habitat needs of important wildlife species
    - *How is this to be assured without a mitigation plan?*

EE-117

  - Without compromising

- Integrity of the of the flood control facilities
- Flood conveyance capacity
- ARPP management goals
- *Where is it demonstrated that this can be done? Has there been an assessment of this possibility?*

EE-118

- 130 ac of riparian would be planted
  - On top of rock trenches.
    - Corps vegetation policy allows
      - Trees to be planted >15 ft. from levee toes.
    - To comply with
      - This policy
      - And to reduce maintenance on compensation lands
  - Trees could be planted on top of rock trenches starting 30 ft. from the waterside levee toe.
    - If the rock trench is 70 ft wide, trees plantings for riparian habitat could occur on the outer 40 ft.

EE-119

- *Will the launchable rock trench surfaces be within the elevation and distance for natural riparian zone sub-irrigation required by trees?*

EE-120

- *Section 2.3.1 indicates:1) that the trench rock will be covered with a minimum of 3 ft. of stockpiled soil, 2) some vegetation could be permitted over the trench if planted outside the specified vegetation free zone required by ETL 1110-2-581, 3) disturbed areas would be reseeded with native grasses, small shrubs, and trees with shallow root systems (to ensure rock trench functionality) but 4) would only be permitted if it does not burden floodway maintenance agencies and does not interfere with floodway capacity. It sound very much that the "riparian" revegetation in Section 3.3.6 is not compatible with Section 2.3.1. which prohibits deep rooted trees.*

EE-121

- *This says that there will be at least 130 ac of rock trench surface outside the vegetation free zone (surface areas >30 ft. from the waterside levee toe). What does this say about the total area of (and length of) rock trench surface area on the LAR/ARP?*

EE-122

- *How was the 130 ac of riparian replanting on rock trenches counted for impact/ mitigation?*

EE-123

- *When and if the launchable rock trenches actually launch the rocks due to erosive bank retreat (that is when the project functions as designed), how will the losses of real riparian vegetation along the banks, and the Corps' "riparian plants" on the rock trench surfaces, be counted as impacts resulting from proper project functioning?*
- The exact location of compensation lands
  - Would be coordinated in the design phase with
    - SCRP
  - And would comply with the ARPP objectives and goals.
- It is assumed that sufficient compensation lands are available in the ARP.
  - If not
    - Other location within Sacto Co. would be identified
    - And public coordination would occur.

- Prior to construction;
  - For several years
    - Survey will be conducted to determine if nesting birds are within 0.5 mi of construction sites.
  - If nests are located in any given year
    - Coordination with appropriate resource agencies would occur
      - To determine what actions should be taken.
    - Trees with active nests would not be removed
      - Until young have fledged.
  - If no nests are found in the vicinity of construction sites for that year
    - Construction may commence without further coordination.
- Sacramento River (104):
- East side tributaries (105)
- Sacramento weir and bypass (105-106):

- **3.7 Fisheries (106-115):**
  - 3.7.1 Environmental setting (106-110):
    - Regulatory setting (106):
    - Existing conditions (106-110):
      - Sacramento River and American River (106-109):
      - East side tributaries (109):
      - Sacramento bypass (109-110):
  - 3.7.2 Methodology and basis of significance (110-111):
    - Methodology (110-111):

- Basis of significance (111):
- 3.7.3 No action alternative (111):
- 3.7.4. Alternative 1 – improved levees (112-114):
  - American River (112):
  - Sacramento River (113):
  - East side tributaries (113-114):
- 3.7.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (114-115):
  - Sacramento weir and bypass (114-115):
- 3.7.6. Avoidance, maintenance, and mitigation measures (115):

3.8 Special status species (115-150):

- 3.8.1 Environmental setting Regulatory setting (116-126):
  - Regulatory setting (116):
    - Federal:
      - ESA
      - Migratory Bird Treaty Act
      - Bald and Golden Eagle Protection Act
    - State:
      - Calif. ESA
      - Calif. Fish and Game Code
      - Calif. Native Plant protection Act
  - Existing conditions (116-110):
    - A list of species status species was compiled from
      - USFWS website
      - CNDDB
    - Those expected to be found in the study area are addressed below.
    - They may occur in any of the project areas so are not broken out to specific areas.
    - VELB (116-117):
      - Federally listed as threatened.
      - Documented along the LAR.
      - Corps conducted a survey of elderberry shrubs along levees in 2012 including
        - Levee structure
        - 15 ft. on either side
          - Where access was available.
      - Survey found the south side of the American River had the greatest amount of clusters.
      - All shrubs are considered to be in the riparian zone
        - Except if located on the landside of levees.
          - *How was this "consideration" made? Simply assumed? Or used established criteria?*
          - *Just because a particular shrub was "considered" to be in a "riparian zone," for impact/mitigation assessment are these particular plants considered riparian?*

EE-124

EE-125

  - Giant garter snake (117):

        - Federal and state listed as threatened.
        - Inhabits; rice fields, irrigation supply and drainage canals, freshwater marshes, sloughs, ponds, other aquatic habitats
        - Primary cause of decline;
            - Loss or degradation of aquatic habitat caused by agricultural development
            - Compounded by loss of;
                - Upland refugia
                - Bankside vegetation cover
        - Large waterways such as the American River do not provide habitat.
    - Swainson's hawk (120):
        - Federal listed as species of concern
            - Protected under the Migratory Bird Treaty Act
        - State listed as threatened
        - Occur March-September for breeding
            - Nesting territories established by April
            - Incubation and rearing occurring through June.
        - Found most often in;
            - Grasslands
            - Low shrublands
            - Agricultural areas
        - Nests are found in
            - Riparian woodlands
            - Roadside trees
            - Trees along field borders
            - Isolated trees
        - Majority of nesting sites are in remnant riparian forest corridors along drainages
        - Mostly forage within 1 mile of nest
        - Prey abundance and accessibility are the most important suitability parameters
            - Subject to land use operations (mowing, flood irrigation)
        - American River area is less likely to support nests
            - Urban development
            - Food less abundant than in agricultural areas.
    - Sacramento River winter-run chinook salmon (120-121):
        - Federally listed as endangered.
        - Sacramento River is considered to be critical habitat.
        - All reaches within the ARCF GRR area are considered EFH.
    - Central Valley spring-run chinook salmon (121-122):
        - Federally listed as threatened.
        - Critical habitat has been designated
                - Including the American River
            - Includes channel widths to the;
                - Bank-full elevation
                - Or ordinary high-water line elevation

        - All reaches within the ARCF GRR area are considered EFH.
    - Central Valley fall-/late fall-run chinook salmon (122-123):
        - Listed as a species of concern by NMFS
        - Critical habitat is not designated
        - Essential Fish Habitat is designated
            - EFH is defines as those
                - Waters and substrate necessary for
                    - Spawning
                    - Breeding
                    - Feeding
                    - Growth to maturity
                - Whether current or historical
            - All reaches within the ARCF GRR area are considered EFH.
    - Central Valley steelhead (123):
        - Federally listed as threatened
        - Critical habitat has been designated
            - For designated reaches
            - Includes channel widths to the;
                - Bank-full elevation
                - Or ordinary high-water line elevation
        - There is no EFH designated.
    - Delta smelt (124):
    - Green sturgeon (124-125):
    - Vernal pool fairy shrimp (125-126):
    - Vernal pool tadpole shrimp (126):
- 3.8.2 Methodology and basis of significance (126-127):
    - Methodology (126):
        - Potential effects were based on
            - Existing documentation
            - 2011 field surveys
                - Conducted on;
                - Levee slopes
                - Landside levee toe – out 15 ft.
                - Waterside levee toe – out 30 ftt.
                - Included;
                - Trees
                - Size
                - Species
                - Health
                - Location
                - Elderberry shrubs
                - Size
                - Location
                - *Does this survey area include all the construction impact zone of the LAR? Was the SCRP GIS database of elderberry shrub locations used? The wording in Section*

EE-126

EE-126

(Cont.)

3.8.6 specifies that the recorded elderberry plants were on and near the levees and not in berm and bank areas where launchable rock trenches and bank protection work would occur. Isn't it very likely that the number of elderberry shrubs along the LAR to be substantially larger?

- Significant impacts occur if
  - The project has substantial adverse effect
    - Directly
    - Through habitat modification
      - On any species identified as
        - Candidate
        - Sensitive
        - Special-status
      - In any local or regional
        - Plans
        - Policies
        - Regulations
      - Or by
        - DFW
        - USFWS
        - NOAA Fisheries.
- Basis of significance (127):
  - Effects are considered significant (substantial?) if project would result in any;
    - Direct or indirect
      - Reduction in
        - Growth
        - Survival
        - Reproductive success
      - Of any species
        - Listed
        - Proposed for listing
      - As
        - Threatened
        - Endangered
      - Under
        - Federal ESA
        - State ESA.
    - Direct
      - Mortality
      - Long-term habitat loss
      - Lowered reproductive success
      - Federal or state species listed as
        - Threatened
        - Endangered
      - Federal species listed as

- Candidates.
- Direct or indirect
  - Reduction in
    - Growth
    - Survival
    - Reproductive success of substantial populations
  - Of any
    - Federal species of concern
    - State species listed as
      - Endangered
      - Threatened
    - CNPS listed
      - Plant species
    - Species of special concern
    - Regionally important commercial or game species.
- Have an adverse effect on species'
  - Designated critical habitat.

- 3.8.3 No action alternative (127-128):
- 3.8.4. Alternative 1 – improved levees (128-136):
  - VELB (128):
    - 250 shrubs were found along the LAR
    - Prior to construction
      - A survey within 100 ft. of construction area will be conducted
        - In accordance with USFWS guidelines
      - Potentially effected shrubs will be
        - Mapped
        - Surveyed
          - To determine
            - Size of stems
            - Location "of shrubs to riparian habitat"
            - Presence of exit holes.
    - Shrubs that cannot be avoided
      - Would be transplanted
        - Between Nov. and mid-Feb. when plants are dormant.
      - Transplanting procedures will comply with Conservation Guidelines for the VELB (USFWS 1999)
      - Potential impacts due to damage or transplantation include
        - Direct beetle mortality
        - Disruption of lifecycle
    - Temporal loss of habitat
      - May occur due to transplantation
      - Even with compensation measures including
        - Habitat restoration
        - Habitat creation

- Mitigation plantings would likely require 1 or more years
  - To provide supporting habitat.
- Associated riparian habitats
  - May take several decades to reach full value.
    - *What "associated riparian habitats?" Some that the Corps will plant? Where?*

EE-127

- Project is likely to adversely affect VELB.
- Compensation is discussed in Section 3.8.6
- Implementation of
  - Avoidance, minimization, compensation measures
    - Impact to VELB would be
      - Less than significant.

- Giant garter snake (129):
- Swainson's hawk (129-130):
  - 134 ac, of riparian habitat (project-wide)
    - Used by Swainson's hawk
      - For;
        - Roosting
        - Nesting
    - Will be affected
      - By construction.
      - *How is this acreage computed?*

EE-128

  - Any trees removed
    - Would be mitigated
  - However
    - Temporal losses would be significant due to time delay to recover use values.
  - 2.5 ac of non-native grassland/barren lands (project-wide)
    - Would be removed/disturbed
      - Due to construction at levees
  - Much of it
      - In the Sacto. River and American River area,
    - Where hawks nest and forage.
  - Prior to construction
    - Annual surveys would be conducted
      - Within ½ mi. of anticipated construction areas.
    - If hawks are found
      - Resource agency coordination would occur
        - Appropriate avoidance and minimization measures would be established
          - Prior to construction.
  - Adverse effect would be significant
    - Due to temporary loss of
      - Nesting habitat
        - Along waterways while new mitigation trees grow.

- Sacramento River winter-run chinook salmon (130):
- Central Valley spring-run chinook salmon (132):
- Central Valley fall-/late fall-run chinook salmon (133):
- Central Valley steelhead (133-134):
- Delta smelt (134-135):
- Green sturgeon (135-136):
- Vernal pool fairy shrimp (136):
- Vernal pool tadpole shrimp (136):

- 3.8.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (137-138):
  - Sacramento bypass and weir (137-138):
- 3.8.6. Avoidance, maintenance, and mitigation measures (138-150):
  - Estimates of compensation measures are based on
    - The largest potential footprint
    - Worst case scenario
      - For the purposes of NEPA compliance

EE-129

        - *Does this include the possibility that the vegetation variance will not apply to the LAR or that it will not be approved??*

EE-130

        - *Based on the 2011 survey area, there could be additional elderberry shrubs impacted. (See comments in Section 3.6.2 above.)*
  - If design refinements result in reduced impacts to vegetation
    - Compensation would be coordinated with the appropriate resource agencies and adjust accordingly.

EE-131

        - *As well as increased impacts??*
  - VELB (138-145):
    - 250 elderberry shrubs were located on the LAR
      - On levee slopes and within
        - 15 ft of the landside toe
        - 30 ft of the waterside toe.
    - In accordance with
        - Conservation Guidelines for VELB (USFWS 1999)
      - Adverse effects would be compensated by;
        - Transplanting shrubs with >1 inch diameter
        - Planting a mix of native riarian/or upland vegetation at a 2:1 And 6:1 ratios
          - Depending on stem diameter
      - Amount of compensation
        - Is based on the 2011 preliminary survey
          - Within the construction footprint

EE-132

          - *Is this the same as the levee slope and 15/30 ft. extension survey above?*
    - On the LAR,
      - Shrubs would be transplanted
      - Additional compensation would be installed
        - On top of rock trenches
          - When possible

- Outside the vegetation free zone
- It is expected that on these <u>trench surfaces</u>
  - <u>Sufficient lands</u> would be available to
    - Plant these shrubs and <u>associated natives</u>.
    - *This implies that there will be at least 89 ac (see note below) of rock trench surface outside the vegetation free zone (surface areas >30 ft from the waterside levee toe (See Section 3.6.6). What does this say about the total area of (and length of) rock trench surface area on the LAR/ARP?*

EE-133

    - *What associated natives?*

EE-134

    - *When and if the launchable rock trenches actually launch the rocks due to erosive bank retreat (that is when the project functions as designed), how will the losses of real riparian vegetation along the banks, and the elderberry plants on the rock trench surfaces, be counted as impacts resulting from proper project functioning?*

EE-135

  - If <u>additional lands</u> are required,
    - Off-site plantings could occur
      - At the existing Cal Expo mitigation site
      - <u>Adjacent</u> to the existing mitigation site at River Bend Park
      - *More land for mitigation would be needed at River Bend?*

EE-136

- Based on
  - 2011 survey results
  - Specific shrub stem characteristics assumptions (see text)
  - USFWS compensation requirements
- <u>66 ac</u> of compensation would be required on the LAR (TABLE 18, p140)
  - *Why does the LAR have 83% of the surveyed elderberry shrubs (205 LAR plants /302 total plants = 0.83) ((with many more possible)) but only has 61% of the estimated mitigation area requirements (66 ac LAR/108 ac total = 0.61)?*

EE-137

- Since the survey was limited to areas within 30 ft. of the waterside of levee toes
  - There are likely many additional shrubs to impacted
    - More compensation will be required.
- PAGE 144: Summary of measures based on
  - *Conservation Guidelines for the VELB (USFWS 1999a)*
- Giant garter snake (145-146):
- Swainson's hawk (145-147):

- To avoid and minimize effects
    - The Corps would implement the following BMP measures;
        - Before ground disturbance
            - All construction personnel would participate in a DFW-approved worker awareness program
                - Present life history
                - Importance of
                    - Nest sites
                    - Foraging habitat.
        - Breeding season surveys (for Swainson's hawk):
            - For nesting birds
            - Would be conducted
                - For all trees and shrubs that would be removed or disturbed
                    - Within 500 ft
                    - (0.5 mi. for Swainson's hawk)
                - Of construction activities
            - Completed
                - During at least 2 of the following periods;
                    - 1/1 – 3/20
                    - 3/20 – 4/5
                    - 4/5 – 4/10
                    - 6/10 – 7/30
                - With no fewer the 3 surveys completed in at least 2 survey periods
                - With at least 1 of these occurring immediately prior to project initiation
                    - (Swainson's Hawk Advisory Committee 2000).
            - Breeding season surveys (for other birds):
                - Migratory bird nest survey could be conducted
                    - Concurrent with Swain. hawk surveys
                - With at least 1 survey
                    - No more than 48 hr. prior to initiation of project activities
                    - To confirm absence of nesting.
            - If area contains no active nests
                - Construction activities could commence
                    - Without any further mitigation.
        - If active nests are found;
            - There would be a 0.25 mi buffer
                - Between construction activities and active nests.
            - A qualified biologist would be present on-site
                - To ensure

        - That the buffer distance in adequate
        - Birds are not showing stress
    - If stress could cause nest abandonment
        - Construction activities would cease
        - Until it is determined that fledglings have left the nest.
- If other migratory birds are nesting in or adjacent to the study area the following BMP would be implemented.
    - Tree and shrub removal and other construction activities
        - Would not be conducted during the nesting season (generally 2/15 – 8/31).
            - Depending on species and varying conditions year-to-year.
            - *It is unclear about the buffer distances.*

EE-138

- Implementation of mitigation measure
        - Described below
            - Would avoid, reduce, minimize
                - The significant effect.
    - For Swainson's hawk
        - The Corps will seek a vegetation variance
            - For the lower half of the levee slope
            - Including of LAR levees?
        - Bank protection work site
            - Would be planted with vegetation and trees
                - That over time will provide habitat.
            - *Will this be applied to the LAR?*
            - *This seems to be contrary to the design approach for LAR bank protection work in Section 2.3.1. (See notes above)*

EE-139

EE-140

    - To compensate for 134 ac of riparian habitat supporting
        - Swainson's hawk
        - Other migratory species
        - Approximately 268 ac of replacement habitat will be created
            - As a mitigation area
            - May consider
                - Woodlake
                - Cal Expo
            - *What are the specific riparian habitat types (or structural conditions) that are needed for mitigation? Are there really opportunities for these specific riparian habitat conditions in the Woodlake/Cal Expo areas?*

EE-141

        - **For mitigation in the ARP**
            - Species selected to compensate for riparian corridor removal

        - Will be consistent with approved native plant list of the ARP.
    - Will prove to be contiguous and create
        - Habitat connectivity
        - Wildlife migratory corridors
        - Support the needs of important wildlife species
    - Without compromising;
        - Integrity of flood control facilities
        - Flood conveyance capacity
        - Management goals of the ARPP.
    - To comply with the ARPP
        - ARP lands will be <u>evaluated for compensation opportunities</u>
        - For any <u>riparian habitat removed</u> in the ARP.

EE-142

- *Specifically, for impact/mitigation purposes; what type of riparian habitat losses constitutes adverse effects on Swainson's hawk?.*

EE-143

- *What is this acreage of this riparian habitat type in the LAR?*

EE-144

- *How, exactly will this opportunity-evaluation be conducted and by who?*
- Location of ARP compensation lands
    - Will be determined in the design phase
    - Coordinated with SCRP
    - To comply with ARPP objectives and goals

EE-145

- *What level of SCRP coordination is anticipated? What guarantees are in place?*
- It is assumed that sufficient compensation lands are available in the ARP
    - If not other locations in Sacto. Co will be identified
    - And public coordination will occur.
- Additional mitigation may be
    - In the expanded Sacto. bypass
    - Other lands with similar value to those removed.

- Listed fish species (147-149):
- Vernal pool fairy shrimp and tadpole shrimp (149-150):

- **3.9 Cultural resources (150-172):**
    - 3.9.1 Environmental setting (150-162):
        - Regulatory setting (150):
        - Existing conditions (150-162):
            - Prehistoric and ethnographic setting (151-153):
            - Historic setting (153-154):

        - Results of the records search (154-155):
        - Field survey results (155-156):
        - Cultural resource site types (156-159);
        - Area of potential effects (159-160):
        - Archaeological sensitivity assessment (160):
        - Programmatic agreement (160-161)
    - 3.9.2 Methodology and basis of significance (163-166):
        - Methodology (163-166):
            - Previous Section 106 compliance of the ARCFD Study (163-165):
            - Application of archaeological sensitivity assessment (165-166):
        - Basis of significance (166):
    - 3.9.3 No action alternative (166-167):
    - 3.9.4. Alternative 1 – improved levees (167-
        - American River (170):
        - Sacramento River (170):
        - East side tributaries (170-171):
    - 3.9.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (171-172):
        - Sacramento bypass (172
    - 3.9.6. Avoidance, maintenance, and mitigation measures (172)
- **3.10 Transportation and circulation (173-181):**
    - 3.10.1 Environmental setting (173-177):
        - Regulatory setting (173):
        - Existing conditions (173-177):
            - American River (175-176):
            - Sacramento River (176)
            - East side tributaries (176)
            - Sacramento bypass (177):
    - 3.10.2 Methodology and basis of significance (177):
        - Methodology (177):
        - Basis of significance (177):
    - 3.10.3 No action alternative (178):
        - American River (178-179):
        - Sacramento River (179):
        - East side tributaries (180):
    - 3.10.4. Alternative 1 – improved levees (178-180):
        - American River (178-179):
        - Sacramento River (179):
        - East side tributaries (180):
    - 3.10.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (180):
    - 3.10.6. Avoidance, maintenance, and mitigation measures (180-181):
- **3.11 Air quality (181-203):**
    - 3.11.1 Environmental setting (181-188):
        - Regulatory setting (181-182):
        - Existing conditions (182-188):
    - 3.11.2 Methodology and basis of significance (188-192):
    - 3.11.3 No action alternative (192):
    - 3.11.4. Alternative 1 – improved levees (192-197):
    - 3.11.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (197-200):

- 3.11.6. Avoidance, maintenance, and mitigation measures (200-203):

- **3.12 Climate change (203-215):**
  - 3.12.1 Environmental setting (203-210):
    - Regulatory setting (203-204):
    - Existing conditions (204-210):
      - Global climate trends and associated impacts (205-206): Climate change conditions in California (206-208):
      - Greenhouse gas emissions (208-209):
      - Greenhouse gas emissions inventories (209-210):
  - 3.12.2 Methodology and basis of significance (210- 212):
    - Methodology (210-211):
    - Basis of significance (211-212):
  - 3.12.3 No action alternative (212):
  - 3.12.4. Alternative 1 – improved levees (213-214):
  - 3.12.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (214):
  - 3.12.6. Avoidance, maintenance, and mitigation measures (214-215):
- **3.13 Noise (215-229):**
  - 3.13.1 Environmental setting (215-222):
    - Regulatory setting (215):
    - Existing conditions (216-222):
  - 3.13.2 Methodology and basis of significance (223-
    - Methodology (223):
    - Basis of significance (223):
  - 3.13.3 No action alternative (223):
  - 3.13.4. Alternative 1 – improved levees (223-228)
  - 3.13.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (228):
  - 3.13.6. Avoidance, maintenance, and mitigation measures (229-230):
- **3.14 Recreation (230-239):**
  - 3.14.1 Environmental setting (230-234):
    - Regulatory setting (230):
      - ARPP
      - Sections 9 and 10 of the Rivers and Harbors Appropriation Act (1899)
      - S W&SR Act (1972)
      - Sacto. City Parks and Recreation Master Plan
      - Sacto. Co. Bikeway Master Plan
      - Old Sacto. State Historic General Plan.
    - Existing conditions (230-234):
      - American River (230-233):
        - Short discussions of
          - ARP
          - SW&SR//FW&SR
            - Designated
              - Recreation
          - ARPP (addressed in Land use, 3.3)
          - ARPP-allowed recreation
          - Jed Smith Bike trail
          - Recreation boating

- ARP-related parks;
    - Discovery Park
    - Sutter's Landing Regional Park
    - Paradise Beach
    - CC CG
    - Guy West Bridge
    - Howe Ave
    - Waterton // Save the American \River Association (Park)
    - Watt Ave
    - Gristmill Park
    - William Pond Recreation Area
    - River Bend Park
    - Soil Born Farms.
- Sacramento River (233-234):
- East side tributaries (234):
- Sacramento bypass (234):

- 3.14.2 Methodology and basis of significance (235):
    - Methodology (235):
        - Impacts to recreation opportunities
            - Are evaluated based on
                - Temporary changes
                - Permanent changes
        - Taking into consideration;
            - ARRP
            - Other regional plans including
                - Sacto. City General Plan
                - Sacto. City Parks and Recreation Master Plan
            - Sacto. Co. Bikeway Master Plan
            - Rivers and Harbors Appropriation Act
            - W&SR Act.
    - Basis of significance (235):
        - Thresholds of significance were,
            - Based on the environmental checklist in Appendix G of the State CEQA Guidelines..
        - Significant adverse effects are determined if any of the following occur;
            - Eliminate or substantially restrict or reduce the
                - Availability
                - Access
                - Quality
            - Of existing recreational
                - Sites
                - Opportunities.
            - Cause substantial long-term disruption in the use of
                - Existing recreational
                - Facility

- Activity.
  - Result in inconsistences or non-compliance
    - With regional planning documents.
  - Result in inconsistences or non-compliance
    - With ARPP.
  - Result in inconsistences with
    - Rivers and Harbors Act
    - W&SR Act

EE-146

- *Do construction activity impacts differ from "long-term disruption?"*

EE-147

- *How does "long-term disruption" differ from "eliminate or substantially restrict?"*

- 3.14.3 No action alternative (235-236):
  - Without project levee improvements
    - Existing problem would continue
      - Potentially leading to future flood-levee failure.
    - Sustained high flows would erode banks in the ARP
      - Over time
        - The ARP
        - And recreational facilities within it
      - Would be lost.
  - No Action Alt. would,
    - Result in
      - Inconsistences
      - Non-compliance
    - With the ARPP.
    - The ARPP states;
      - "Public facilities and private encroachments that inappropriately constrain the operation and maintenance of the flood-control system should be redesigned or relocated"

EE-148

- *Why does this statement imply that the No Action Alt. is inconsistent with the ARPP?*

      - "Bank scour and erosion shall be proactively managed to protect public levees and infrastructure, such as bridges, piers, power lines, habitat and recreational resources. These erosion control projects, which may include efforts to anchor berms and banks with rock revetment, shall be designed to minimize damage to riparian vegetation and wildlife habitat, and should include a revegetation program that screens the project from public view, provides for a naturalistic appearance to the site, and restores affected wildlife habitat values."

EE-149

- *Why does this statement imply that the No Action Alt. is inconsistent with the ARPP?*
- ***Where are these in the ARPP?***

EE-150

- ***Are there other ARPP goals/objectives that relate to the No Action Alt.?***

  - No Action Alt. would cause significant impacts to,
    - Recreational facilities

- That could not be mitigated
    - As there are no other similar recreational experience resources in the Sacto. region.

- 3.14.4. Alternative 1 – improved levees (236-238):
    - American River (236-237):
        - Construction closures and disturbances
            - Would result in ARPP non-compliance (See No Action Alt. above).
            - Erosion protection measure construction may take 10 years
                - Occurring at multiple locations at the same time
                    - Considered a significant effect
                    - Due to reduced quality of existing recreation activities.
            - Construction closures include;
                - Portions of the levee-top road
                    - Would be closed to pedestrians during construction.
                - Launchable rock trenches
                    - Would disturb several miles of bike trails
                    - Limit access to public parks and boat launches.

EE-151

                - *Why are these short-term impacts inconsistent with the ARPP?*
        - These same issues make the Alt 1 inconsistent with the federal W&SR Act.
            - Specified resource values "shall be preserve in free-flowing conditions, and that their immediate environment shall be protected for the benefit and enjoyment of present and future generations."
                - Potentially affected (construction) resources include;
                    - Paradise Beach
                    - CC GC
                    - Guy West Bridge
                    - Howe Ave boat ramp
                    - Watt Ave boat ramp
                    - Gristmill Park

EE-152

                - *Why are these short-term impacts inconsistent with the National W&SR Act?*
        - Construction activities would entail various closures and impacts during construction.
            - Mitigation measures would be implemented reduce impacts,
                - Construction impacts would significant.
        - Post-construction;

- Recreation facilities would be returned to pre-construction conditions
    - Long-term effect would be less than significant.
    - ***In the No Action Alt. the Corps attribute land and resource losses due to ongoing erosion as a significant recreation impact that is not consistent with ARPP. The proper functioning of the launchable rock trenches anticipates (and depends on) ongoing bank erosion and retreat to launch the rocks. When the rocks are launched there will be a continuous revetment slope from the levee toe to the eroded channel margin. This slope will be absent of habitat and recreation values and will constitute losses of recreation areas, facilities, and values. Why are these impacts, which are implicit to the expected proper functioning of the project as designed, not counted as project impacts?***

EE-153

    - Sacramento River (237):
    - East side tributaries (238):
- 3.14.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (238):
    - Sacramento bypass (238):
- 3.14.6. Avoidance, maintenance, and mitigation measures (238-239):
    - **ADD DETAILS here when time allows**

▪ **3.15 Visual resources (239-258):**

- 3.15.1 Environmental setting (239-252):
    - Regulatory setting (239):
        - No applicable state or federal regulations
    - Existing conditions (239-252):
        - Visual resources are;
            - Natural features including
                - Land
                - Water
                - Vegetation
                - Geologic
            - Built features including
                - Buildings
                - Roadways
                - Bridges
                - Levees
                - Other structures
        - A common set of criteria (FHWA 1988) for visual quality includes
            - Vividness:
                - The visual

        - power
        - memorability
    - Of landscape components
        - That combine in visual patterns.
- Intactness:
    - The visual integrity of
        - Natural and constructed landscape
        - And its freedom from encroachments
    - This factor can be present in
        - Urban setting
        - Rural landscapes
        - Naturel settings
- Unity:
    - The visual
        - Coherence
        - Compositional harmony
    - Of the landscape resources.
- Existing visual quality is determined based on het relative degree of
        - Vividness
        - Intactness
        - Unity
    - Apparent
        - In views
        - Visual sensitivity
- Sensitivity is based on;
    - Visibility of the landscape
    - Proximity of viewer to the visual resource
    - Elevation of viewers compared to elevation of the resource
    - Frequency and duration of views
    - Number of viewers
    - Type of viewer individuals and groups
    - Viewer expectations.

- American River (240-243):
    - Main viewer groups;
        - Residents living adjacent to the LAR levees
        - Highway travelers
            - Bus. I-80
            - Fair Oaks Blvd/H St.
            - Howe Ave.
            - Watt Ave.
        - ARP recreational uses
        - LAR boaters
    - Visual environment includes;
        - Urban development on the landside of levees
            - ARP views are blocked by levees

        - Second story views are possible
    - Users on the levee tops
        - Have views of ARP riparian forests and open space lands.
    - ARP resourced provide users with
        - A highly-valued
            - Natural setting
            - Feeling of serenity
        - In a developed urban area
    - ARP provides all of the visual quality of
            - Intactness
            - Vividness
            - Unity
        - In a linear park
            - Which can be viewed with limited urban disruption.
    - The ARP aesthetic values
        - Are those unique qualities that define the ARP experience
            - For ARP users
- The ARPP flood control policies include:
    - "Bank scour and erosion shall be proactively managed to protect public levees and infrastructure, such as bridges, piers, power lines, habitat and recreational resources. These erosion control projects, which may include efforts to anchor berms and banks with rock revetment, shall be designed to minimize damage to riparian vegetation and wildlife habitat, and should include a revegetation program that screens the project from public view, provides for a naturalistic appearance to the site, and restores affected wildlife habitat values."
- Sacramento River (243):
- East side tributaries (245-250):
- Sacramento bypass (250-252):

- 3.15.2 Methodology and basis of significance (252-253):
    - Methodology (252):
        - Potential impacts based on
            - Review of
                - Scenic vistas
                - Landscapes
            - That could be affected
                - By project-related activities.
        - Visual contracts were examined including
            - Changes in
                - Form
                - Size color
                - Project dominance

        - View blockage
        - Duration of impacts
    - Also considered were
        - Natural setting
            - Vegetation
            - Landforms
        - Placement of project components in relation to existing structures
        - Likely viewer groups.
- Basis of significance (252-253):
    - Thresholds of significance encompass
        - The factors taken into account
            - Under NEPA
                - To determine significance of action un terms of
                    - Context
                    - Intensity
    - Thresholds used are based on
        - Appendix G of CEQA Guidelines.
    - Significant impacts would occur if the project
        - Have a substantial adverse effect on a scenic vista
            - Are specific vistas identified?
            - What is substantial?
        - Substantially damage scenic resource,
            - Including but not limited to
                - Trees
                - Rock outcrops
                - Historical buildings
        - Substantially degrade
            - The existing visual character or quality of
                - The site
                - Its surroundings
        - Create a new source of substantial
            - Light
            - Or glare
            - That would adversely affect
                - Day or nighttime
                    - Views in the area.

- 3.15.3 No action alternative (253):
    - No project construction activities
        - Therefore would not cause additional effects to visual resources.
    - Visual conditions would remain consistent with present conditions
        - Adverse affects
            - Would be caused by
                - Future flood event
                - Levee failure.

EE-154

- *Unlike other resource sections (ie. LU, vegetation etc.) the Corps does not associate the ongoing bank erosion and berm area that would result from the No Action Alt as resulting in visual impacts; Why not?*

- 3.15.4. Alternative 1 – improved levees (253-256):
  - Barrow sites (253-254):
  - American River (254):
    - Launchable rock trench (LRT) approach
      - Construction:
        - On 11 miles of the 26 mi ARP 200 ac of construction area
          - 65 ac of riparian habitat
            - Removed to construct LRT
          - 135 ac are
            - Levees; that will be degraded to install rock trenches
            - Staging areas

EE-155

- *So is this then launchable rock trench construction on berms/banks along 11 river miles (22 linear miles of project work along 11 miles of channel) on both sides of the LAR, or a total of 11 linear miles of project work along a shorter reach of the LAR?*

        - Construction will last 10 years
          - Short-term construction activity impacts will be significant.
      - Post construction;
        - Loss of riparian vegetation would have
          - Long-term impact
        - LRT would be designed to
          - Include a <u>planting berm</u>
            - Which would be <u>planted with trees</u> outside the 15 ft. vegetation free zone
            - To compensate for some of the 65 ac of lost riparian habitat.

EE-156

- *This "planting berm" is not mentioned in Section 2.3.1 nor indicated on Figure 1; it is not mentioned in any other resource impact section of the EIS.*

EE-157

- *In section 2.3.1 the Corps states that LRT would be constructed outside the natural channel; how would the "planting berm" work and where would it be placed?*

EE-158

- ***The design description of the LRT approach includes a prohibition against planting deep-rooted trees on the trench***

surface which should preclude riparian trees.

- Shrubs would be transplanted
- Additional compensation would be installed
  - On top of rock trenches
    - When possible
  - Outside the vegetation free zone
  - *In Section 3.8.6 for VELB impacts/mitigation; the Corps states that impacted shrubs would be transplanted, that additional compensation would occur thought planting be on top of rock trenches (when possible), outside the vegetation free zone, and that it is expected that on these trench surfaces sufficient lands would be available to plant these shrubs and associated natives.*
    - The VELB use-area of the rock trench surfaces seems to conflict with the 65 ac of riparian habitat revegetation.
    - ***Elderberry shrubs are not an exclusively riparian plant nor does it, on its own, constitute riparian habitat.***
    - ***Calling elderberry plants riparian does ot make an elderberry replanting area riparian habitat.***
    - ***If the launchable rock trenches truly displace riparian habitat, then the 65 ac of riparian habitat replacement on the launchable rock trench surface should use truly riparian species.***
    - ***However the vegetation prohibitions in Section 2.3.1 and the most likely finished elevation of the launchable rock trench surfaces (+/- 20 ft above low water surfaces) seems to preclude truly riparian plant species and thus riparian habitat.***
  - However these trees would take many years to grow to similar visual values
    - Considered a significant impact
    - That cannot be mitigated.
  - *These impacts/mitigation actions address construction and project footprint considerations only. Unlike other resource*

EE-159

EE-160

EE-161

EE-162

EE-163

EE-164

EE-164
(Cont.)

sections (ie. LU, vegetation etc.) the Corps does not associate the ongoing bank erosion and berm area that would result from the No Action Alt as resulting in visual impacts; Not sure why this is the case. The proper functioning of the launchable rock trenches anticipates (and depends on) ongoing bank erosion and retreat to launch the rocks. When the rocks are launched there will be a continuous revetment slope from the levee toe to the eroded channel margin. This slope will be absent of vegetation, habitat, and recreation values and will constitute lost visual resource quality and value. Why are these impacts, which are implicit to the expected proper functioning of the project as designed, not counted as project impacts?

- Bank protection approach:
  - Construction:
    - Footprint would be
      - Adjacent to the bank
      - Varying distances from public access areas.
    - Activities include;
      - Trees would remain in place
        - Anchored with rock to protect them from future erosion
      - Sites planted with vegetation
      - *The design specifications (Section2.3.1) state that "large" trees will remain; all other vegetation will be stripped and bank stabilization work will be done, and "planting berms" would be provided where feasible. The berms are not specifically indicated in Figure 1 and there seems to be notable hedging language.*

EE-165

EE-166

      - *The bank protect that would have to occur on the steep RR bank in the Corps' "critical reach" will not end up looking like the photos of the Sac State project area. Need a realistic description of bank protection project results on steep banks.*
  - Post construction:
    - Visual impacts only seen from
      - The river
      - The ARP
    - Once vegetation is established
      - The rock will not likely be visible from either

        - The river
        - ARP
- Visual values would take time to reach
    - Likely to take 3-5 years to establish vegetation
    - FIGURES 8-10: indicate revegetation progress thru post-construction year 9 (2001-2010)
    - *These figures show an apparent improvement in the visual conditions at this (Sac State) project location. However, the pre-project levee and bank conditions at this site are atypical of most of the intended 11 mile project area.*
        - *Except for the RL Fairbairn-Paradise Beach bank which has levee slopes that are adjacent to the LAR bank, and the frontage of Campus Commons golf course (which is an actively eroding bank [largely due to coarse sediment aggradation in the LAR in RM 6]), most of the existing LAR banks are steep and are heavily wooded with riparian trees.*
        - *The Corps proposed "bank protection" approach application at these other more natural bank sites will not have a post-construction configuration as at pictured for the Sac State section and will have decidedly different pre- and post-project visual impacts than those represented by Figures 8-10.*
    - The "<u>full natural environment</u>"
        - Preferred by users
    - *Even when revegetation has reached its maximum, the rock bank will be clearly seen from the river.*
    - *Even when revegetation has reached its maximum, no observant user could mistake the rocked bank and channel margin from a natural bank.*
- Visual effects
    - Are considered to be less than significant
        - Site would quickly revegetate
        - Provide a <u>natural looking</u> environment

EE-167

EE-168

EE-169

EE-170

- Similar to or enhances from existing conditions
- *It is not likely that these sites will ever "look natural" or look "similar to or enhanced" compared to conditions. There are presently essentially no rare eroded banks – almost all of the banks under consideration are heavily wooded with riparian vegetation with natural un-rocked banks and shorelines.*

EE-171

- *As noted above, the Corps proposed "bank protection" approach application at these other more natural bank sites will not have a post-construction configuration as at pictured for the Sac State section and will have decidedly different pre- and post-project visual impacts than those represented by Figures 8-10.*

EE-172

- Sacramento River (255):
- East side tributaries (255-256):

- 3.15.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (256-257):
  - Sacramento bypass (256-257):
- 3.15.6. Avoidance, maintenance, and mitigation measures (257-258):
  - Based on construction and project footprints
  - American River (257):
    - Construction:
      - Impacts to visual resource during construction are
        - Unavoidable
          - Cannot be mitigated
    - Post construction:
      - Trees will be planted along the waterside edge of the LRT
        - Where there is sufficient space.
      - Will take time to mature to pre-project visual values
        - Should not take too long
          - See project figures
      - Additional trees could be planted
        - At other ARP locations
          - In compliance with the ARPP
            - To mitigate tree removal
          - Which provide a natural environment in a urban area.
      - Short-term effect will be significant.
      - Planted trees will reduce effects to less than significant
        - Once they are established
          - And provide similar views to those removed.
  - Sacramento River (257-258):
  - East side tributaries (258):

- **3.16 Public utilities and services system (258-266):**
  - 3.16.1 Environmental setting (258-260)
    - Regulatory setting (258):
    - Existing conditions (258- 260):
      - Water supply (258-259):
      - Storm water (259):
      - Wastewater (259-260):
      - Solid waste (260):
      - Electrical and natural gas service (260):
      - Telephone and cable (260):
      - Fire and police protections (260):
  - 3.16.2 Methodology and basis of significance (261):
    - Methodology (261):
    - Basis of significance (261):
  - 3.16.3 No action alternative (261-262):
  - 3.16.4. Alternative 1 – improved levees (262-265):
    - Water supply (262-263):
    - Storm water (263):
    - Wastewater (263):
    - Solid waste (264):
    - Electrical and natural gas service (264):
    - Telephone and cable (265):
    - Fire and police protections (265):
  - 3.16.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (265-266):
  - 3.16.6. Avoidance, maintenance, and mitigation measures (266):
- **3.17 Hazardous wastes and materials (266-273):**
  - 3.17.1 Environmental setting (267-270):
    - Regulatory setting (267-268):
    - Existing conditions (268-270):
      - American River (269):
      - Sacramento River (269):
      - East side tributaries (269-270):
      - Sacramento bypass (270):
  - 3.17.2 Methodology and basis of significance (270):
    - Methodology (270):
    - Basis of significance (270):
  - 3.17.3 No action alternative (270);
  - 3.17.4. Alternative 1 – improved levees (270-272):
    - American River (271):
    - Sacramento River (271-272):
    - East side tributaries (272):
    - Barrow sites (272):
  - 3.17.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (272):
    - Sacramento weir and bypass (272):
  - 3.17.6. Avoidance, maintenance, and mitigation measures (272-273):
- **3.18 Socioeconomic, population, and environmental justice (273-277):**
  - 3.18.1 Environmental setting (273-274):
  - 3.18.2 Methodology and basis of significance (275):

- 3.18.3 No action alternative (275):
- 3.18.4. Alternative 1 – improved levees (276-277):
- 3.18.5. Alternative 2 – Sacramento bypass and improve levees (TSP) (277):
- 3.18.6. Avoidance, maintenance, and mitigation measures (277):

- **4.0 Cumulative impacts, growth-inducing impacts, and other requirements (278_):**
  - 4.1 Cumulative effects:
    - 4.1.1 Methodology and geographic scope of analysis
    - 4.1.2 Past, present, and reasonably foreseeable future projects:
  - 4.2 Cumulative impacts analysis
    - 4.2.1 Water quality
    - 4.2.2 Vegetation and wildlife
    - 4.2.3 Fisheries
    - 4.2.4 Special-status species
    - 4.2.5 Cultural resources
    - 4.2.6 Air quality
    - 4.2.7 Climate change
    - 4.2.8 Noise
    - 4.2.9 Recreation
    - 4.2.10 Visual resources
  - 4.3 Growth inducing impacts
  - 4.4 Unavoidable adverse effects
  - 4.5 Relationship of short-term and long-term productivity
  - 4.6 Irreversible and irretrievable commitment of resources

- **5.0 Compliance with applicable laws, policies, and plans (294 -):**
  - 5.1 Federal laws, regulations and polices
  - 5.2 state of California laws, regulations, and polices

- **6.0 Consultation and coordination (308 -):**
  - 6.1 Public involvement under NEPA and CEQA
    - 6.1.1 Notice of Intent, Notice of Preparation, and scoping meetings
    - 6.1.2 Next steps in the environmental review process
    - 6.1.3. Major areas of controversy
  - 6.2 Native American consultation
  - 6/3 Coordination with other federal, state, and local agencies
  - 6.4 List of recipients
    - 6.4.1 elected officials and representatives
    - 6.4.2 Government departments and agencies

Questions and issues:

Page 12

- Issues of Vegetation Variance. EIS (p 13) states that this was for the Sacto River;
  - It is stated that the vegetation variance would be developed during the design phase.

EE-173 - *Is there any possibility that the vegetation variance would apply to LAR levees?*

EE-174 - *Do vegetation impact/mitigation assessments for the LAR include the assumption that the vegetation variance is approved?*

EE-175 - *If so, what would be LAR vegetation impacts/mitigation estimates for the LAR?*

Page 30

- The Corps states that Bank Protection project elements: consists in placing rock on banks and in some cases levees, when necessary eroded portion of banks would be filled and compacted prior to rock placement; sites would be prepared by clearing and stripping prior to construction, small vegetation and loose material would be removed; in most cases large vegetation would be left in place.

EE-176 - *What size criteria are to be used for small/large?*

EE-177 - *If large trees are left in place will the amount be specified by hydraulic modeling of conveyance? At this project stage, before site specific design and planning, how can it be determined what portions of project banks would have retained trees and at what density; how can an estimate of the expected vegetation impacts be developed?*

EE-178 - *If large trees are left in place, when they die will they be replaced; will natural revegetation be allowed or even possible with the rocked surface?*

EE-179 - *If these trees are expected to die and not be replaced by natural revegetation, how should these trees be counted for impact/mitigation purposes?*

EE-180 - *Should the recreation and visual impact assessment be based on no trees at all on these banks?*

- The Corps states that the excavator will place a large rock berm in the water to an elevation slightly above mean summer flow elevation; a planting trench would be established on this rock surface for revegetation.

EE-181 - *A berm of large rock or a large berm of rock?*

EE-182 - *This berm is not indicated on Figure 1. What size can be expected?*

EE-183 - *Would not a berm added to the foot of the existing banks further narrow the channel resulting in some measure of greater floodflow velocities?*
  - *If so does this not add constraining parameters on vegetation occurrence and added vegetation maintenance activities?*

EE-184 - *What is to be the configuration of the "planting trench" and what plants and plant area widths are to be expected?*

EE-185 - *Long-term, what will be the vegetation configuration of the berm and bank protection project element?*

EE-186 - *Are there other bank protection project element design approaches that could result in satisfactory bank protection and meet project objectives;*
  - *with better long-term resource results*
  - *but perhaps with greater short-term impacts?*

Page 30, other

- The Corps states that Launchable Rock Trench project elements: designed to deploy revetment once erosion has removed the bank material beneath it; will be placed outside the channel, located at the toe of existing levees; the bottom of the trench would be constructed to an elevation near the summer mean water surface (to reduce the rock launching distance and the amount of rock required); will be covered with a minimum of 3 ft. of soil; all disturbed areas would be reseeded

with native grasses and small shrubs (where appropriate); some vegetation could be permitted over the trench, if planted outside the specified vegetation free zone, and would likely be limited to native grasses, shrubs, and trees with shallow root systems (to ensure the functionality of the launchable rock trench);. and vegetation would only be permitted if 1) it does not put undue burden on flood protection maintenance agencies, 2) it is in locations that do not interfere with channel conveyance capacity.

- Elsewhere (p 65) the Corps states that the maximum rock trench width would be about 70 ft. - In most of the resource impact/mitigation sections the Corps states that portions of the rock trench surface will be used to replace recreational facilities, and vegetation including elderberry shrubs and riparian habitat.

- Also in most of the resource impact/mitigation sections the Corps' treatment the impacts associated with the launchable rock trench project element is limited to construction activities and the post-construction configuration; the discussions do not address the impacts associated with the ultimate functioning of the protect element as designed, that is when it is achieving its design purpose of levee protection at the expense of channel, riparian, and American River Parkway resource protection.

- In the project reach there are few if any situations where 1) the levee toe is within 70 ft of the present channel margin and/or 2) is lower than about 15-20 ft. above the lowflow water surface elevation.

EE-187

- Given this; and the vegetation limitation described above, how can the Corps expect the rock trench to support riparian revegetation and provide riparian habitat values? By its very nature, riparian vegetation requires sub-irrigation, which seems to be precluded by the Corps' revegetation criteria. Not to mention the hydraulic parameters.

EE-188

- With rock trench slope criteria (2:1 and 1:1), each foot of rock trench depth entails 3 ft. of rock trench surface width; a 70 ft. width results in a 23 ft. deep trench if there is no trench bottom width. With most levee toes in the range of 20 above the lowflow channel elevation, with any rock trench bottom width at all, it seems that a 70 ft. rock trench surface width may be more of a typical condition than a maximum width.

EE-189

- In most resource sections the Corps states with the No Action Alt. the waterside berm in the ARP would erode overtime, resulting in the loss of land area and various vegetation, wildlife habitat, recreation, and visual resource values; that these losses constitute signification impacts.

EE-190

- The Corps does not state what lands (locations and amounts) that are at risk of loss due to the No Action Alternative so impacts associated with and the loss of land area and various vegetation, wildlife habitat, recreation, and visual resource values for this alternative are not quantifiable..

EE-191

- However, the proper functioning of the launchable rock trench approach anticipates (and depends on) ongoing bank erosion and retreat to launch the rocks. The bank erosion and bank retreat imply the same resource value losses (land area, and various vegetation, wildlife habitat, recreation, and visual resource values) that the Corps attributes to the No Action Alternative. Why shouldn't these same resource losses be attributed to the launchable rock trench protect elements?

EE-192

- When the rocks are launched (as per the project design objectives), there will be a continuous revetment slope from the levee toe to the eroded channel margin. This slope will be absent of habitat and recreation values. Why are these impacts, which are implicit to the proper and expected functioning of the

project as designed, not counted as project impacts (as was the case for the No Action Alt.)?

- Elsewhere (p 254) the Corps states that launchable rock trenches: would be designed to include a planting berm; which would be planted with trees outside the 15 ft. vegetation free zone; to compensate for some of the 65 ac of lost riparian habitat.

EE-193

- However the design specifications in Section 2.3.1 does is not mentioned a "planting berm" and it is not mentioned in any other resource impact/mitigation section.

- In Section 2.3.1 the Corps states that launchable rock trenches would be constructed outside the natural channel; how would the "planting berm" work and where would it be placed?

- The design description of the LRT approach includes a prohibition against planting deep-rooted trees on the trench surface which should preclude riparian trees.

EE-194

- Except possibly on RL between Fairbairn and Paradise Beach, are there any portions of the project reach where levee toes (where the trench is to be located) are set close enough to the present LAR bank such that a planting berm (similar to that described for "bank protection" approach) added to the channel margin would be part of the launchable rock trench approach?

EE-195

- How are these statements in the visual impacts/mitigation section compatible with the design specification on Section 2.3.1?

- Elsewhere (p 254) the Corps states that launchable rock trench construction would occur along 11 of the 26 miles of the ARP involving 200 ac of disturbance. In many locations of the EIS the Corps refers to 11 miles of construction work.

EE-196

- So is this then launchable rock trench construction on berms/banks along 11 river miles (22 linear miles of project work along 11 miles of channel) on both sides of the LAR, or a total of 11 linear miles of project work along a shorter reach of the LAR?

Page 63, 65

- The Corps states (p 63) that for the No Action Alt., the waterside berm in the ARP would erode overtime, resulting in the loss of ARP lands. An since the ARPP designated most of the lands within the project area for various uses, the No Action Alt. is inconsistent with the ARPP and would be considered a significant effect.

EE-197

- The Corps does not provide an estimate of potential land, habitat, and recreational facility losses that will be due to the No Action Alt.

- The Corps states (p 65) for Alternative 1, that the launchable rock trench protection approach is in compliance with ARPP because no lands would be lost and construction impacts would be mitigated. Further LU impacts are considered less than significant and no additional (non-construction) mitigation is required.

EE-198

- In the No Action Alt. the Corps' attribute land and resource losses due to ongoing erosion as a significant LU impact that is not consistent with ARPP. However, the proper functioning of the launchable rock trench approach anticipates (and depends on) ongoing bank erosion and retreat to launch the rocks. When the rocks are launched, there will be a continuous revetment slope from the levee toe to the eroded channel margin. This slope will be absent of habitat and recreation values. Why are these impacts, which are implicit to the proper and expected functioning of the project as designed, not counted as project impacts (as was the case for the No Action Alt.)?

Page 65

- The Corps states that the maximum trench width will be 70 ft., and that a total of 65 ac will be disturbed along 11 miles of treatment.

EE-199

- However with design trench slopes (2:1 and 1:1) (p31), a 70 ft. wide trench-top would be 23 ft. deep (70/3=23.3), if it has no bottom width. Design indicates varying trench bottom widths so independently estimating trench top-widths is not possible here. However I'm thinking that most of the levee toe elevations are about 20 ft. above with lowflow water surface which indicates that, if there is to be any bottom-trench width at all, maximum trench surfaces may be in excess of 70 ft. It is possible that 70 ft. could be the average trench surface width.

EE-200

- Does the 65 ac of disturbance exclude staging areas and access ramps etc.?

Page 71-73

- The Corps' long-term modeling concluded that in 50 years the average LAR bed will degrade 4.8 ft and in 100 years it will degrade 5.8 ft. (with maximum degradation RM 1-11, 12-22 of 16-20 ft. and maximum aggradation RM11-12 of 3-4 ft.

EE-201

- Without further discussion and explanation this appears not sensible.

EE-202

- Were the cemented/indurated clay channel bed nick points considered and over these timelines what influence would they have on channel degradation upstream of their locations?

EE-203

- What is the volume of sediment predicted by this modelling to be lost in the LAR over these timelines?

EE-204

- Where does this sediment go?

EE-205

- Have they overlooked that the LAR channel is drowned downstream of RM 5 (due to geologic timescale sea level rise) and that now and in the future (increasing rates of sea level rise), out-fluxing of coarse sediment past this point is not likely. What are the implications of this sea-level rise process on long-term degradation/aggradation in the RM 5-7 reach?

- The Corps stated that irregular channel reaches may not be adequately represented by this model, especially in braided reaches above RM 8.

EE-206

- There are no really braided channel plan forms on the LAR (above RM 8) except possibly a 0.5 mile section at about RM 14/15 (this is really just a short reach recently experiencing over-loaded sediment influx in conjunction with erodible banks – local widening and the development of multiple channels. This "braided" feature is in the process of change and could develop into a single thread channel with time.).

- The complex channel in the RM 11-12 reach is the result of the breaching of off-channel gravel pits – not channel braiding.

- The complex channel configuration at RM 9 downstream of the Watt bridge is due to a natural process of sediment deposition and channel re-configuring resulting from late-date gravel bar mining and the resulting over-widened channel – this is not channel braiding. The source of the sediment that is being deposited downstream of the Watt bridge is most likely due to ongoing scour in the 0.5 mi of channel upstream of the Watt bridge.

- At about RM 6 there is a 0.5 mi braided reach that is due to coarse sediment deposition at the head of the drowned LAR channel reach (RM 0-5) (due to geologic time-scale sea level rise). This is the expected final location of all coarse sediment transported through the LAR.

Page 73

- The Corps concluded that the LAR is sediment starved; that bedrock (likely the cemented/indurated clay member of the Turlock Lake Frm.) has been reached as far downstream as Guy West Bridge which is slowing further degradation; and that without significant bed slope reduction, it will now tend to erode laterally to satisfy need for sediment.

EE-207

- This conclusion seems to contradict the long-term (50 and 100 years) predictions of significant channel bed degradation presented on p 72 (see notes in outline above).

Page 74

- The Corps concluded that field review verified erosion of the bank is occurring at RM 9.0 RR, even at lowflow of 7,000 cfs.; erosion of the LAR is continually occurring; which leaves the banks sacred and susceptible to future erosion, especially at high flow events; further reducing the amount of berm separating the channel from the levees; and that the loss of vegetation is leaving the bare soil, which is susceptible to erosion at a lower velocity.

*- All of these statements about "erosion" appear to be true **only when applied** to the field-verified erosion at "RM 9.0 RR."*

EE-208

- This site of erosion is not generally characteristic of the LAR: It is due to local-scale natural channel adjustments underway in response to channel over-widening that occurred in the 1960-70's when the RL attached longitudinal gravel bar was removed for gravel mining purposes. With reduced stream power at this location a regime of net deposition was induced and a medial bar developed which is now morphing into a diagonal bar attached to the RL bank at the bridge. Since the 1970's the process has progressively forced more flow and power to the RR bank causing the Corps' "field-verified" erosion. At the location of the original attached bar, the channel is aggrading to a significant degree making the existing boat ramp dysfunctional.

- This condition in not representative of the LAR in general, nor of the critical RM 6-11 reach but is a local phenomenon, with local symptoms, and local causal factors.

EE-209

- This bank erosion problem could be corrected with proper local-scale channel restoration actions.

EE-210

- The real long-term erosion issue in this critical reach is the sewer main undercrossing at about RM 7. The line was installed as an inverted syphon with one riser at the edge of the RR active channel bank, with revetment armoring on this bank slope. This constitutes a critical channel impingement and constraint which resulted in severe RR bank erosion upstream of the line due to progressive erosive eddy development during the 1986 flood event. Without that armored nick point on the RR bank (and with the inverted syphon riser set back from the channel bank edge), it is most likely that bank erosion along the RR bank at that location during the 1986 event would have been very modest. The presence of this sewer undercrossing in its present configuration limits intelligent channel reconfigure alternatives for dealing with this critical flood conveyance reach.

EE-211

- The Corps' flood conveyance actions in this critical reach should be focused on the modification of the existing inverted syphon (setting back the riser and eliminating the bank revetment at the existing riser which anchors the eddy erosion process/dynamic immediately upstream) such that GRR- project (and possible future-flood management) options for stream channel, channel bank, and riparian setting reconfiguration and restoration are maximized not minimized.

Page 78-82

- The Corps' criteria for hydrology/hydraulic impact significance (P 78) is limited to floodflow magnitude changes and induced inundation risks to safety and damage.

EE-212

- Does not concern itself with channel stability issues related to hydraulic effects of bank protection and launchable rock trench design approaches.

EE-213

- What may be the hydraulic effects of bank protection and launchable rock trench design approaches, particularly when and if launchable rocks are launched due to bank retreat?

- The Corps stated that project work primarily includes landside levee fixes; that do not change in-channel geometry or characteristics; and therefore would not substantially alter erosion or siltation in the system.

EE-214

- Can this be said of the proposed 11 miles of bank protection and launchable rock trench work in the LAR/ARP?

- What about the bank erosion that would have to occur to launch the launchable rocks where that approach is used?

- What about channel hydraulic conditions when and if the launchable rocks are launched (that is when the project functions as designed), how will the new channel configuration affect hydraulics; what are the consequences of these new channel conditions?

- The Corps stated that the 200-yr flows in the LAR are tied to the changes in Folsom Dam operations; which will be analyzed as part of the ongoing Folsom Dam Water Control Manual Update; the effects of these flows including cumulative effects will be addressed by the Manual Update EIS/EIR.

EE-215

- Does this mean that the 200-yr LAR flows may not be 115,000?

- Does this mean;

- That the impacts of changing the floodflow regime on the LAR will be assessed at a later time?

- That the possible channel implications of the GRR w/o or w/ project conditions do not consider the change in floodflow regime?

- And that the impacts of these flows (increased floodflow magnitudes at more frequent occurrences, reduced floodflow magnitudes at less frequent occurrences) on the LAR channel etc. have not yet been assessed?

- The Corps stated that since flows are not increased, project effects on hydrology/hydraulics are less than significant; no mitigation is required.

EE-216

- This conclusion;

- Is dependent on the narrow conception of the "basis of significance" used for hydrology/hydraulic impacts (p 78).

- Seems to ignore the 11-12 miles of bank protection and launchable rock trench work on the LAR.

- Ignores the hydraulic implications of proper project functioning – that is the consequences of the launching of the launchable rocks;

- Consequences of the bank retreat required to launch the rocks.

- Consequences to channel hydraulics after the rocks have been launched – the new channel configuration.

EE-217

Page 99-100: *- Will the aerial photo overlay of LAR bank protection and launchable rock trench construction footprint be available to SCRP during the NRMP process?*

EE-218

Page 103: *- Could the NRMP be used to assess overall-ARP impacts and implications of mitigation to include greater (short-term) impacts in the construction area with greater long-term mitigation values with restoration/mitigation projects in the Arden/Sacto Bar/Sailor Bar areas?? That is: accept the short-term impacts of temporal riparian vegetation/habitat losses in the construction areas (but re-planting for on-site mitigation) with restoration of industrial impacted areas to riparian habitat.*

EE-219

Page 103-104 *- The discussion of riparian trees on bank protection surfaces seems to be indicate that large trees (as feasible) will be left in place amid placed revetments. Since these revetment surfaces will have*

EE-219 (Cont.)

very poor revegetation success, when these large trees die it is most likely that no trees will replace them. How are these" large trees left in place" counted as impact/mitigation for habitat, recreation, visual, and W&S River values?

Page 103-104

EE-220

- The discussion of riparian plantings on the rock trenches appears to conflict with the design description of launchable rock trench features on page 32. As a result it is unclear how to consider the impacts of the Corps' assertion that 130 ac of riparian will be planted on these trench surfaces.

EE-221

- When and if the launchable rock trenches actually launch the rocks due to erosive bank retreat (that is, when the project functions as designed), how will the losses of real riparian vegetation along the banks, and the Corps' "riparian plants" on the rock trench surfaces, be counted as impacts resulting from proper project functioning?

EE-222

- Since the proper operational functioning of the launchable rock trench approach is predicated on the progressive loss of banks and berms between the channel and the levee, a natural attribute of this approach entails the same losses of lands, vegetation, and wildlife habitat as is attributed by the Corps to the No Action Alternative. Why should the discussion of vegetation and wildlife impacts associated with the launchable rock trench approach be limited to construction aspects and not include impacts associated with its preforming as designed and achieving its functional purpose?

Pages 117,

- The Corps considered all elderberry shrubs on the waterside of levees as being in the "riparian zone."

EE-223

- What criteria were applied to make this riparian zone determination?

- If a particular shrub is found in a defensibly identified riparian area, could this plant be considered "riparian?" That is, when replanted somewhere else could that new site be defensibly considered "riparian habitat?"

EE-224

- When talking about planting riparian in portions of rock trench surfaces; is the Corps referring to elderberry?

EE-225

- When these plants are newly established on rock trench surfaces, given the likely elevation and distance from water surface, could they be defensibly considered as constituting "riparian habitat?"

EE-226

- The Corps states that if there is insufficient space for the 66 ac of VELB mitigation on rock trench surfaces along the LAR, additional mitigation area will be needed. Could be at the Cal Expo and River Bend Park mitigation sites. Are these mitigation sites considered as really "riparian?" Certainly not the River Bend Site!!

EE-227

- For the LAR area, it is unclear how the 66 ac of VELB mitigation needs relates to the need for 130 ac of riparian mitigation. Can these acreages be clearly sorted out?

EE-228

- When and if the launchable rock trenches actually launch the rocks due to erosive bank retreat (that is, when the project functions as designed), how will the losses of real riparian vegetation along the banks, and the elderberry plants on the rock trench surfaces, be counted as impacts resulting from proper project functioning?

Page 138-139

- It is indicated that there are 250 elderberry plants on the LAR and mitigation is based on this number.

EE-229

- However this number was based on a 2011 survey of levee slopes and 15 ft. out from the landside toe and 30 ft. out from the waterside toe. Isn't it most likely that many more elderberry plants would be located along the LAR on berm and bank sites where

EE-229 (Cont.)

launchable rock trenches and bank protection projects would be constructed? It appears that contrary to the introductory statement in the "measures" paragraph, the impact/mitigation is not based on a worst-case case scenario; more (perhaps much more) mitigation than stated may be required. Does the Corps really have suitable mitigation opportunities?

Page 145-147 - To reduce impact/mitigation for Swainson's hawk the Corps

- Will seek a vegetation variance to maintain vegetation on the lower half of the levee slope.

EE-230

- But in Section 1.4.5 the variance appears to only apply to Sacto R. levees.

- Will it be extended to Amer. R. levees.

- What will be the impact if the variance is not approved?

- Corps stated that for bank protection works; revetment slopes will be planted with vegetation and trees that over time will provide habitat.

EE-231

- This seems to contradict the description of bank protection work in Section 2.3.1.

- "Brush/shrubs/small trees" will be removed

- Rocks will be placed among the "larger" riparian trees

- Where feasible; a planting berm will be established

EE-232

- It seems the construction result will be revetment slopes with a few "large trees."

- When these few large trees die, why wouldn't the revetment slopes prevent the reestablishment of "large" trees, or really anything?

EE-233

- Under what conditions would a planting berm be established and how large would they be? If the project work uses tight tolerances (which is normally done), i.e. does not over-build conveyance capacity (to limit costs and project construction impacts/mitigation); realistically, what space will be left for planting berms?

EE-234

- If the planting berms extend into the existing channel area wouldn't that result in reduced floodflow conveyance area, and therefore place more constraints on existing vegetation and mitigation revegetation, leading to net reduction in acceptable vegetation (more vegetation management to maintain floodflow conveyance capacity)?

EE-235

- Practically speaking, what impact reduction could be expected from the proposed bank protection construction approach?

- The Corps stated that 238 ac of riparian mitigation will be needed.

EE-236

- How much is needed in the ARP?

EE-237

- For Swainson's hawk, specifically what riparian vegetation types or structure is needed?

EE-238

- Is the Woodlake/Cal Expo site suited for developing this riparian type/structure?

EE-239

- How does this 238 ac relate to the need for 66 ac of elderberry mitigation and the 130 ac of riparian habitat mitigation on the LAR/ARP?

- Are they separate and distinct mitigation needs?

- Is there some overlap?

Page 235, 236-7 - The Corps' discussion of recreation impacts for Alternative 1 is limited to construction and temporary closures.

- For the No Action Alt. the Corps attribute land and recreation resource losses due to ongoing erosion as a significant recreation impact that is not consistent with ARPP (235).

EE-240

- However, the proper functioning of the launchable rock trenches anticipates (and depends on) ongoing bank erosion and retreat to launch the rocks. When the rocks are launched, as designed, there will be a continuous revetment slope from the levee toe to the eroded channel margin. This slope will be absent of recreation areas, facilities, and values which can only be counted as impacts to the existing, pre-project, conditions. Under this levee protection approach, the impacts associated with its proper functioning and design objectives, would be identical in scope and timing with the No Action Alternative.

- Why are these impacts, which are counted as representing significant impacts for the No Action Alternative, not recognized as impacts at all for the launchable rock trench approach?

- Why is the discussion of impacts limited to the construction phase and to the construction/project footprint area?

Page 254

- The Corps states that for Launchable Rock Trench project elements: <u>construction</u> will occur on 11 miles of the ARP, disturbing 200 ac (65 ac of riparian habitat and 135 ac of existing levees and staging areas), lasting 10 years; resulting in significant short-term visual impacts.

EE-241

- So is this then construction on levees/banks along 11 river miles (22 linear miles of project work along 11 miles of channel) on both side of the LAR, or 11 linear miles of project work along a shorter reach of the LAR?

- The Corps states that for Launchable Rock Trench project elements: <u>post-construction</u> will include, a loss of 65 ac of riparian habitat; would be designed to include a planting berm, which would be planted with trees outside the 15 ft. vegetation free zone, to compensate for some of the 65 ac of lost riparian habitat; but given the time delay in the tree plantings reaching maturity, there will be significant long-term visual impacts that cannot be mitigated.

EE-242

- This "planting berm" is not mentioned in Section 2.3.1 nor indicated on Figure 1; it is not mentioned in any other resource impact section of the EIS.

EE-243

- In Section 2.3.1 the Corps states that launchable rock trench would be constructed outside the natural channel; how would the "planting berm" work and where would it be placed?

EE-244

- The design description of the launchable rock trench approach includes a prohibition against planting deep-rooted trees on the trench surface which should preclude riparian trees.

EE-245

- Except possibly on RL between Fairbairn and Paradise Beach, are there any portions of the project reach where levee toes (where the trench is to be located) are set close enough to the present LAR bank such that a planting berm (similar to that described for "bank protection" approach) added to the channel margin would be part of the launchable rock trench approach?

EE-246

- In Section 3.8.6 for VELB impacts/mitigation; the Corps states that impacted shrubs would be transplanted, that additional compensation would occur thought planting be on top of rock trenches (when possible), outside the vegetation free zone, and that it is expected that on these trench surfaces sufficient lands would be available to plant these shrubs and associated natives.

- The VELB use-area of the rock trench surfaces seems to conflict with the 65 ac of riparian habitat revegetation.

- Elderberry shrubs are not an exclusively riparian plant nor does it, on its own, constitute riparian habitat.

EE-246
(Cont.)

- Calling elderberry plants riparian does not make an elderberry replanting area riparian habitat.

- If the launchable rock trenches truly displace riparian habitat, then the 65 ac of riparian habitat replacement on the launchable rock trench surface should use truly riparian species.

- However the vegetation prohibitions in Section 2.3.1 and the most likely finished elevation of the launchable rock trench surfaces (+/- 20 ft. above low water surfaces) seems to preclude truly riparian tree species and thus riparian habitat.

EE-247

- These impacts/mitigation actions address construction and project footprint considerations. And impacts associated with the time delay in riparian tree reestablishment.. Unlike other resource sections (ie. LU, vegetation, etc.), the Corps does not associate the ongoing bank and berm erosion and the loss of land area that would result from the No Action Alt as resulting in visual impacts; Not sure why this is the case.

- The proper functioning of the launchable rock trenches anticipates (and depends on) ongoing bank erosion and retreat to launch the rocks. When the rocks are launched there will be a continuous revetment slope from the levee toe to the eroded channel margin. This slope will be absent of vegetation, habitat, and recreation values and will constitute lost visual resource quality and value. Why are these impacts, which are implicit to the expected proper functioning of the project as designed, not counted as project impacts?

Page 254

- The Corps states that for Bank Protection project elements: <u>construction</u> footprint would be adjacent to the bank; small trees and brush would be stripped; large trees would remain in place, anchored with rock to protect them from future erosion; and the sites will be planted with vegetation.

EE-248

- The design specifications (Section2.3.1) state that "large" trees will remain; all other vegetation will be stripped and bank stabilization work will be done, and "planting berms" would be provided where feasible. The berms are not specifically indicated in Figure 1 and there seems to be notable hedging language.

- Under what circumstances would this "planting berm be feasible and infeasible?

- Where a planting berm is infeasible, what will the post-construction vegetation look like?

EE-249

- The bank protect that would have to occur on the steep RR banks through most of the Corps' "critical reach" will not end up looking like the photos of the Sac State project area (Figures 8-10). Need a realistic description of the "bank protection" approach post-construction conditions on the steep "natural" banks that are presently pervasive through the project reach.

- The Corps states that for Bank Protection project elements: <u>post-construction</u>; visual impacts only seen from <u>t</u>he river and the ARP; once vegetation is established the rock will not likely be visible from either the river or the ARP; likely to take 3-5 years to establish vegetation; Figures 8-10: indicate revegetation progress thru post-construction year 9 (2001-2010); visual effects are considered to be less than significant, sites would quickly revegetate and provide a natural looking environment similar to or enhanced from existing conditions.

EE-250

- These figures show an apparent improvement in the visual conditions at this (Sac State) project location. However, the pre-project levee and bank conditions at this site are atypical of most of the intended 11 mile project area.

- Except for the RL Fairbairn-Paradise Beach bank which has levee slopes that are adjacent to the LAR bank, and the frontage of Campus Commons golf course (which is an actively eroding bank [largely due to coarse sediment aggradation in the LAR in the RM 6 area]), most of the existing LAR banks are steep and are heavily wooded with riparian trees.

EE-251

- The Corps proposed "bank protection" approach application at these other more natural bank sites will not have a post-construction configuration as at pictured for the Sac State section and will have decidedly different pre- and post-project visual impacts than those represented by Figures 8-10.

- Even when revegetation has reached its maximum, the rock bank will be clearly seen from the river and no observant user could mistake the rocked bank and channel margin for a natural bank.

EE-252

- It is not likely that these sites will ever "look natural" or look "similar to or enhanced" compared to conditions. There are presently essentially no rare eroded banks – almost all of the banks under consideration are heavily wooded with riparian vegetation with natural un-rocked banks and shorelines.

- As noted above, the Corps proposed "bank protection" approach application at these other more natural bank sites will not have a post-construction configuration as at pictured for the Sac State section and will have decidedly different pre- and post-project visual impacts than those represented by Figures 8-10.

-- END --

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May 14, 2015

By e-mail and U.S. mail

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Re: Draft American River Watershed Common Features General Reevaluation Report, March 2015

Ms. Baker:

We have reviewed the draft American River Watershed Common Features General Reevaluation Report, March 2015 (dGRR).

First we would like to express our gratitude for extension of the comment period to May 18, 2015. Unfortunately, we did not become aware that there are issues of concern to us with the dGRR until the last public information meeting on April 17, 2015, and, consequently, did not begin review until that time.

We wish to make the following comments on the dGRR.

Our primary concern with the dGRR is the large amount of proposed "erosion protection" on the Lower American River. In addition, we have a couple of more general comments.

Our organization, Save the American River Association (SARA), was instrumental in protecting the lands along the Lower American River from development and in the creation of the American River Parkway. Founded in 1961, we have been protecting and advocating for the River and Parkway for 54 years.

It is our viewpoint that the Lower American River is a Federal and State protected Wild and Scenic River, and the "crown jewel" of Sacramento. Consequently, any proposed actions that would have a significant adverse impact on the River and Parkway must be rigorously and completely justified

before adoption by the Corps of Engineers, or State and local flood control agencies. It is clear that the "erosion protection" measures proposed in the dGRR would have an enormous detrimental impact on vegetation, wildlife, recreation, and esthetics of the River and Parkway.

FF-1 However, the justification for the "erosion protection" measures proposed in the dGRR is at best weak, and seems to proceed with a "guilt by association" approach that says if there is clearly concern with erosion risk in one part of the leveed stretch there must be reason for concern with many other areas. This is inappropriate and calls the entire "erosion protection" proposal into question.

FF-2 For example, in Figure 2-7 on p. 2-19 the dGRR presents the American River Velocity Contours from roughly Howe Ave. to Paradise Beach at 115,000, 145,000 and 160,000 cfs. The water velocities in one part of this area are quite high, around 12 feet/second (ft/sec). However, this area is not typical of the rest of the leveed section of the River. The area between roughly Howe Ave. and Paradise Beach has a relatively narrow flood channel between the levees, due to the Corps of Engineers construction of the right bank levee (as part of the Folsom Dam project in the 1950s) close to the left bank levee. However, as shown in Figures 4-4 and 4-5 of the Engineering Appendix Erosion Protection Analysis (Appendix C, Attachment E, pp. 41-2) the narrow section of floodway between roughly Howe Ave. and Paradise Beach is an anomaly. The floodway both upstream and downstream is wider, in many areas much wider, and water velocities are correspondingly lower. Thus, the figure in the dGRR itself is misleading to the reader who does not bore down into the Engineering Appendix.

FF-3 Another figure that is misleading is the dGRR Figure 4-5: TSP Recommended Features along the American River (dGRR p. 4-9). This appears to show selective areas of erosion protection work, with some areas of the left bank and levee impacted and others not impacted. However, when one goes to the Engineering Appendix Erosion Protection Analysis, Figure 6-4, we find that all the sites on the left bank that are not proposed for erosion protection are already sites of "modern revetment repair." Thus, the entire left bank or levee from the confluence of the American with the Sacramento River to the terminus of the levee upstream from the Mayhew Drain would be impacted.

FF-4 One very important feature of the proposed work, bank protection, has inconsistent diagrams between the dGRR itself and the Engineering Appendix. In the dGRR, Figure 4-9, bank protection is shown as rock covering the bank to below the waterline. There is no soil covering the rock. In the Engineering Appendix Erosion Protection Analysis (Appendix C, Attachment E, p. 64) Figures 6-1 and 6-2 show the rock covering the bank and levee covered with soil. Also, figures 6-1 and 6-2 show a trapezoidal soil trench for growth of shielding vegetation that is absent from the dGRR Figure 4-9. We think that it is critically important for any bank protection project to have soil with appropriate vegetation (grasses and small shrubs) covering the rock. We have heard in the past that this makes inspection of the rock more difficult. However, it is fairly obvious that if the soil covering is intact, the rock below must also be in place. We also support the soil trench for growth of shielding vegetation where appropriate.

FF-5 The Engineering Appendix Erosion Protection Analysis (Appendix C, Attachment E, p.7), describing the history of levee construction on the Lower American River, states: "Construction of the south levee of the American River started around 1850 and was completed in the 1910s."

FF-5 (Cont.)

There is no further description of south (left bank) levee construction. This description is incomplete and misleading. The levee upstream of the Mayhew Drain (often called the Mayhew Levee) was originally constructed in the mid 1970s, apparently by the company that developed the adjacent Butterfield community. This levee was lower by about three feet than other levees in relation to flood elevation. This levee was raised by about 2.5 feet and widened by the Corps in 2008. The omission of this history in the Erosion Protection Analysis may have contributed to the inappropriate inclusion of this section of river in the proposed erosion protection.

FF-6

Another feature that is worth mentioning is that the dGRR, in Figure 2-6, Problems at Specific Locations in the Study Area (p. 2-15), shows areas of the Lower American River with "Erosion Area(s) of Concern." On the left bank, there is no indication of "erosion concern" upstream from a point about half way between Watt Ave. and the Mayhew Drain. In particular, there is no "erosion concern" on the left bank upstream of the Mayhew Drain, aka the Mayhew Levee area. We find it odd, then, that the proposed plan includes erosion protection work upstream from the point about half way between Watt Ave. and the Mayhew Drain as well as the Mayhew Levee area (dGRR Figure 4-5, p. 4-9).

FF-7

What, from our viewpoint, is the most important about the dGRR and the Erosion Protection Analysis is what is not there. That is, the Erosion Protection Analysis is actually a review of many disparate studies and models, none of which were conducted for the purpose at hand. Perhaps the most useful study is the 2D velocity modeling study by Ayers (2004). But if one asks why the upstream and downstream ends of the right bank are not designated for erosion control and the opposite stretches of the left bank are designated for erosion control, there is no analysis or cogent explanation.

FF-8

We would like to recommend some changes to the erosion protection proposals in the dGRR (Figure 4-5, p. 4-9). First, an additional alternative is desperately needed. This alternative could be called "further study" or "watch and wait." It would involve characterization of the river banks (and levees if appropriate) with sufficient detail that small to moderate erosion events could be documented and quantified. Possibly it could include a comprehensive program of bore holes to characterize the subsurface strata between the river and the levees. This work would be conducted either by the local agencies (Sacramento Area Flood Control Agency, Central Valley Flood Protection Board staff) or by a collaboration between the Corps and the local agencies. Over time, this documentation would allow decisions based on facts to guide further efforts, or to decide that further efforts are not needed. Second, we propose that the left bank from the confluence of the American and Sacramento Rivers to about Paradise Beach should be assigned to this "further study" alternative. So also would the left bank from about Howe Ave. up to the Mayhew Drain (the Mayhew Levee area) be assigned to "further study." Additionally, the right bank upstream from Howe Ave to about half way between Watt Ave. and the Mayhew Drain would be assigned to "further study." Thirdly, the left bank upstream of the Mayhew Drain would be assigned to normal operations and maintenance. The left and right banks between roughly Howe Ave. and Paradise Beach would remain as shown in Figure 4-5. These proposals derive from the flow velocities of the 2D modeling study by Ayers (2004).

The rationale in the foregoing paragraph for placing the left bank upstream of the Mayhew Drain into normal operations and maintenance derives from the following facts. There have been no

FF-8 (Cont.)

reports of erosion events along the river bank from either the 1986 or 1997 flood events (Appendix C, Attachment E, pp. 6-7). Also, the 2D modeling studies (Ayers 2004) indicate that the areas of rapid flow are the same in the 115,000 cubic foot/second (cfs) as 160,000 cfs. In addition, overlays of aerial photos from before and after these flood events show no detectable erosion. Finally, there is a quite substantial terrace or bench that is about 200 feet wide between the river and the new levee for most of the length of the levee. The terrace widens to about 500 feet at the upstream end of the levee. Therefore, there is minimal chance of erosion from even large storm events undermining the levee.

FF-9

In addition, we have some general comments on the dGRR. While many people are familiar with Environmental Impact Statements and Reports and there are ample resources available for becoming more informed, the same is not true of the dGRR. The dGRR would benefit from a description of how the final document is approved, and what uses it may be put to when finished.

FF-10

Also, in the dGRR, the acronym "LPP" suddenly appears in the plan description row of the Final Alternative 2 column in table 3-25 (dGRR p. 3-53). We note that this acronym is not in the list of acronyms in the beginning of the dGRR (pp. xi-xiii). We presume that it refers to Locally Preferred Project or Proposal. This raises some important questions that should be addressed. These include who determined what the LPP is and how did they determine it? Also, was this the subject of action by the Board of the Sacramento Area Flood Control Agency or the Central Valley Flood Control Board? Was there public notice, and if so when? This is a particularly important area to elaborate on as the designation of the LPP appears to be the sole justification for the Corps selecting Final Alternative 2 as the "Tentatively Selected Plan" when Final Alternative 1 was the National Economic Development plan.

We thank you, in advance, for your attention to the issues, concerns, and recommendations above.

Sincerely,

James Morgan
Board Member, SARA

Stephen Green
President, SARA

GG

James Morgan
[redacted]95827
May 17, 2015

by e-mail and U.S. mail

Ms. Anne Baker
U.S. Army Corps of Engineers
1325 J street
Sacramento, CA 95814

Anne.E.Baker@usace.army.mil

Re: Draft American River Watershed Common Features General Reevaluation Report, Draft Environmental Impact Statement/Environmental Impact Report, March 2015

Ms. Baker:

First, let me express my gratitude for extension of the comment period to May 18, 2015. Given the size of the subject documents, the extra time is most appreciated.

I have reviewed in part the Draft American River Watershed Common Features General Reevaluation Report (dGRR), Draft Environmental Impact Statement/Environmental Impact Report (DEIS/DEIR), March 2015. These are my comments.

GG-1

Perhaps the most important shortcomings of the dGRR DEIS/DEIR are in what is not there. I may be reading too much into the text, but I get the distinct impression that the Corps (and possibly cooperating agencies) is/are of the opinion that they could go to construction with only the environmental documentation of this DEIS/DEIR (see text on p. ES-1). I would strongly disagree if that is the case. The DEIS/DEIR is so broad-brush and nebulous that it is not really possible for the public, other stakeholders, or relevant government agencies to assess the environmental impacts or make suggestions towards reducing environmental impacts. I would think that at least one additional Environmental Impact Statement/Report would be needed for each of the major elements of the project: the Lower American River work, the Sacramento Levee and Sacramento Weir work, and the small creeks work. Possibly even more project specific environmental documents would be needed. The final version of the DEIS/DEIR would benefit greatly from an explanation, one way or the other, as to what additional environmental impact statements/reports would be anticipated on the way to construction.

GG-2

The second important element that is missing is alternatives for the Lower American River erosion protection work. Both of the action alternatives in the DEIS/DEIR have the same erosion protection proposal for the Lower American River. Thus, for the Lower American River, the only alternatives are no action and the proposed action. This is inadequate. The Lower American River is a State and Federally protected Wild and Scenic River. It has been called the "crown jewel" of Sacramento, and receives a huge amount of recreational use (too

GG-2 (Cont.)

much in some cases). As the proposed action on the Lower American in the DEIS/DEIR is acknowledged to have significant adverse environmental impacts, it is critically important that one or more alternatives that would reduce these impacts be seriously considered.

GG-3

In that regard, allow me to share an experience that I had with you. I regularly attend the meetings of the Lower American River Task Force (LARTF). The GRR has been the topic of presentations at the LARTF. At the meeting on December 9, 2014, a Sacramento Area Flood Control Agency (SAFCA) representative stated that the dGRR was proposing to do erosion protection work in the area from H street to Watt Ave. In a subsequent meeting, on March 10, 2015, a Corps of Engineers representative stated that erosion protection work was to be in the area from Paradise Beach to Watt Ave. Imagine, then, my shock to discover at the last public information meeting on the dGRR on April 17, 2015, that erosion protection work is proposed on the left (south) bank and levee all the way from the confluence of the American and Sacramento Rivers to the end of the leveed stretch upstream from the Mayhew Drain. Additionally, work on the right bank is proposed upstream from Watt Ave. to about half way between Watt Ave. and the Mayhew Drain.

My purpose in relating the above history is to point out that the Corps (and other agencies?) had recently been considering a much smaller erosion protection work footprint than is presented in the dGRR or the DEIS/DEIR.

GG-4

I propose an alternative that is taken from comments on the dGRR itself to be submitted by the Save the American River Association:

"This alternative could be called 'further study' or 'watch and wait.' It would involve characterization of the river banks (and levees if appropriate) with sufficient detail that small to moderate erosion events could be documented and quantified. Possibly it could include a comprehensive program of bore holes to characterize the subsurface strata between the river and the levees. This work would be conducted either by the local agencies (Sacramento Area Flood Control Agency, Central Valley Flood Protection Board staff) or by a collaboration between the Corps and the local agencies. Over time, this documentation would allow decisions based on facts to guide further efforts, or to decide that further efforts are not needed…. We propose that the left bank from the confluence of the American and Sacramento Rivers to about Paradise Beach should be assigned to this 'further study' alternative. So also would the left bank from about Howe Ave. up to the Mayhew Drain (the Mayhew Levee area) be assigned to 'further study.' Additionally, the right bank upstream from Howe Ave to about half way between Watt Ave. and the Mayhew Drain would be assigned to 'further study.'… The left bank upstream of the Mayhew Drain would be assigned to normal operations and maintenance. The left and right banks between roughly Howe Ave. and Paradise Beach would remain as shown in Figure 4-5. These proposals derive from the flow velocities of the 2D modeling study by Ayers (2004)."

Note that Figure 4-5, cited in the above from the dGRR, is the same as Plate 3 and Plate 4 in the DEIR/DEIS in regard to proposed erosion protection work on Lower American River.

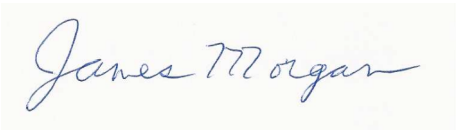
It is critically important that one or more alternatives with smaller footprint(s) for Lower American River erosion protection work be considered in the final environmental document. If

this is not the case, the document would be inadequate or deficient under applicable statute and regulations.

GG-5 One other point. The "bank protection" alternative as shown in the lower half of Figure 1 of the DEIS/DEIR (p. 32) has bare rock on the river bank. This method of erosion protection would be significantly improved if the rock was covered with moderately cohesive dirt fill and appropriate vegetation (grasses and shrubs). This would greatly reduce the long-term adverse impacts on vegetation, wildlife, recreation, and esthetics. It would help with public acceptance of erosion protection work. I would note that the rock covering the waterside levee surface in the "launchable trench" alternative is covered with dirt fill and hydroseeded in the upper half of Figure 1. Also, in the dGRR Engineering Appendix Erosion Protection Analysis (Appendix C, Attachment E, p. 64), Figure 6-2 shows the rock covering the river bank is covered with soil. Thus, this is a viable and useful change that should be made to the bank protection alternative.

Thank you for your attention to these comments.

Sincerely



James Morgan

HH

From: Gay Jones [redacted]]
Sent: Monday, May 18, 2015 4:14 PM
To: Baker, Anne E SPK
Cc: [redacted]
Subject: [EXTERNAL] Comments on Draft Environment Impact Statement - EIR (March 2015) and Draft General Reevaluation Report (March 2015)

To Anne Baker,

Thank you for extending the comment period on these reports. However, the broad scope of the aforementioned documents begs for more study.

Following are examples of broad policy concerns and specific area concerns.

1. The best outcome will occur if the USACE works with stakeholder groups at the local level. This cannot be emphasized enough. The Lower American River Task Force is an excellent example of a local stakeholder group. It is imperative to work in concert with local representation.

HH-1

2. From the public perspective, the scope of the proposal expanded greatly at the end from what had initially been discussed in print. Hence, more study is necessary.

HH-2

3. Due to the numerous variances in the topography, a range of multiple alternatives are needed.

HH-3

4. Significant flood control projects have already occurred upstream from Watt Avenue to the Gristmill Recreation Area:

Specifically, the entire levee at Gristmill, including modifications to the Mayhew Drain, was recently completed. This USACE and SAFCA project already meets the American River Parkway Plan 160,000 cfs goal as described on page 100 of your report.

Rip-rap with soil and plant covering is completed at the four areas deemed important. This includes an area just upstream, river left, from the Waterton Access; the area adjacent to the Larchmont Community Park; and two sites at Gristmill where "rills" occurred during levee construction.

HH-4

A reassessment for the risk of flooding should be done against the backdrop of these newly completed projects. It seems the "fix-in-place" levee improvements have already been accomplished in these areas upstream, river left, from Watt Avenue.

HH-4 (Cont.)

5. Selected quotes from the American River Parkway Plan used in the report are out of context. "Erosion Control Program" section on page 88 (ARPP) discusses the balancing of many goals, "…relying on methods of protection that minimize habitat impacts…each project must consider the nature of the erosion threat and the most effective method for controlling erosion with the least damage to riparian vegetation, wildlife and the aesthetics of the final product."

HH-5

6. On pages 291 and 292 in your report discussing short term and long term impacts, it seems to justify destroying the habitat to build a levee to protect the habitat. It is a circular argument. The proposal would have such devastating impacts on the environment that there would be no environment to protect.

HH-6

Thank you for the opportunity to briefly comment on your proposals.

Gay Jones

[redacted]

[redacted]

[redacted]

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

State Water Resources Control Board

May 18, 2015

Ms. Erin Brehmer
Department of Water Resources,
3464 El Camino Avenue Room 200
Sacramento, CA 95821

U.S. Army Corps of Engineers,
Sacramento District,
Attn: Ms. Anne Baker
1325 J Street
Sacramento, CA 95814

Dear Ms Brehmer:

State Water Resources Control Board staff comments on the Draft Environmental Impact Statement/Environmental Impact Report for the American River Common Features General Reevaluation Report

The State Water Resources Control Board staff provides these comments on the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Common Features General Reevaluation Report (Project), to be implemented by the Central Valley Flood Protection Board (CVFPB) in cooperation with the U.S. Army Corps of Engineers (Corps) (State Clearinghouse Number 2009012081).

State Water Resources Control Board (State Water Board) staff have reviewed this report, as noticed at http://www.cvfpb.ca.gov/PublicNotices .

The proposed project would construct fix-in-place levee improvement measures to address seepage, slope stability, erosion, and overtopping concerns identified for the American and Sacramento River, Natomas East Main Drainage Canal, Arcade Creek, Dry/Robla Creeks, and Magpie Creek levees. In addition, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass during flood events.

Pursuant to CEQA guidelines, California Code of Regulations (CCR), title 14, section 15096, responsible agencies must specify the scope and content of the environmental information germane to their statutory responsibilities. State Water Board staff has reviewed the Draft EIS/EIR to determine if the proposed Project will have significant adverse impacts to water quality and, ultimately, the beneficial use of waters of the state.

We recognize the great importance of flood protection for the communities and farms of the Sacramento River valley and the tributary streams that would benefit by the

proposed project. We understand the enormous economic risk and the risk to human life that exists without a safe, functional levee system. However, significant ecological impacts may result from the proposed project.

II-1 In general, we encourage the Corps and the CVFPB to implement alternatives which conserve to the greatest extent the existing riparian vegetation, especially large mature trees that would not likely pose a threat to the integrity of the levee banks. Alternatives that maximize meander zones should be selected. Setback levees should be used when feasible.

State Water Board staff has prepared the attached comments on the Draft EIS/EIR (see Attachment 1, Table 1). Comments which pertain to the entire project and the entire document, or which are broadly applicable throughout the DEIR/EIS, are presented first. Specific comments about specific sections of text follow in the table, to facilitate location of the sections that are the subject of the comments.

State Water Board staff thanks the CVFPB and the Corps for this opportunity to comment on the proposed project. If you have questions regarding any of the comments in this letter or Table 1, please contact:

Cliff Harvey
Environmental Scientist
(916) 558-1709
clifford.harvey@waterboards.ca.gov

Sincerely,

[Clifford Harvey]
(Pdf submitted via email - signed hard copy to follow by mail)

Clifford Harvey
Environmental Scientist
Division of Water Quality

cc: see next page

cc:

Elizabeth Lee
401 Program Manager
Central Valley
Regional Water Quality Control Board
– Sacramento Office
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670

	Table 1: State Water Board Staff Comments on Specific Contents of the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Watershed Common Features General Reevaluation Report (SCH No. 2005072046)			
Com-ment No.	**Chapter**	**Section/ Sub-section**	**page**	
GENERAL COMMENTS – JURISDICTION AND AUTHORITIES				
	1. AUTHORITY T All waters of the state are protected under California law pursuant to the Porter-Cologne Water Quality Control Act (Porter-Cologne). All surface waters and groundwater are considered waters of the state, which include, but are not limited to, aquifers, drainages, streams, washes, ponds, pools, and wetlands. Surface water bodies may be permanent, intermittent, ephemeral or seasonal. Additional protection is provided for waters of the United States (WOUS) under the federal Clean Water Act (CWA). The Regional Water Quality Control Boards (RWQCB); and in this case, the Central Valley RWQCB, have the responsibility for protecting water quality in accordance with their regional water quality control plans (basin plans). The basin plans provide regulations pertaining to the protection of water quality and implementation measures to carry out the Basin Plan provisions in the region. Any discharges of waste that may affect water quality and, ultimately, the beneficial uses of waters of the state may be regulated by the Water Boards. . Water Board staff request that the final environmental document refer to the basin plans and incorporate mitigation measures that consider all applicable water quality standards, prohibitions, and provisions found there.			
II-2				
	2. FEDERAL AND STATE JURISDICTION Some waters of the state are "isolated" from waters of the U.S., or do not have a “significant nexus” to WOUS. It is important to note that some of these non-federal waters of the state may occur in the project area, and may be subject to impacts by the proposed project. When impacts may occur as a result of project activity to any waters of the state, regardless of federal jurisdiction,, a Report of Waste Discharge (ROWD) must be submitted to the appropriate Regional Water Quality Control Board, and Waste Discharge Requirements (WDRs) must be obtained from that Regional Water Board before the activity commences.			

	Table 1: State Water Board Staff Comments on Specific Contents of the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Watershed Common Features General Reevaluation Report (SCH No. 2005072046)			
Com-ment No.	**Chapter**	**Section/ Sub-section**	**page**	
II-3	We request that the Project proponent consult with the Corps and the Water Boards when performing the necessary jurisdictional determinations for surface waters within the project area, to ensure that the full extent both state and federal jurisdictional areas are accurately verified, and to ensure that appropriate regulatory pathways are followed.			
II-4	**3. BENEFICIAL USE ANALYSES** We request that the FEIR/EIS identify and list the beneficial uses of the identified surface waters, as outlined in the basin plans, and evaluate the project's potential impacts to those beneficial uses. All mitigation measures proposed for the protection of surface waters should present evidence that the mitigation avoids, minimizes or compensates for all potentially impacted beneficial uses.			
II-5	**4. NEED FOR SYSTEM-WIDE PLANNING CONTEXT:** Project planning should be conducted in the context of ecosystem-wide assessments and evaluation of the existing system for long term sustainability.[1] This includes sustainability of the Sacramento Flood Control System from a flood risk reduction perspective and an ecosystem restoration perspective (providing more frequently inundated floodplain habitat and allowing natural river processes to continue). Coordination with SAFCA projects is needed. How the Project compliments the Central Valley Flood Conservation Strategy should be highlighted (http://www.water.ca.gov/conservationstrategy/)			
	8. RELIANCE ON ASSUMPTIONS THAT VARIANCES AND A PROPOSED SYSTEM WIDE IMPROVEMENT FRAMEWORK (SWIF) WILL BE DEVELOPED As stated in section 1.1 (p. 1) *"The alternatives being analyzed assume a vegetation variance would be obtained for the lower one half of the waterside levee slope on all waterways. This would allow vegetation to remain in place unless required for construction. Additionally, the No Action alternative assumes that the non-Federal sponsor would prepare a System Wide Implementation Framework (SWIF) to bring the levees into compliance with*			

[1] See, for example, Florsheim, J. et al. 2008. BioScience (2008) 58 (6): 519-529. doi: 10.1641/B580608 http://bioscience.oxfordjournals.org/content/58/6/519.full

	Table 1: State Water Board Staff Comments on Specific Contents of the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Watershed Common Features General Reevaluation Report (SCH No. 2005072046)			
Com-ment No.	**Chapter**	**Section/ Sub-section**	**page**	

Corps' Engineer Technical Letter (ETL) 1110-2-583 Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures over the next 20 to 40 years."

This is reiterated in section 1.4.5 (p. 11) where vegetation and encroachment compliance are discussed. Throughout the EIR-EIS, it is assumed that a variance from the Corps would be obtained to allow for greater retention of existing vegetation than the baseline provided in the Corps ETL 1110-2-583..

Impacts and mitigations described are contingent upon adoption of a System Wide Improvement Framework (SWIF). The SWIF is an agreement between the Corps and the non-Federal sponsor that allows the [local management agency] LMA to defer compliance with [the Corps rules on vegetation management for levees] ETL 1110-2-583. This proposed Framework is not yet adopted, and may take many different forms when it is completed.

These uncertainties lie at the basis of the entire analysis presented. No alternatives are discussed for cases where the Corps denies variance requests. Discussion of the range of possible forms that future SWIF agreements is not presented.

II-6

For these reasons, the alternatives presented do not represent a full range of possibilities. Alternatives that describe impact scenarios in the absence of a Corps variance should be provided. Alternatives that describe a reasonable range of forms that the SWIF may take are also needed.

9. INCLUSION of SAFCA PROJECTS IN THE "FUTURE WITHOUT PROJECT CONDITION"

The Sacramento Area Flood Control Agency (SAFCA) is preparing an *Environmental Impact Report for the North Sacramento Streams, Sacramento River East Levee, Lower American River, and Related Flood Improvements/Levee Accreditation Project*; this document is being prepared simultaneously with the proposed American River Common Features Project. This proposed SAFCA project would affect many miles of levees in the Common Features Project area, and proposes to do so on a schedule that could be in advance of many Common Features Project elements by many years.

II-7

Consideration of these proposed SAFCA projects should be provided in this "Future Without Project Condition" section of the EIR. A discussion of how these SAFCA projects would interact with the proposed Project should also be provided.

	Table 1: State Water Board Staff Comments on Specific Contents of the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Watershed Common Features General Reevaluation Report (SCH No. 2005072046)			
Com-ment No.	**Chapter**	**Section/ Sub-section**	**page**	
	COMMENTS ON SPECIFIC TEXT IN THE DOCUMENT			
10	ES		12	**DREDGE AND FILL IMPACTS TO WATERS OF THE STATE NOT DISCLOSED OR DISCUSSED IN THE EXECUTIVE SUMMARY.** Table ES.3 summarizes environmental effects and mitigation measures for three project alternatives. No effects are listed for direct impacts to surface waters of the state, including waters of the U.S. Table ES.3 mentions effects to Hydrology, Water Quality, Special Status Species, Vegetation and Wildlife. None of these topics adequately discloses impacts to waters due to the physical manipulation of the channels and levees that are to modified by the proposed Project. The Executive Summary the Final EIR/EIS should address these effects specifically; it should not be assumed that vegetation or habitat impacts are the same as impacts to waters.
		1.4.5	12	**VEGETATION AND ENCROACHMENT VARIANCE** **SWIF = system wide improvement framework** "The ARCF GRR project description (Section 2.0 below) assumes that the variance and SWIF agreements are both in place. The variance is included as a part of the proposed alternatives, while the SWIF would be a part of the future condition, both with or without the project in place" • What happens if the variance is not approved? • When is action by the Corps on the variance request expected? Much of the concern regarding levee improvements focuses on the disposition of vegetation, especially large, old trees, that are within or near the levee footprint. The proposed SWIF criteria cited in the Draft EIR/EIS states that, "Based on the engineering inspection and

II-8

II-9

II-10

II-11

	Table 1: State Water Board Staff Comments on Specific Contents of the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Watershed Common Features General Reevaluation Report (SCH No. 2005072046)			
Com-ment No.	**Chapter**	**Section/ Sub-section**	**page**	
II-11 (Cont.)				evaluation, trees and other woody vegetation that do not pose an unacceptable threat need not be removed (bullet 1)." Bullet two continues: "In cases of levee repair or improvement projects, vegetation within the project footprint shall be removed as part of construction activities. " This statement should be qualified as per the SWIF criteria above to emphasize that vegetation in the project footprint that does not pose an unacceptable threat need not be removed.
II-12	**3**	3.6.1	94	The regulatory setting for vegetation and wildlife impacts lists only local government agencies and ordinances. The Regional Water Quality Control Board, through the Clean Water Act section 401 certification process, should be included. Inclusion of the Department of Fish and Wildlife and the US Fish and Wildlife Service, and the various species and habitat protection laws they enforce, would also be appropriate here.
II-13	**3**	3.6.2	97-98	Chapter 3.6 describes the affected environment and environmental consequences of the alternatives proposed on vegetation and wildlife. In particular, section 3.6.2 describes the methodology and basis of significance used for this analysis. One effect described which could rise to the level of significance is: *"Substantial effects on a sensitive natural community, including Federally protected wetlands and other waters of the U.S., as defined by Section 404 of the Clean Water Act."* This statement of significance does not recognize the need for protections of wetlands and other waters under state law. Recommended rewording of this statement: *Substantial effects on a sensitive natural community, including <u>all waters of the state as defined by Porter-Cologne, which may also include</u> Federally protected wetlands and other waters of the U.S., as defined by Section 404 of the Clean Water Act.*

	Table 1: State Water Board Staff Comments on Specific Contents of the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Watershed Common Features General Reevaluation Report (SCH No. 2005072046)			
Com-ment No.	**Chapter**	**Section/ Sub-section**	**page**	
II-13 (Cont.)				Note again that protection of vegetation and habitats that occur as wetlands, streams and associated riparian areas does not necessarily provide protection of all beneficial uses of waters of the state. The link between habitat functions, hydrologic functions, and water quality and protections provided under CWA section 404 and 401, and Porter-Cologne should be clearly disclosed as part of the discussion of impacts, significance, and mitigation proposals.
II-14		3.6.6	103	Loss of very large native trees is a significant concern for water quality as well as for fish and wildlife. The discussion of vegetation impacts and mitigations often does not clearly distinguish between loss of smaller trees (which grow back to size sooner) and loss of tall, old riparian and near floodplain overstory trees such cottonwoods. These take many decades to replace. The temporal lag for loss of this riparian forest element is therefore significant, and it may not be possible to fully mitigate for this loss. Analysis of all water quality effects, such as loss of shading on water temperature over time, associated with the loss of very large trees should be provided and should be considered when making mitigation plans.
II-15		3.6.6	103	Compensatory mitigation is proposed as follows: *"To compensate for the removal of 65 acres of riparian habitat, approximately 130 acres of replacement habitat would be created. Species selected to compensate for the riparian corridor removal would be consistent with the approved list of trees, shrubs, and herbaceous plants native to the Parkway."* How and where would this "habitat" be created? While the State Water Boards may not consider some riparian areas to be waters of the state and U.S., impacts to riparian areas often lead to adverse effects on water quality – including, but not limited to, impacts to aquatic plants and wildlife. For this reason, the State Water Board recommends that proposals for riparian mitigation are clearly described in the EIR-EIS. Although riparian mitigation sites may not be permitted under CWA section 404 or as dredge and fill discharges under Porter-Cologne, State Water Board staff would categorize compensatory mitigation sites in a manner that is consistent with the Clean Water Act

	Table 1: State Water Board Staff Comments on Specific Contents of the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Watershed Common Features General Reevaluation Report (SCH No. 2005072046)				
	Com-ment No.	**Chapter**	**Section/ Sub-section**	**page**	
II-15 (Cont.)					mitigation rule, the "404(b)(1) guidelines," In these guidelines, we find that *Compensatory mitigation* means "the restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts." The term "creation" is generally avoided in favor of the term "establishment." If the proposed mitigation sites could appropriately be characterized by this definition, the EIR should acknowledge that the CWA definitions are in use. If some other definition is intended, that definition should be provided as part of the proposal.
II-16			3.6.6	103	What is the source of approval for this "approved list" of plants to be used in this mitigation effort? Recent research is showing that a diverse set of plants is needed for successful revegetation efforts. In addition to the common species, representatives of the uncommon species – which may make up a large proportion of the species list of a site, but only a very small percentage of overall prevalence or dominance – is necessary at the planting stage. These less common species have been shown to not repopulate areas after revegetation with dominant species, even decades after restoration work. Timing of revegetation is also critical in that it should not be assumed that a single episode of planting can be sufficient. Repeated cycles of planting over many years should be considered to help mimic natural patterns of recruitment and succession.
II-17			3.6.6	103	Compensatory mitigation site plans and restoration plans for areas of temporary disturbance should include a long term commitment to monitoring of the performance and condition of the site. All monitoring and assessment should be conducted using methods that are consistent with guidance provided by the California Water Quality Monitoring Council.
II-18			4.2.4,	286	The discussion of cumulative effects on special status species focuses on condition of riparian vegetation, and once again assumes issuance of a variance from the Corps. No discussion or analysis of alternatives where the variance is not obtained is provided.

	Table 1: State Water Board Staff Comments on Specific Contents of the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) for the American River Watershed Common Features General Reevaluation Report (SCH No. 2005072046)			
Com-ment No.	**Chapter**	**Section/ Sub-section**	**page**	

Department of
Community Development
Lori A. Moss, Director

Divisions
Administrative Services
Building Permits & Inspection
Code Enforcement
County Engineering
Economic Development & Marketing
Planning & Environmental Review

May 22, 2015 Via Email: Anne.E.Baker@usace.army.mil

U.S. Army Corps of Engineers
Sacramento District, Attn: Ms. Anne Baker
1325 J Street
Sacramento, CA 95814

County of Sacramento Comments on the Draft EIS/EIR for the American River Common Features GRR

Dear Ms. Baker:

Thank you for providing Sacramento County the opportunity to provide comments on the proposed project's Draft EIS/EIR (Document). These comments supplement the comments we provided verbally to the recorder at the April 15th meeting at the Tsakopoulos Library Galleria. The County's concerns are primarily related to impacts to the American River Parkway (Parkway) and secondarily associated with the project's proposed soil borrow operations. Our concerns with the Parkway analysis include impacts that have not been evaluated and a lack of specificity in the project and alternatives descriptions.

JJ-1

JJ-2 This project may result in loss of use, access, and subsequently, revenue, to the Sacramento County Department of Regional Parks (Parks Department), through daily fees, special event fees, annual pass sales, and other park revenues. In particular, JJ-3 potential impacts to the Campus Commons Golf Course were not disclosed. In JJ-4 addition, project areas may not have viable detour routes for equestrians on the Parkway's designated equestrian/hiking trails. Access to angling, wildlife viewing, JJ-5 rafting and other river-based activities may be limited by construction activities. Furthermore, special events such as Eppie's Great Race, May is Bike Month activities, JJ-6 fun runs, and other trail-based events use facilities that could be closed, detoured out of the Parkway, or otherwise impacted by construction. All of these impacts may result in loss of Parks revenue, which should be mitigated.

JJ-7 In addition to loss of revenue, the Parks Department may incur additional costs due to the construction of this project. New ramps and haul roads may increase social trails (unofficial trails) and visitor use in some areas, leading to additional natural resource damage, fire risk and suppression costs, social trails management, maintenance, and ranger patrol to areas not previously utilized by the public. The additional on-going

costs to manage these areas could be mitigated through funding a social trails management plan.

JJ-8 The Document describes the impacts associated with detouring traffic from the paved trails on the American River Parkway. To avoid past USACE contractor difficulties of communicating trail detour information, we recommend that mitigation include funding a public outreach program that is staffed by Parks Department personnel. A Parks Department staffed outreach program would maximize communication with the target audience, minimize confusion, and provide greater overall coordination to better mitigate recreational impacts. Mitigation, of longer term construction detours, on the south side of the Parkway, could also include completion of the planned Two Rivers Trail, to provide alternative detour options that minimize the impacts of detouring traffic onto surface streets.

JJ-9 We would like the project to have the potential to consider borrow sites on the American River Parkway, as there may be areas where park managers desire floodplain lowering.

JJ-10 In addition, please be advised, that many of the proposed borrow sites will require County and State permitting, pursuant to the Surface Mining and Reclamation Act (SMARA). The County Department of Community Development is the SMARA lead agency for unincorporated Sacramento County and should be contacted early in the process once a borrow site is known.

In addition to the comments above, we request clarification regarding the clearing and stripping of small vegetation on bank protection sites:

JJ-11 1. What criteria are established to determine which vegetation is large and which is small?

JJ-12 2. If large trees are to be left in place, will these trees be considered in the hydraulic modeling for conveyance? And if modeled, will this information be sufficient to replace these trees (with new plantings) when they die without having to re-model the roughness coefficient and conduct new permitting through the Central Valley Flood Protection Board.

JJ-13 3. What kind of vegetation, both planted and naturally occurring, will be allowed to occur on top of either alternative?

JJ-14 4. Will trees that die during or after the project is completed, due to construction impacts, be mitigated?

JJ-15 5. Figure 1 of the bank protection area does not include a planting berm, but it is indicated in the text: Should a planting berm be indicated in Figure 1 and how would it work?

JJ-16 6. The discussion of the vegetation variance in section 1.4.5 appears to be specific to the Sacramento River: Will this variance also apply to the levees on the American River?

JJ-17 7. Have project impacts been evaluated should the vegetation variance not be applied to the American River levees?

JJ-18

8. As an element of the restoration of disturbed areas, native grasses and small shrubs would be planted "where appropriate." What criteria are used to determine the appropriateness of the replanting?

JJ-19

9. In the "no action" alternative, it is assumed that the land and habitat loss will happen over time: Can this loss, and timing of loss, be estimated with existing modeling?

We also have reservations and concerns about the consequences of choosing launchable rock trench for protection of the Parkway levee. Our specific questions include:

JJ-20

1. The design indicates a maximum width of 70 feet and 23 foot deep trench: Is the 70 foot width measured at the bottom or the top, and what is the total footprint required to terrace a 23 foot deep trench?

JJ-21

2. In the "no action" alternative, the expected bank erosion is listed as a significant impact, while at the same time; the launchable rock trench also would allow significant bank erosion to occur: Why are the impacts of the launchable rock trench, including the loss of habitat and land, not disclosed as significant project impacts?

We understand from participating in the April 15th public comments session that this Document was written at a program level, but this was not apparent in the Document itself. Please clearly state in the Document that there will be additional project level

JJ-22

environmental analysis, with a commitment to additional outreach and cooperative planning. Ongoing coordination of site specific designs on the Parkway should also be

JJ-23

coordinated with recommendations from the Lower American River Task Force.

If you have any questions please contact John Lundgren at (916) 874-8043 or lundgrenj@saccounty.net.

Sincerely,

for - Catherine Hack
Environmental Coordinator

C: Jeff Leatherman, Director
Sacramento County Regional Parks

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Assembly
California Legislature

KEN COOLEY
ASSEMBLYMAN, EIGHTH DISTRICT

COMMITTEES
ACCOUNTABILITY AND ADMINISTRATIVE REVIEW
GOVERNMENTAL ORGANIZATION
INSURANCE
RULES (D-ALT)

SELECT COMMITTEES
CHAIR: COMMUNITY AND NEIGHBORHOOD DEVELOPMENT
COMMUNITY COLLEGES
JOB CREATION FOR THE NEW ECONOMY
GOVERNMENT EFFICIENCY, TECHNOLOGY AND INNOVATION
ASIA/CALIFORNIA TRADE AND INVESTMENT PROMOTION

ALFRED E. ALQUIST SEISMIC SAFETY COMMISSION

June 1, 2015

Ms. Anne Baker
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, CA 95814

RE: American River Common Features

Dear Ms. Baker,

I am writing to encourage the Army Corps of Engineers, Sacramento District, to continue to work with local districts and agencies as they move forward with the proposed levees along the American River Parkway.

The American River Parkway is of great value to our community. I understand the importance of your work, and appreciate the considerations that are being undertaken during the planning stages of this project. However, I do encourage you to consider the feedback from agencies such as Sacramento Regional Parks and the Butterfield - Rivera East Community Association.

It is my firm belief that by working together, a plan can be made that will balance safety and flood resilience with access to natural habitats and recreation areas. Again, I thank you for your diligent work on this matter. Please do not hesitate to reach out to me should you ever require my assistance.

Sincerely,

Ken Cooley

Ken Cooley
Assemblymember, 8th District

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Comment Number	Commenter	Method of Submission	Category	Response
A-1	Sandra Maxwell	Public Meeting Transcript	Flood Insurance	Verano Street is not located immediately adjacent to any of the planned work activity areas. The proposed project would strengthen levee stability and improve flood protection for the Sacramento region. The determination of flood insurance rates does not relate to the environmental analysis contained in the EIS/EIR. Cleanup of trash and other debris is a City and/or County maintenance issue.
B-1	Beverly Nason	Public Meeting Transcript	Construction Impacts	Comment noted. Minimization and mitigation measures are proposed to reduce potential impacts from construction vibration.
B-2	Pamela Bigelow	Public Meeting Transcript	O&M and Construction Impacts	The trees that would be removed as part of the ARCF GRR are limited to the trees that would be directly impacted by construction of the project. The Corps understands the commenter's concerns related to the use of staging areas within existing developed neighborhoods. However, such staging areas are necessary to carry out the proposed project. The Corps will minimize disturbance in the staging areas to the extent feasible. The commenter's concern for this potential fire hazard is appreciated and this issue will be brought to the attention of the appropriate State levee maintenance agency.
B-3	Shirley Short	Public Meeting Transcript	Public Meeting Format	The purpose for the public meeting was to provide interested members of the public and agencies with an opportunity to provide comments on the environmental analysis and to respond to questions regarding the proposed project.
B-4	Craig Carroll	Public Meeting Transcript	Vegetation Removal, Privacy During Construction, and Encroachment removal.	Under the ARCF GRR, the trees proposed for removal are limited to the trees that would be directly impacted by construction of the project. High hazard tree removal is a separate action being conducted by SAFCA. The Corps tagged trees in 2011 as part of preliminary vegetation surveys that were used to establish a baseline condition and effects analysis for this EIS/EIR. The Corps tags do not indicate that a tree is proposed for removal. The Corps appreciates the commenter's concern over privacy during construction; however privacy fences between construction activities and adjacent properties are not proposed as part of the project. Permitted encroachment removal would be coordinated between the non-federal sponsors and the owners, and would be replaced following construction.
C-1	John Lundgren, on behalf of Jeff Leatherman	Public Meeting Transcript	Recreation Impacts	The recreation section of the EIS/EIR has been updated with more detail, including these concerns. The Corps is committed to coordinating with County Parks prior to implementation of construction.
C-2	John Lundgren	Public Meeting Transcript	Borrow Sites	The Corps or its contractor would consult with Sacramento County and ensure receipt of all applicable permits prior to construction. The Corps has not proposed any activities in the Dry Creek Parkway, however SAFCA has proposed a borrow site within the parkway. SAFCA would coordinate with Sacramento County regarding any work in the Dry Creek Parkway if that borrow site is selected for use.
D-1	Pat Hara and Jack Burrows	Public Meeting Transcript	Flood Insurance	This comment does not relate to the environmental analysis contained in the EIS/EIR; the comment is noted.
D-2	Judith Scott	Public Meeting Transcript	Public Meeting	Thank you for your comments.
E	Lissa McKee	Comment Sheet	Various	Thank you for your comments.
F	Carolyn Baker	Comment Sheet	Tree Removal	SAFCA intends to implement the specific levee improvements in the North Sacramento Streams and Sacramento River East Levee areas; other improvements identified in the ARCF GRR would be implemented by the Corps. The Corps Sacramento District will apply for a variance to the vegetation policy and if granted would only remove vegetation within the footprint necessary for construction under the ARCF GRR. The local maintaining agencies are responsible for any further vegetation maintenance activities.

G	Ellen Broms	Comment Sheet	O&M and Construction Impacts	SAFCA understands the commenter's concerns related to the use of staging areas within existing developed neighborhoods. However, such staging areas are necessary to carry out the proposed project. SAFCA will minimize disturbance in the staging areas to the extent feasible. SAFCA's Vegetation Management Decision Key (included as Appendix B of the Levee Accreditation Program DEIR) states that fruit- and nut-bearing trees will be assessed and removed from both landside and waterside levee slopes. Fruit- and nut-bearing trees at these locations were identified as high-hazard trees for removal as part of the proposed project. The locations of trees that would be removed as part of the proposed project are shown on Exhibit 3-17 in Chapter 3, of SAFCA's EIR "Project Description" (page 3-110 of the DEIR).
H	Mary Schwartz	Comment Sheet	Public Meeting Format & Construction Schedule	The Corps will ensure that the commenter's address is added to the final mailing list. Comments regarding meeting format and schedule are noted.
I-1	Dan Kopp	E-mail	Vegetation Removal	The tagged trees by your house may not necessarily be associated with this project, but your description of the locations of the tagged trees sound like they could be from the 2011 tree survey that was conducted by this project. The 2011 tree survey was conducted as preliminary information only and does not necessarily indicate that the trees will be removed. The trees were tagged and logged into a GIS database for data purposes only. No trees have been definitely identified for removal at this time. In the preconstruction engineering and design phase of the project following Congressional authorization, site-specific analysis would be conducted prior to construction to determine specific impacts, including which trees would be need to be removed for construction purposes only.
I-2	Dan Kopp	E-mail	Wildlife Impacts	Tree removal would occur outside of the nesting season and would be monitored by a biologist to ensure that no impacts occur to nesting birds.
I-3	Dan Kopp	E-mail	Typos	Thank you for your comment.
J-1	Stan Jones	E-mail	Public Accessibility During Construction	It is unclear what the purpose would be for providing "viewing areas" for members of the public to see the project-related construction activities. Furthermore, such "viewing areas" would result in a safety hazard for members of the public in proximity to construction equipment, and would not reduce the environmental impacts of the proposed project in any way.
J-2	Stan Jones	E-mail	Public Levee Access	Levee encroachments would be replaced following construction based on existing CVFPB encroachment permits.
J-3	Stan Jones	E-mail	Tree Removal	SAFCA proposes to remove high hazard vegetation as a part of their Levee Accreditation Program. The specific locations of proposed high hazard vegetation can be found in SAFCA's EIR on Exhibits 3-18 (Chapter 3, "Project Description"), and 4.6 3a through 4.6 3d (Section 4.6, "Biological Resources – Terrestrial"). Details regarding the evaluation criteria for trees and other vegetation that would be removed are contained on pages 3 48 through 3 50 of Chapter 3, "Project Description," and in DEIR Appendix B.
K-1	Janet Fullwood	E-mail	Seepage	Both SAFCA and the Corps propose to address seepage concerns through the construction of seepage cutoff walls, including at the location of the commenter's home.
K-2	Janet Fullwood	E-mail	O&M	SAFCA is proposing to construct the seepage and stability improvements in this portion of the ARCF project area. SAFCA will bring this issue to the attention of the appropriate State levee maintenance agency. SAFCA also notes that proposed Conservation Strategy Policy SSP-1 requires that construction vehicles and equipment must be cleaned inside and out at an authorized washing facility before arrival at the project construction areas and must be inspected in an attempt to ensure they are free of soil and debris that could harbor nonnative plant seeds, roots, or rhizomes. If invasive or noxious weeds are already present in portions of the project areas, vehicles must be cleaned before moving from infested areas to areas that are weed free. Exterior cleaning must consist of pressure washing vehicles and equipment, with close attention paid to the tracks, feet, and/or tires and on all elements of the undercarriage. Vehicle cabs must be swept out, and refuse must be disposed at an approved off-site location.
L	James Geary	E-mail	Public Levee Access	Levee encroachments would be replaced following construction based on existing CVFPB encroachment permits.
M	Maggie Beddow	E-mail	Public Levee Access	Levee encroachments would be replaced following construction based on existing CVFPB encroachment permits.

N-1	United Auburn Indian Community of the Auburn Rancheria	E-mail	Alternatives	CEQA Guidelines 15126.6(e)(2) refers to the identification of the No Action Alternative, which was included in accordance with the cited regulations. Identification of the Least Environmentally Damaging Practicable Alternative (LEDPA) is required as a part of the Section 404(b)(1) Analysis and is included in Appendix E of the EIS/EIR. For this project, Alternative 2 is identified as the LEDPA.
N-2	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	The Corps attempts to avoid impacts to known cultural resources wherever possible. The consideration of setback levees, stability berms, and seepage berms, is made and incorporated where feasible. The Corps welcomes the opportunity to consider the specific design features the UAIC would like incorporated to reduce the potential for direct cultural impacts. Corps cultural resources staff followed up with UAIC in a letter dated July 7, 2015, in a staff-to-staff consultation meeting on August 6, 2015, and in emails dated August 10 and 17, 2015 requesting this specific information. The Corps has not only consulted during the planning phase, and will continue to consult with UAIC throughout the design and construction phases of the project.
N-3	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	The Corps values the role that Native American tribes, including the UAIC, has as a Tribe, government, and partner. UAIC is identified within Section 5.0 (Compliance with Applicable Laws, Policies, and Plans) as a Native American tribe. Within Section 6.0 (Consultation and Coordination) there is extensive description of efforts to consult with tribes, including UAIC. These concerns and a process for addressing them are reflected in the Programmatic Agreement for ARCF as well as the EIS/EIR. As a consulting party, the UAIC, and its comments, are given consideration by the Corps from the initiation of consultation through to the fulfillment of the Section 106 process, and in many cases, beyond. The Corps has not only consulted during the planning phase, and will continue to consult with UAIC throughout the design and construction phases of the project.
N-4	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	The Corps appreciates the opportunity to consider tribe/tribal values throughout the document. The Corps has added to section 3.9.1 "Cultural Resources Site Types" descriptions for Traditional Cultural Properties and Traditional Cultural Landscapes which address sites of importance to tribes, and are resource category types directly related to tribal values that tribes have indicated to the Corps are important. Language has been added to ES.9 (Areas of Controversy and Unresolved Issues) to consider effects to cultural resources and resources significant to tribes.
N-5	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	The NEPA/CEQA process allows participation through the public comment period. Further, we are currently engaged in government-to-government consultation with the UAIC. The Corps and the CVFPB will provide the updated EIS/EIR to the Tribe at the next public review period (tentatively scheduled for January 2016) and welcome the Tribe's ongoing participation at that time.
N-6	United Auburn Indian Community of the Auburn Rancheria	E-mail	Alternatives	The Corps has considered a reasonable range of alternatives, as required by NEPA. The Corps considered a wide variety of alternatives to reduce flood risk to the city of Sacramento. Further, the Corps provided an extensive explanation for all alternatives considered, but not carried through. Because the levees surrounding the City are in such poor shape, the most effective plan to reduce that risk is to improve the existing levees in place. A setback levee with a seepage berm is recommended for the Sacramento Bypass north levee which would approximately double the floodplain area. The remainder of the levees are adjacent to urban development with little to no available land for a levee setback or seepage berm. These levees would be improved with a slurry cutoff wall through the center of the levee. The top half of the levee would be removed to create a construction platform while the bottom half of the levee on both sides would remain intact.

N-7	United Auburn Indian Community of the Auburn Rancheria	E-mail	Public Review	The Corps and CVFPB would supplement the EIS/EIR in accordance with NEPA/CEQA regulations, if needed. Under CEQA, a lead agency is required to recirculate an EIR when significant new information is added to the EIR after public notice is given of the availability of the draft EIR for public review under Section 15087 but before certification. As used in this section, the term "information" can include changes in the project or environmental setting as well as additional data or other information. New information added to an EIR is not "significant" unless the EIR is changed in a way that deprives the public of a meaningful opportunity to comment upon a substantial adverse environmental effect of the project or a feasible way to mitigate or avoid such an effect (including a feasible project alternative) that the project's proponents have declined to implement (14 CCR Section 15088.5). Under NEPA, the Corps shall prepare supplements to either draft or final environmental impact statements if: (i) The agency makes substantial changes in the proposed action that are relevant to environmental concerns; or (ii) There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts (40 CFR 1502.9[c]). Additionally, under NEPA the Corps is required to circulate the Final EIS to the public prior to approval. Currently release of the Final EIS is tentatively scheduled for early 2016.
N-8	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	The Corps appreciates UAIC's suggestion to evaluate effects to cultural resources and propose treatment prior to construction beginning. The Programmatic Agreement (PA) (Enclosure 1 of Appendix C of the DEIS/DEIR) includes stipulations (Stipulation III - "The HPMP [which provides the framework by which remaining identification, evaluation of eligibility, findings of effect, and resolution of adverse effect efforts] shall be developed after execution of the Agreement, but before construction commences." and Stipulation IV - "The Corps shall complete any identification and evaluation, and as necessary, any evaluation of effects to Historic Properties prior to proceeding with construction") for the identification and evaluation of cultural resources as construction details become available. Additionally, the PA outlines many potential treatment options for adverse effects to historic properties, not limited to data recovery. These potential treatment options would be developed in consultation with the SHPO and Native American tribes.
N-9	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	The Corps has added to section 3.9.1 "Cultural Resources Site Types" descriptions for Traditional Cultural Properties and Traditional Cultural Landscapes which address sites of importance to tribes, and are resource category types directly related to tribal values that tribes have indicated to the Corps are important. The PA includes procedures to consult with tribes on identification, eligibility, and evaluation determinations (Stipulations III, IV, VI, XI) for sites of importance to tribes, throughout its implementation.
N-10	United Auburn Indian Community of the Auburn Rancheria	E-mail	Alternatives/Cultural	Preservation in place is considered as a potential mitigation for cultural resources. Where appropriate, avoidance is the preferred mitigation measure. The Corps has added to section 3.9.1 "Cultural Resources Site Types" descriptions for Traditional Cultural Properties and Traditional Cultural Landscapes which address sites of importance to tribes, and are resource category types directly related to tribal values that tribes have indicated to the Corps are important. The PA includes procedures throughout implementation to consult with tribes on identification, eligibility, and evaluation determinations (Stipulations III, IV, VI, XI) for sites of importance to tribes.
N-11	United Auburn Indian Community of the Auburn Rancheria	E-mail	Utilities/Cultural	Utility relocations, including PG&E lines, are addressed in the EIS/EIR under the Utilities Section (Section 3.16). There is the potential that relocation of underground utility lines could impact cultural resources. During the design phase of the project, site-specific analysis would occur prior to construction, including any impacts associated with utility relocations and associated cultural resources impacts. The Corps will continue to consult with UAIC throughout the design and construction phases of the project.

N-12	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cumulative/Cultural	The cumulative impacts to cultural resources are considered in the EIS/EIR. NEPA and CEQA require the consideration of unavoidable impacts to cultural resources, to include cumulative impacts. The cumulative impact section does not state that "cultural resources are typically not subject to cumulative effects". The document states that "cumulative overall impact to non-renewable cultural resources is likely, as well as significant and unavoidable." The section further states that the project is addressing effects (to include mitigation) through the execution of a PA.
N-13	United Auburn Indian Community of the Auburn Rancheria	E-mail	Borrow/Staging	At this time, no borrow sites and staging areas have been identified for the project. Typical impacts of borrow activities have been analyzed throughout the EIS/EIR, including some updates in the Final EIS/EIR based on project review. If additional impacts occur beyond those described in this EIS/EIR, the Corps would produce a supplemental NEPA/CEQA document, as appropriate.
N-14	United Auburn Indian Community of the Auburn Rancheria	E-mail	Vegetation	For the purposes of this EIS/EIR, the Corps took a conservative approach in analyzing wetlands, and considered all potential wetlands jurisdictional. Wetland delineations will be conducted on a site-specific basis prior to construction. If the delineation determines that there are significant impacts to wetlands beyond those addressed in this document (Sections 3.5, 3.6, and 3.8), then a supplemental NEPA document may be required.
N-15	United Auburn Indian Community of the Auburn Rancheria	E-mail	Construction Details	A Corps project does not take into consideration the requirements for FEMA. Local entities work directly with FEMA to determine if they are in a regulatory floodplain and the implications of any land use restrictions. For bank protection work on the Sacramento River, it is likely that barges will be used.
N-16	United Auburn Indian Community of the Auburn Rancheria	E-mail	NEPA	During the preconstruction engineering and design phase of the project, the Corps will be designing each phase of the project on a site-specific basis. During this site-specific design, an analysis will be conducted to determine whether the impacts are consistent with those described in this EIS/EIR or whether supplemental NEPA analysis would need to occur.
N-17	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	Thank you for your comment regarding the potential need for vibration or compression effects of the project on cultural resources. These types of studies have not been conducted but may be considered appropriate at a later stage of the project once more specific design details are known. Effects to historic properties will be evaluated in accordance with Stipulations III and IV of the PA.
N-18	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	Thank you for your comment regarding the potential need for vegetation impacts of the project on cultural plants, including mounds or cultural landscapes. These types of studies have not been conducted but may be considered appropriate at a later stage of the project once more specific design details are known. During the design phase, site specific analysis would occur and localized effects at each site would be evaluated to determine what additional studies may need to occur.
N-19	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	The Corps appreciates the suggestion and will consider this as future mitigation for the project, which would be determined through the execution of the PA. At present the Corps is not aware of an existing mitigation bank for cultural resources.
N-20	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	Regarding post-approval technical studies for cultural resources, 36 CFR Part 800.14(b)(1)(ii) allows that a PA be used when effects on historic properties cannot be fully determined prior to approval of an undertaking. Specific to the project, the PA will allow for the Corps to follow the Section 106 process to identify historic properties, evaluate their National Register eligibility, assess potential adverse effects, and, if necessary, resolve adverse effects. Regarding other technical studies, the ARCF GRR is a study that evaluates the alternatives and proposes a plan for authorization by Congress. Following Congressional authorization, further studies will occur during the design phase, including site specific engineering and environmental analyses, such as construction plans and specs, wetland delineations, and other more detailed design-level efforts.
N-21	United Auburn Indian Community of the Auburn Rancheria	E-mail	Climate Change	Raising structures was analyzed in the initial array of alternatives in the GRR under "Non-structural Measures" and eliminated from further consideration, and explained why. In the EIS/EIR, this process is summarized in Section 2.1.2 under "Non-Structural Measures".

N-22	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	Under "Cultural Resource Types" there is a section that describes Traditional Cultural Properties (TCPs) that is directly quoted in part from National Parks Service Bulletin 38. A section to describe the Advisory Council on Historic Preservation's definitions of traditional cultural landscapes has also been added to this section. The Corps will continue to consult with the UAIC and other tribes throughout the implementation of the project regarding the importance of place, setting, and landscape to the tribe and will follow up with a request for this information.
N-23	United Auburn Indian Community of the Auburn Rancheria	E-mail	Cultural	NAHC is listed in the EIS/EIR's list of recipients as a State agency that received a copy of the draft report.
O-1	California Department of Transportation	Letter	Bridge Design/H&H	Concur. The Corps will evaluate site-specific conditions, including impacts to critical bridges during site-specific design in the design phase of this study known as Preconstruction, Engineering and Design (PED).
O-2	California Department of Transportation	Letter	Bridge Design	Where project features interface with Caltrans bridges, appropriate steps in PED phase will be taken to coordinate bridge access.
O-3	California Department of Transportation	Letter	Bridge Design/H&H	Concur. The Corps will evaluate site-specific conditions, including impacts to bridge embankments during site-specific design in the design phase of this study known as Preconstruction, Engineering and Design (PED).
O-4	California Department of Transportation	Letter	Bridge Design	Any bridge modifications to incorporate project features will be designed based on current Caltrans design codes and criteria.
O-5	California Department of Transportation	Letter	Bridge Design	Project flood features, including floodwall and levee heights, will be coordinated during PED phase.
O-6	California Department of Transportation	Letter	Transportation	Prior to construction, the Corps and/or its construction contractor will prepare a Traffic Control and Road Maintenance Plan. Hauling by barge is possible for bank protection repairs on the Sacramento River. For this measure, the Corps will consider hauling by barge to reduce truck traffic impacts.
O-7	California Department of Transportation	Letter	Transportation	Detours would be provided during construction for all impacted bike trails. Levee encroachments would be replaced following construction based on existing CVFPB encroachment permits.
O-8	California Department of Transportation	Letter	Transportation	The Corps will continue to provide documents to CalTrans for review, as appropriate.
P-1	California Department of Fish and Wildlife	Letter	Biological Resources	Section 3.6 has been expanded to include analysis of habitat types in the study area, including sensitive habitats. State-listed species have been added to the analysis in Section 3.8.
P-2	California Department of Fish and Wildlife	Letter	Vegetation	Section 3.6 has been expanded to include impact analysis to sensitive species. Habitat maps of the study area have been added as Appendix B of the EIS/EIR.
P-3	California Department of Fish and Wildlife	Letter	Fisheries	The analysis in Section 3.7.5 has been expanded to elaborate on potential impacts to fish species in the Sacramento Bypass, to include fish passage through the bypass and stranding.
P-4	California Department of Fish and Wildlife	Letter	Fisheries	The impact analysis in Section 3.7.4 has been expanded to address predation at bank protection sites.
P-5	California Department of Fish and Wildlife	Letter	Vegetation	As detailed in Section 1.4.5 of the EIS/EIR, the Corps has conducted an analysis to determine the feasibility of acquiring a vegetation variance. The analysis determined that receipt of a variance is a reasonable assumption for the project and therefore all effects analyses assumed the variance is in place. If a variance is not granted by USACE HQ, then the Corps will conduct further NEPA/CEQA analysis at that time to analyze the effects of compliance with ETL 1110-2-583. The variance application process will be conducted following Congressional authorization during the preconstruction engineering and design phase of the project.
P-6	California Department of Fish and Wildlife	Letter	Fisheries	The Corps is not proposing to alter the existing Sacramento Bypass under this action. The Corps is proposing to design the newly widened Sacramento Bypass in a manner to ensure positive drainage, which would prevent further stranding of fish in this area.
P-7	California Department of Fish and Wildlife	Letter	Agriculture	Concur. The final EIS/EIR will be updated to reference the current land uses in the proposed widened Bypass area.

P-8	California Department of Fish and Wildlife	Letter	Land Use	After project construction, the CVFPB will evaluate the appropriate course of action regarding the future land use in the Bypass.
P-9	California Department of Fish and Wildlife	Letter	Recreation Impacts	The CVFPB staff coordinated with CDFW to discuss recreation impacts in the Sacramento Bypass, and the recreation section of the EIS/EIR has been updated in response to those discussions to elaborate on impacts to recreation and access. Through these discussions, it was determined that no additional mitigation measures to address recreation impacts needed to be added to the EIS/EIR at this time.
P-10	California Department of Fish and Wildlife	Letter	Recreation Impacts	The CVFPB staff coordinated with CDFW to discuss recreation impacts in the Sacramento Bypass, and Section 3.14.5 of the EIS/EIR has been updated in response to those discussions to include potential restrictions for hunting during some aspects of construction. However, it is anticipated that there would be no conflict for the majority of the construction period, because construction would be occurring outside of the existing bypass with the levee providing a barrier between the wildlife area and the construction area.
P-11	California Department of Fish and Wildlife	Letter	Land Use/GGS	After project construction and turn over, the CVFPB will evaluate the appropriate course of action regarding the future land use in the Bypass. Impacts to GGS associated with removal of canals has been coordinated with USFWS and is included in the Biological Opinion appended to the final EIS/EIR.
P-12	California Department of Fish and Wildlife	Letter	Invasive Species	Section 3.6 was updated to include impact analysis and measures to prevent the spread of invasive species during construction of the project.
P-13	California Department of Fish and Wildlife	Letter	Fisheries	Language was added to the EIS/EIR in both the project description and the Fisheries analysis to reflect that during construction, the expanded bypass would be sloped to the south and graded in a manner consistent with the existing bypass to provide positive drainage.
P-14	California Department of Fish and Wildlife	Letter	Special Status Species	The new north levee of the Sacramento Bypass would be consistent with the existing north levee of the bypass. Impacts to listed species were analyzed with this design considered.
P-15	California Department of Fish and Wildlife	Letter	HTRW	The local sponsors are required to acquire all necessary lands and easements to facilitate the project. Lands acquired for the project must be free of contamination. As a result, they would be required to ensure that the appropriate parties remediate the landfill prior to providing the lands to the Corps for project implementation. As a result, the landfill remediation is not considered to be a part of the proposed action. Any environmental compliance activities associated with the remediation would be the responsibility of the entity conducting the remediation of the site.
P-16	California Department of Fish and Wildlife	Letter	Borrow Sites	Thank you for your comment. We will take this into consideration when selecting final borrow sites during the preconstruction engineering and design phase of the project.
P-17	California Department of Fish and Wildlife	Letter	Borrow Sites	At this time, no borrow sites have been identified for the project. Typical impacts of borrow activities have been analyzed throughout the documents, including some updates in the Final EIS/EIR based on project review. If additional impacts occur beyond those described in this document, the Corps would conduct supplemental NEPA/CEQA compliance analyses, as appropriate. If a borrow site is used as a future mitigation site, the conditions of the site would be improved to provide mitigative habitat beyond the existing condition of a borrow site. Borrow site restoration only includes returning it to pre-project conditions. Mitigation would involve creation of new habitat beyond what was existing prior to borrow activities.
P-18	California Department of Fish and Wildlife	Letter	Borrow Sites	Thank you for your comment. We will take this into consideration when selecting final borrow sites during the preconstruction engineering and design phase of the project.
P-19	California Department of Fish and Wildlife	Letter	Land Use	The EIS/EIR has been updated to describe the existing land use and public access in the Sacramento Bypass, and its operations by both CDFW and DWR.
P-20	California Department of Fish and Wildlife	Letter	Editorial/Land Use	Editorial changes to the EIS/EIR have been made as recommended. After project construction, the CVFPB will evaluate the appropriate future land uses in the Bypass.

P-21	California Department of Fish and Wildlife	Letter	Fisheries	The Corps has not conducted any studies at this time to assess fish passage through the Sacramento Bypass. As a term and condition of the NMFS Biological Opinion, the Corps has committed to conducting monitoring in order to assess these effects. Section 3.8 of the EIS/EIR has been updated to include fish passage measures, measures to prevent stranding, and the other terms and conditions of the Biological Opinion. The final Biological Opinion, with a finding of no jeopardy to listed species, is included as Appendix J of the EIS/EIR.
P-22	California Department of Fish and Wildlife	Letter	Fisheries	Section 3.8 of EIS/EIR has been updated to include further discussion of impacts to listed fish species from stranding and passage concerns. In accordance with the NMFS Biological Opinion, the mitigation section has been updated to reflect the terms and conditions and reasonable and prudent measures, including proposed fish passage measures for the study. Prior to construction, detailed design will occur and these measures will be refined and expanded. At that time, an analysis will occur to determine whether additional NEPA analysis needs to occur. Additional coordination with the resource agencies and other local action agencies would occur during detailed design to ensure that the project is designed to allow for fish migration and passage through the bypasses.
P-23	California Department of Fish and Wildlife	Letter	Fisheries	Concur, the construction window discussion has been updated. A general assumption of August 1 to November 30 was assumed, however this assumption will be reconsidered on a site-specific basis, depending on what species are known to be present and the proposed construction activities at each site.
P-24	California Department of Fish and Wildlife	Letter	Project Design	Concur. Site specific designs would occur during the preconstruction engineering and design phase of the project, to include consideration of fish stranding.
P-25	California Department of Fish and Wildlife	Letter	BA	The compensation times cited in the BA were developed during ongoing consultation with NMFS and USFWS through a variety of Corps programs and are based on the species' life cycles.
P-26	California Department of Fish and Wildlife	Letter	BA/Fisheries	The final BA was transmitted to NMFS and USFWS on 4/3/15 and Biological Opinions have been received from USFWS and NMFS (Appendix J). The Corps acknowledges CDFW's comments and concerns, and should consultation be reinitiated, the Corps will consider incorporating these comments.
P-27	California Department of Fish and Wildlife	Letter	BA/Fisheries	Comment noted.
P-28	California Department of Fish and Wildlife	Letter	BA/Fisheries	Comment noted.
P-29	California Department of Fish and Wildlife	Letter	BA/Fisheries	The life cycles discussion in the EIS/EIR has been updated to focus more on what stages are expected to occur in the study area.
P-30	California Department of Fish and Wildlife	Letter	BA/Fisheries	The Corps' Sacramento River Bank Protection Project has been monitoring bank protection sites to determine optimal designs and effects of these sites on juvenile salmonid species. The results of these studies will be used during site-specific design of the ARCF GRR project to ensure that bank protection sites include features that benefit salmonid species long-term. Additional monitoring of salmonid species is not proposed for this action; however, the Corps intends to initiate a green sturgeon monitoring program under this project to evaluate effects and optimal designs for this species. The details of this program are included in Section 3.8 of the final EIS/EIR and are also discussed in the NMFS Biological Opinion and the Mitigation Monitoring Plan.
P-31	California Department of Fish and Wildlife	Letter	EIS/EIR	CDFW's comments have been addressed as appropriate for this phase of the project and the level of design that currently exists in this Corps SMART Planning study. More detailed design on many aspects of the project will occur following Congressional authorization of the project, and further coordination will occur at that time. During detailed design of the project, an analysis will occur to determine whether further NEPA/CEQA compliance will be required.
Q-1	U.S. Department of the Interior	Letter	Construction Schedule	Tables 4 and 6 of the Draft EIS/EIR show the proposed construction schedule for each alternative, respectively. These tables indicate that construction would take approximately 10 years. For the American River Parkway, Tables 4 and 6 show that construction would occur over 9 of the 10 construction years, sometimes with multiple sites in the Parkway occurring during the same year.

Q-2	U.S. Department of the Interior	Letter	Recreation Impacts	Each construction season would vary depending on the length of the reach being constructed and applicable species work windows. Proposed mitigation for recreation would be implemented, as described in the document, with coordination occurring in advance with Sacramento County and the public. Note that the cumulative effects analysis specifically states that at the time of this analysis, no additional heavy construction projects are expected to occur within the Parkway at the same time as the recommended plan and thus no cumulative effects are assumed. During site-specific design, an analysis will occur to determine whether further NEPA or CEQA documentation would be required.
Q-3	U.S. Department of the Interior	Letter	Vegetation Impacts	The Corps will ensure that the construction contractor adheres to all required BMPs during construction, including ensuring that all appropriate mitigation and restoration is completed.
Q-4	U.S. Department of the Interior	Letter	Recreation	The Corps has added the Wild and Scenic Rivers Act to the Recreation Regulatory Setting.
Q-5	U.S. Department of the Interior	Letter	Coordination	Section 6.3 has been updated to include language regarding coordination with the National Park Service. The Corps will continue coordination with the NPS throughout the design phase of the project.
R-1	Sacramento County Department of Transportation	Letter	Transportation	The Corps will ensure that site-specific traffic studies are completed during the preconstruction engineering and design phase of the project once borrow sites, staging areas, and haul routes are defined for each construction area. If these studies result in impacts beyond those disclosed in this EIS/EIR, then supplemental NEPA documents would address these impacts.
R-2	Sacramento County Department of Transportation	Letter	Transportation	The Corps will ensure that a Traffic Plan is completed by the construction contractors, coordinated with SACDOT, and implemented during construction, to include all required BMPs and mitigation measures discussed in this EIS/EIR.
S-1	Sacramento Metropolitan Air Quality Management District	Letter	Air Quality	The Corps has updated the EIS/EIR to reflect that on-road haul trucks will comply with 2010 standards.
S-2	Sacramento Metropolitan Air Quality Management District	Letter	Air Quality	Concur. The Corps will update the air quality emission calculations to include the differences between Alternatives 1 and 2.
S-3	Sacramento Metropolitan Air Quality Management District	Letter	Air Quality	Concur. This mitigation measure has been removed from the EIS/EIR.
S-4	Sacramento Metropolitan Air Quality Management District	Letter	Air Quality	Concur. The Corps has updated the Air Quality section to clarify that the required mitigation for off-road equipment would be the SMAQMD enhanced exhaust controls. However, the Corps will encourage their contractors to use Tier 4 equipment as well to further reduce emissions.
S-5	Sacramento Metropolitan Air Quality Management District	Letter	Climate Change	Concur. The final EIS/EIR will include language acknowledging SMAQMD GHG thresholds for use in supplemental analyses.
S-6	Sacramento Metropolitan Air Quality Management District	Letter	Climate Change	Concur. The Corps revised the referenced GHG mitigation measure and significant threshold discussions in the final EIS/EIR to remove the 7,000 metric ton presumptive threshold.
S-7	Sacramento Metropolitan Air Quality Management District	Letter	Air Quality	Tables 1a and 1b have been added to Appendix D for the final EIS/EIR.
S-8	Sacramento Metropolitan Air Quality Management District	Letter	Air Quality	Concur. The Corps will ensure that all applicable SMAQMD rules are identified prior to and during construction.
T-1	State Lands Commission	Letter	Real Estate	The Corps will ensure that appropriate coordination occurs with SLC prior to construction.

T-2	State Lands Commission	Letter	Real Estate	Thank you for your comment and for notifying us up front. We will contact State Lands Commission if we have any questions.
T-3	State Lands Commission	Letter	Real Estate	Construction of the proposed project would not restrict or impede the easement rights of the public. Any in-water construction activities would occur on the bankside and would allow for recreation traffic to continue as normal.
T-4	State Lands Commission	Letter	EIS Revisions	Concur. This paragraph has been revised as requested.
T-5	State Lands Commission	Letter	Turbidity	Section 3.5.6 of the EIS/EIR includes specific mitigation measures to control sediment release during construction. Additional mitigation, as needed, may be coordinated with the CVRWQCB as a part of the Water Quality Certification process during the preconstruction engineering and design phase of the project.
T-6	State Lands Commission	Letter	Turbidity	The Corps proposes BMPs in Section 3.5 to reduce potential water quality effects, including turbidity. The proposed project will ensure that the Basin Plan turbidity standards are not exceeded during construction.
T-7	State Lands Commission	Letter	Cultural	In the event of a cultural resource discovery, the landowner would be notified. Due to the size and scope of the project, this includes many landowners, to include the State Lands Commission. As a result, the general term "landowner" is used throughout the documents. This process is described further in the PA.
T-8	State Lands Commission	Letter	Cultural	The MMRP documents the proposed mitigation associated with this project. The MMRP does not identify specific landowners or parcels, and rather focuses on general mitigation measures to be implemented throughout project construction. At this time, there is no proposed mitigation that the SLC is associated with, and therefore there is not an outlet to add language to the MMRP per this request. The Corps will coordinate with the SLC, as necessary, during the construction phase.
T-9	State Lands Commission	Letter	Cultural	Concur. In the event that cultural resources are discovered on California State Lands Commission lands during construction or any other phase of the project, the commission would be contacted.
T-10	State Lands Commission	Letter	Sea Level Rise	Concur. The Corps addressed Sea Level Rise in the final EIS/EIR in the Climate Change Section.
T-11	State Lands Commission	Letter	Sea Level Rise	Concur. Comment noted.
T-12	State Lands Commission	Letter	Contact	The Corps will ensure that all project related documents are provided to the State Lands Commission, as appropriate.
U-1	Kim Tremaine	Letter	Cultural Resources	Thank you for your comment. The Programmatic Agreement that has been executed for this project will guide future identification of potential historic properties to occur when design details are better known and prior to construction. The Corps is aware of the potential for subsurface sites and will employ a variety of methods, which are to be determined, to identify sites. Consideration of effects to historic properties will be completed through implementation of the PA (Stipulation III and IV). Further, the PA also includes procedures to follow in the event of the discovery of unknown historic properties (Stipulation IX).
V-1	Kim Tremaine	Letter	Geotech	The Corps is required to conduct a Probable Failure Mode Analysis, which is currently in progress through the Corps' Risk Management Center. The RMC is currently conducting the Probable Failure Mode Analysis, which corresponds with the Total Conditional Performance Analysis. This study will be completed prior to authorization of the project.
V-2	Kim Tremaine	Letter	Geotech	There is a significant amount of existing field data that was evaluated for the study. The data will be expanded as needed during PED. Additionally, the Folsom Dam Water Control Manual Update is conducting a channel stability assessment on the American River. In the design phase of the project, the design will be updated as appropriate to reflect the findings of the channel stability assessment. We are unaware of any "fine grained geophysical data" that leads us to a change in our conclusions, however if any data is found, we will incorporate this data during the design phase.

W-1	Delta Stewardship Council	Letter	Systemwide Evaluation/GRR	A wide variety of possible alternatives was considered, including features throughout the watershed, to find ways to reduce the flood risk to the City of Sacramento. USACE has developed a hydraulic model of the Sacramento River which allows us to analyze the effects of modifications to the flood management system. Because the levees surrounding the City are in such poor shape, the analysis showed that most effective plan to reduce the flood risk is to improve the existing levees. A setback levee is recommended for the north levee of the Sacramento Bypass which would approximately double it's floodplain area. The remainder of the levees are adjacent to urban development with little to no available land for a levee setback. The ongoing Central Valley Integrated Flood Management Study (CVIFMS) is a multi-purpose watershed study that is considering the larger, regional scale benefits associated with flood risk management, ecosystem restoration and other water resource related purposes.
W-2	Delta Stewardship Council	Letter	Risk Analysis/GRR	The ARCF GRR identifies the Federal interest in a flood risk management project, and is not constrained by, nor seeks to achieve FEMA levee accreditation standards and local laws such as SB-5. The extent that the recommended plan complies with FEMA and SB-5 standards is a determination required to be made by the non-federal sponsor.
W-3	Delta Stewardship Council	Letter	GRR/Coordination	The Project Delivery team (PDT) for the American River Common Features GRR is made up of staff from USACE as well as staff from the Department of Water Resources (DWR) and the Sacramento Area Flood Control Agency (SAFCA). During the development and evaluation of the alternative plans, weekly team meetings were held to coordinate information and report on the status of analysis. Part of this coordination included reports from the sponsors on activities they are involved in, including the Basin-wide feasibility study. Widening of the Sacramento Bypass was identified by the sponsors as a feature that would be consistent with and supportive of the goals of the Basinwide Feasibility Study.
W-4	Delta Stewardship Council	Letter	GRR/Variance	As detailed in Section 1.4.5 of the EIS/EIR, the Corps has conducted an analysis to determine the feasibility of acquiring a vegetation variance. The analysis determined that receipt of a variance is a reasonable assumption for the project and therefore all effects analyses assumed the variance is in place. If a variance is not granted by USACE HQ, then the Corps will conduct further NEPA/CEQA analysis at that time to analyze the effects of compliance with ETL 1110-2-583. The variance application process will be conducted following Congressional authorization during the preconstruction engineering and design phase of the project.
W-5	Delta Stewardship Council	Letter	Variance	As detailed in Section 1.4.5 of the EIS/EIR, the Corps has conducted an analysis to determine the feasibility of acquiring a vegetation variance. The analysis determined that receipt of a variance is a reasonable assumption for the project and therefore all effects analyses assumed the variance is in place. If a variance is not granted by USACE HQ, then the Corps will conduct further NEPA/CEQA analysis at that time to analyze the effects of compliance with ETL 1110-2-583. The variance application process will be conducted following Congressional authorization during the preconstruction engineering and design phase of the project.
W-6	Delta Stewardship Council	Letter	CVFIMS	Thank you for your comment. The Central Valley Integrated Flood Management Watershed Study (CVIFMS) will include an assessment of existing and future conditions of the Sacramento River watershed in order to develop recommendations for future actions that integrate co-equal objectives of long-term water supply, flood risk management, and ecosystem sustainability. Assessment of future conditions will include consideration of reasonably foreseeable future actions within the watershed and their effects to watershed resources and function.
W-7	Delta Stewardship Council	Letter	Alternatives	A wide variety of possible alternatives was considered to find ways to reduce the flood risk to the City of Sacramento. Because the levees surrounding the City are in such poor shape, the most effective plan to reduce that risk is to improve the existing levees in place. A setback levee is recommended for the Sacramento Bypass north levee which would approximately double the floodplain area. The remainder of the levees are adjacent to urban development with little to no available land for a levee setback. In areas along the river where bank protection is recommended, riparian vegetation can be maintained and expanded. There is also an opportunity to establish riparian vegetation in the widened portion of the Sacramento Bypass.

X-1	Delta Stewardship Council	Letter	Compliance	The Central Valley Flood Protection Board recognizes its obligations under the Delta Reform Act and the Delta Plan regulations, and the importance of the Delta's co-equal goals. The Board will promote the inclusion of the Delta Stewardship Council's recommendations into future project specific environmental analyses, and the lead agencies intend to initiate additional public involvement and agency coordination prior to project implementation.
X-2	Delta Stewardship Council	Letter	Risk Analysis	Results of the risk analyses are included in the GRR, which is a companion document to the EIS/EIR. The potential for downstream effects is addressed in Section 3.4 of the EIS/EIR and the Hydraulic Appendix to the GRR.
X-3	Delta Stewardship Council	Letter	O&M	The Corps typically updates the O&M Manual during the construction phase of the project. General O&M activities are discussed in the draft EIS/EIR in Section 2.3.4. The Corps reviewed the resource sections to ensure that the effects of these activities are analyzed throughout the document. The existing O&M Manual is available upon request from the Corps.
X-4	Delta Stewardship Council	Letter	Variance	As detailed in Section 1.4.5 of the EIS/EIR, the Corps has conducted an analysis to determine the feasibility of acquiring a vegetation variance. The analysis determined that receipt of a variance is a reasonable assumption for the project and therefore all effects analyses assumed the variance is in place. If a variance is not granted by USACE HQ, then the Corps will conduct further NEPA/CEQA analysis at that time to analyze the effects of compliance with ETL 1110-2-583. The variance application process will be conducted following Congressional authorization during the preconstruction engineering and design phase of the project.
X-5	Delta Stewardship Council	Letter	Mitigation	The Corps will mitigate on-site to the maximum extent feasible. Any off-site mitigation is required to be as close to the impact area as possible. The Corps will strive to mitigate on the same waterway when possible, but for some impacts onsite mitigation is not possible and would be compensated through the purchase of mitigation bank credits.
X-6	Delta Stewardship Council	Letter	Variance	As detailed in Section 1.4.5 of the EIS/EIR, the Corps has conducted an analysis to determine the feasibility of acquiring a vegetation variance. The analysis determined that receipt of a variance is a reasonable assumption for the project and therefore all effects analyses assumed the variance is in place. If a variance is not granted by USACE HQ, then the Corps will conduct further NEPA/CEQA analysis at that time to analyze the effects of compliance with ETL 1110-2-583. The variance application process will be conducted following Congressional authorization during the preconstruction engineering and design phase of the project.
X-7	Delta Stewardship Council	Letter	Alternatives	The proposed bank protection measure on the American and Sacramento Rivers allow for opportunity to restore and improve SRA habitat in most reaches of the study area. Through ongoing coordination under the Sacramento River Bank Protection Project, the Corps and NMFS have developed a number of options for self-mitigating bank protection sites that include mitigative features that restore SRA habitat. Additionally, mature trees are proposed to remain in place on the lower waterside levees, to protect existing SRA whenever possible. More information about these measures are included in the Mitigation and Monitoring Plan and Biological Opinion, both of which are appended to the EIS/EIR.
X-8	Delta Stewardship Council	Letter	Invasive Species	The Fisheries section has been updated to include analysis of predation at bank protection sites.
X-9	Delta Stewardship Council	Letter	Invasive Species	The Corps has updated the EIS/EIR to include analysis of invasive species and measures to be implemented during construction to manage these species. These measures will be included in the mitigation and monitoring plan, as well as the project's plans and specs prior to construction. No separate invasive species plan has been developed at this time.
X-10	Delta Stewardship Council	Letter	Adaptive Management	An adaptive management plan was developed for the project and included as part of the Mitigation Monitoring Plan, which is appended to the EIS/EIR.
X-11	Delta Stewardship Council	Letter	Delta Plan	The Corps has added language to the environmental setting of the EIS/EIR acknowledging the project's relationship to the Delta Plan and discussing any inconsistencies between the documents.

Y-1	Delta Protection Commission	Letter	Environmental Effects	During the design phase of the project, following Congressional authorization, the Corps and its local partners intend to look at the proposed measures on a site-by-site basis in an attempt to minimize impacts from those described within this effects analysis, as appropriate.
Y-2	Delta Protection Commission	Letter	Recreation	Comment noted. The Corps does not propose to construct new bike trails under the recommended plan.
Z-1	Metropolitan Water District of Southern California	Letter	Project Design/Water Control Manual	Thank you for your comment. Your consideration for habitat restoration opportunities within the Yolo Bypass is noted. The ARCF study used a conservative characterization of future flood management operations at Folsom Dam assuming the Joint Federal Project (JFP) is complete. The Folsom Dam future operations reflected in the ARCF study are based on the operations identified in the Folsom Dam Modification and Folsom Dam Raise Projects PACR (2007). The purpose of the Folsom Dam and Lake Water Control Manual Update (WCM Update) is to carry out a more detailed analysis of how to revise operation rules for Folsom Dam to reduce flood risk based on the capabilities of the JFP, to reflect operation capabilities created by improved weather forecasts, and to potentially reduce the volume of flood control reservation in Folsom Lake at any particular time in comparison to the operations that have been in effect since 1995. Any proposed refinements to operation rules at Folsom identified in the WCM Update are being evaluated on their effectiveness in meeting the flood risk management objectives as well as on their effects to the other project purposes of Folsom Dam. Those other project purposes are: water supply (agricultural and M&I), hydropower, water quality, sustain fish and wildlife resources, and recreation. The WCM Update is evaluating potential effects to these other project purposes on a local and regional basis. Because Folsom Dam and Lake is a key facility in the Central Valley Project, the WCM Update is utilizing the CalSim II model and outputs to measure effects within the larger CVP/SWP system. Along the lower American River and beyond its confluence with the Sacramento River, the WCM Update will be evaluating resource effects to a greater level of detail, utilizing HEC ResSim and RAS models and output to measure changes in flow frequency, duration, rate, and stage, among other variables, on a sub-monthly timestep. The expectation of the WCM Update is that, through an iterative modeling process, operation rules at Folsom Dam will be refined to be able to not only meet the flood risk management objectives of the JFP, but to also minimize, avoid, or possibly provide incidental beneficial effects to the other Folsom Dam project purposes. Results of the WCM Update will be used to better-inform the detailed design of the ARCF selected plan.
AA-1	U.S. Environmental Protection Agency	Letter	HTRW	The local sponsors are required to acquire all necessary lands and easements to facilitate the project. Lands acquired for the project must be free of contamination. As a result, they would be required to ensure that the appropriate parties remediate the landfill prior to providing the lands to the Corps for project implementation. As a result, the landfill remediation is not considered to be a part of the proposed action. Any environmental compliance activities associated with the remediation would be the responsibility of the entity conducting the remediation of the site.
AA-2	U.S. Environmental Protection Agency	Letter	Air Quality	The Air Quality analysis in Section 3.11 has been reevaluated to confirm that currently the proposed project is not exceeding de minimus thresholds.. As a result, a Conformity Analysis is not required at this time. During the design phase of the project, the project will be refined on a site-specific analysis, and if these adjustments result in exceedance of de minimus thresholds, coordination with the EPA will occur, as required.
AA-3	U.S. Environmental Protection Agency	Letter	Air Quality	The measures and assumptions that were factored into the emissions estimates are described in Section 3.11.2 under "Methodology", and are also detailed in the Air Quality Appendix.
AA-4	U.S. Environmental Protection Agency	Letter	Air Quality	The Corps is responsible for ensuring that all commitments in the EIS/EIR are implemented during construction. Additionally, the construction contractor is required to coordinate directly with SMAQMD during construction to ensure that they are meeting required air quality commitments.

AA-5	U.S. Environmental Protection Agency	Letter	Air Quality	Emissions estimates in the final EIS/EIR do not exceed de minimus thresholds. The Corps is including proposed mitigation in order to further reduce these emissions beyond the estimates provided. A draft conformity determination is not required, since estimated emissions do not exceed de minimus thresholds. If at the time of site-specific design prior to construction, further air quality estimates do exceed de minimus thresholds, then the Corps would consult with the EPA, as required, and prepare a draft conformity determination at that time.
AA-6	U.S. Environmental Protection Agency	Letter	Air Quality	Thank you for your comment. The Corps intends to push for reductions through the use of higher tiered equipment during construction.
AA-7	U.S. Environmental Protection Agency	Letter	Air Quality	Thank you for pointing the errors out. We have fixed these as requested for the final EIS/EIR.
AA-8	U.S. Environmental Protection Agency	Letter	SB5	The State has established a standard for urban flood protection in California which applies to cities with populations greater than 10,000 inhabitants. This standard requires levees to withstand flows with a top elevation equal to the mean 200-year water surface profile, plus three feet of freeboard, plus an allowance for wave run-up, plus one foot to account for climate change. USACE does not identify a target level of risk reduction but rather identifies the plan which reasonably maximizes net benefits. The analysis to identify the plan which maximizes net benefits was done with an awareness of the State's goal for urban flood protection for the purpose of informing the State of where the individual plans fall with regards to the State's standards. Neither of the final alternatives is currently able to contain a 1/200 ACE event with 90% assurance. The levee improvements along the Sacramento River will increase the assurance to a level close to 90% but the assurance for the levees along the American River will remain low for the 1/200 ACE. It will be contingent upon the local community to prove to the State that the aggregate flood risk management projects meet the State's standard. The EIS/EIR has been updated to reflect this.
AA-9	U.S. Environmental Protection Agency	Letter	O&M	This reference from the EIS/EIR was in error. Operation of the Sacramento Weir and Bypass would not be deferred until after construction is complete. General assumptions on the future operation of the Sacramento Weir and Bypass are included in Chapter 2 of the final EIS/EIR, however these assumptions will be refined during the preconstruction engineering and design phase of the project. Page 102 of the EIS/EIR has been updated to address this error.
AA-10	U.S. Environmental Protection Agency	Letter	Wetlands	The final EIS will include a mitigation and monitoring plan that will include plans for future mitigation/compensation sites. Wetland delineations will not be completed until the design phase of the project to allow for potentially changing conditions between the study phase and construction of the proposed project.
AA-11	U.S. Environmental Protection Agency	Letter	Climate Change	Section 3.12 has been updated to reflect the CEQ draft guidance and to ensure that it is clearly stated that all GHGs contribute to climate change.
BB-1	Central Valley Regional Water Quality Control Board	Letter	Construction Permits	The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction. A SWPPP would be prepared prior to construction.
BB-2	Central Valley Regional Water Quality Control Board	Letter	Construction Permits	The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction.
BB-3	Central Valley Regional Water Quality Control Board	Letter	Construction Permits	The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction. The Corps would ensure that project construction complies with the regulations contained in the permits.
BB-4	Central Valley Regional Water Quality Control Board	Letter	Construction Permits	The Corps does not issue a permit to itself. However, the Corps will ensure that the project complies with the substantive requirements of Section 404 through the preparation of a Section 404(b)(1) analysis, which is included with the EIS/EIR as Appendix E.

BB-6	Central Valley Regional Water Quality Control Board	Letter	Construction Permits	The Corps will ensure that prior to initiation of construction, a Section 401 Water Quality Certification is obtained, as necessary, for impacts to waters of the U.S.
BB-7	Central Valley Regional Water Quality Control Board	Letter	Construction Permits	The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction.
BB-8	Central Valley Regional Water Quality Control Board	Letter	Construction Permits	The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction.
BB-9	Central Valley Regional Water Quality Control Board	Letter	Construction Permits	The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction.
CC-1	Sacramento Regional County Sanitation District	Letter	Utilities	The Corps will coordinate with SRCSD during the design phase of the project, as appropriate.
DD-1	Joseph O'Connor	Letter	Mayhew Levee Project	The Corps looked at seven alternatives that would have extended the Mayhew levee upstream to high ground. These alternatives were not cost efficient due to the required real estate acquisition costs, and there would be mitigation required for the removal of trees. The local sponsor was not willing to partner in any of these alternatives. Therefore, the Mayhew Plug was the selected alternative, because it provided most of the 200-year level of flood protection for the least cost, and required no mitigation. Additional work in order to complete the last 4-6 inch tie-in would require the removal of a private fence, the removal of a large (heritage) tree and three smaller trees, and approximately 20 cubic yards of soil to be imported and compacted on private property. Due to the rare frequency that a flood event would reach this elevation, the additional effort and expense required for closing this minimal deficit in the levee height is not cost effective. It should be noted that the height of the levee in this location is almost three feet above the 200-year design water surface elevation, even with the reduced levee height at that location. Should a flood event occur that reaches the top of the plug, sandbagging would be required to close this gap.
EE-1	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	Additions per the below comments have been incorporated.
EE-2	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	The Corps is committed to implementing all proposed mitigation measures as listed at the end of each resource section during the construction phase of the project.
EE-3	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design Phase	During PED, a more substantial site specific design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-4	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	Additional clarifying language was added regarding balancing the risk between additional flow being released causing further distress of the levee versus the risk of a dam failure.

EE-5	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	The cited Bureau and DWR reports were cited to provide additional background on the history of Folsom.
EE-6	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	The levees have had an established emergency condition of 152,000 cfs since completion of the north levee on the American River in 1957. The 160,000 cfs condition was added to the Folsom water control manual after 1986. Language to this effect has been added.
EE-7	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	Some clarifying language was added. However, the stage in Folsom was in the surcharge pool which mandates emergency operations to avoid dam failure.
EE-8	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	Concur that it is a State standard and State defined criteria. The ARCF GRR project documents do not state that performance should be determined through Corps criteria.
EE-9	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	Modeling developed for the Sacramento and San Joaquin River Basin Comprehensive Study showed that substantially more flow reached the combination of the Yolo Bypass and Sacramento River just downstream of Fremont Weir these waterways were designed to convey. However, the language was revised to conform with past published accountings of this event.
EE-10	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	Language in this section was modified. Geotechnical problems were also cited as leading to the levee failures that occurred.
EE-11	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	An additional statement about the PMF was added to this section. The Corps concurs that the purpose of the project is to pass certain magnitude flood flows downstream without levee failure, but the influence of Folsom and the JFP is important to identify the problems affecting the study area.
EE-12	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	Eyewitness verbal accounts cite that there was less than a foot of freeboard during the 134,000 cfs release in certain reaches of the American River. However, the sentence was rewritten to state that during the 1986 event, the design freeboard was encroached upon risking the potential of overtopping.
EE-13	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Velocities/Erosion	Chapter 2.3.1 of the GRR and Section 3.4 of the EIS/EIR have been updated to show a range of velocity conditions for justification of the erosion protection.
EE-14	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Constraints	The GRR will be compliant with all applicable laws and statues, including the Wild and Scenic Rivers Act, which is discussed throughout the GRR's companion document, the EIS/EIR. Compliance with law and policy is assumed in every study. Planning Constraints are project specific items that are not addressed by either law or policy that would limit planning efforts in some way. At this time, no other planning constraints have been identified beyond the restriction of additional bird habitat near the Sacramento International Airport.

EE-15	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Folsom Dam Operations/ Water Control Manual	The ARCF study used a conservative characterization of future flood management operations at Folsom Dam assuming the Joint Federal Project (JFP) is complete. The Folsom Dam future operations reflected in the ARCF study are based on the operations identified in the Folsom Dam Modification and Folsom Dam Raise Projects PACR (2007). The purpose of the Folsom Dam and Lake Water Control Manual Update (WCM Update) is to carry out a more detailed analysis of how to revise operation rules for Folsom Dam to reduce flood risk based on the capabilities of the JFP, to reflect operation capabilities created by improved weather forecasts, and to potentially reduce the volume of flood control reservation in Folsom Lake at any particular time in comparison to the operations that have been in effect since 1995. Any proposed refinements to operation rules at Folsom identified in the WCM Update are being evaluated on their effectiveness in meeting the flood risk management objectives as well as on their effects to the other project purposes of Folsom Dam. Those other project purposes are: water supply (agricultural and M&I), hydropower, water quality, sustain fish and wildlife resources, and recreation. The WCM Update is evaluating potential effects to these other project purposes on a local and regional basis. Because Folsom Dam and Lake is a key facility in the Central Valley Project, the WCM Update is utilizing the CalSim II model and outputs to measure effects within the larger CVP/SWP system. Along the lower American River and beyond its confluence with the Sacramento River, the WCM Update will be evaluating resource effects to a greater level of detail, utilizing HEC ResSim and RAS models and output to measure changes in flow frequency, duration, rate, and stage, among other variables, on a sub-monthly timestep. The expectation of the WCM Update is that, through an iterative modeling process, operation rules at Folsom Dam will be refined to be able to not only meet the flood risk management objectives of the JFP, but to also minimize, avoid, or possibly provide incidental beneficial effects to the other Folsom Dam project purposes. Results of the WCM Update will be used to better-inform the detailed design of the ARCF selected plan.
EE-16	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Auburn Dam	The assumptions regarding Auburn Dam as discussed in the GRR were based on the Corps' 1996 Supplemental Information Report. Further studies by other agencies have occurred, however, those agencies have analyzed the dam based on other project purposes such as water supply and hydropower. The purpose of the ARCF GRR is Flood Risk Management, and, therefore, the 1996 SIR was adequate for the purposes of this study.
EE-17	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	The two largest floods on record are 1986 and 1997 which are post hydrologic design of all the reservoirs in the system. This is not the main driver on why reoperation of upstream reservoirs was screened out but is part of the story. Location plays a key part and the presence of many unregulated water courses entering the Sac River system. Clarifying text was added to this section.
EE-18	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	A statement was added citing the 1991 study for further information on why the alternative was screened.
EE-19	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project History	The design of the overall Sacramento River Flood Control Project was based on historic floods (1907, 1909, and 1927 for the most part). On many segments of river throughout the Sacramento Valley, flows experienced in 1955, 1964, 1986, and 1997 exceeded the design of those reaches. A clarifying statement was added to section 3-6.
EE-20	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Comment noted.

EE-21	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Alternatives	Concur. Table 3-6 in the GRR has been modified to reflect that the Maximum Plan does not meet the acceptability criteria.
EE-22	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Alternatives	The added uncertainty for large events beyond the 200-Year event are included in the larger range of Folsom Releases described in the Hydrologic Appendix to the GRR.
EE-23	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	WRRDA 2014 Section 3013 requires a review of the levee vegetation policy. The review is still in progress, therefore no new policies have been established at this time and the Corps is making no assumptions about what the policy will consist of. However, WRRDA 2014 Section 3013(g)(1) also requires that vegetation removal not be a condition or requirement for the approval of funding of a project or any other action, unless the specific vegetation has been demonstrated to present an unacceptable safety risk. In line with this provision, under the ARCF GRR a study was conducted to determine the acceptability of the safety risk associated with the vegetation on the levees in the study area. This study is described in Section 1.4.5 of the draft EIS/EIR. The study resulted in a determination that it was an acceptable assumption that a variance to the vegetation policy is appropriate under this study, and therefore waterside vegetation can remain on the levees. Additionally, the sponsor has sent the Corps a Letter of Intent to apply for a SWIF for the levees in the study area. The combination of the SWIF and the variance allows the Corps to leave all vegetation outside of the construction footprint in place. As a result, the project is in compliance with Section 3013(g)(1), because compliance with the vegetation policy is not a factor in funding or approving the ARCF GRR. The presence of wildflowers and native grasses on the levees is not in conflict the ETL. The Corps is supportive of the presence of California's State flower on our levee slopes!
EE-24	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project Design	USACE coordinated with the Lower American River Task Force during the previous design and construction of flood risk reduction features in the parkway. This effort resulted in successful implementation of these features and USACE welcomes the opportunity to work together again with the Task Force on this next generation of flood risk reduction features.
EE-25	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Sacramento Weir Operations	The operation of the new Sacramento Weir would be refined during the design and construction phase in conjunction with the project sponsors and the operators of the facility. This refinement would take in consideration other regional efforts to reduce flood risk and optimize the operation of the weir in light of these efforts.
EE-26	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	The project will comply with the Wild and Scenic Rivers Act. The EIS/EIR has been updated to include further discussion of this law and potential effects to the values under which the American River is regulated under this Act.
EE-27	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Compliance	The GRR will be compliant with all applicable laws and statues, including the Wild and Scenic Rivers Act and WRRDA 2014.
EE-28	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Geologic Resources	Further discussion of liquefaction potential is included in the Geotechnical Appendix (Appendix C, Attachment C) to the GRR.

EE-29	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Editorial	Concur. Edits have been made to the EIS/EIR accordingly.
EE-30	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Parkway Plan	Citations have been added to the EIS/EIR to quote, reference, and indicate compliance with the American River Parkway Plan.
EE-31	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project Design	The ARCF GRR is being planned using principles the Corps' SMART Planning initiative, as required by Section 1001 of WRRDA 2014. As a result, the planning phase relied heavily on existing information to drive the decision making process due to the size of the study area and the scope of the project. Under this process it was not possible to conduct site-specific analysis during the planning phase. These analyses will occur during the preconstruction design phase to confirm the assumptions that drove the planning phase.
EE-32	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The Corps concurs that the vegetation and aesthetic resources of the Parkway should not be unnecessarily sacrificed. The ARCF GRR is a public safety project and all measures proposed are to reduce the risk of life loss and damages from a catastrophic flood event. Additionally, the effects analyzed in the EIS/EIR are a worst-case scenario based on a maximum footprint. In the preconstruction engineering and design phase of the project, the Corps will conduct site-specific analysis to refine the proposed construction footprint and anticipates that there is a strong possibility of minimizing the effects that are disclosed in this study.
EE-33	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Regulatory Setting	The State and Federal Wild and Scenic Rivers Acts were added to the Regulatory Setting. The National Park Service provided comments on the draft EIS/EIR and the Corps is addressing their concerns in this final EIS/EIR. Further coordination with the National Park Service will occur throughout the design phase of the project.
EE-34	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project Area	Thank you for your comment. The ARN and ARS basins and the levee reaches described in the study documents are defined based on existing conditions and not historic (pre-leveed) conditions.
EE-35	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The ARCF GRR used a conservative characterization of future flood management operations at Folsom Dam assuming the JFP auxiliary spillway and control structure are complete. The Folsom Dam future operations reflected in the ARCF GRR are based on the operations identified in the Folsom Dam Modification and Folsom Dam Raise Projects Post Authorization Change Report (2007) (JFP PACR).
EE-36	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The operation of the Sacramento Weir is currently based on the gauge at the I Street Bridge. Operations will be refined during the design and construction phase in conjunction with the project sponsors and the operators of the facility. This refinement would take in consideration other regional efforts to reduce flood risk and optimize the operation of the weir in light of these efforts.
EE-37	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Editorial	Thank you for pointing the error out. We have fixed this for the final EIS/EIR.
EE-38	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The Corps is committed to reducing impacts to the maximum extent possible during the design phase. The impacts presented in this EIS/EIR were intended to be a worst-case scenario. When site-specific analysis is conducted during the design phase, we expect to be able to minimize impacts from those presented in this document.

EE-39	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Erosion	Independent External Peer Review was conducted on the feasibility report and its technical appendices including the erosion assumptions. Additionally, a 60-day public review period occurred and allowed for external review of the proposed alternatives. The Corps of Engineers is committed to working with stakeholders during the design and construction process. Previous bank protection constructed working with the Lower American River Task Force is a good example that the Corps is supportive of using as a working model.
EE-40	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Regulatory Setting	The State and Federal Wild and Scenic Rivers Acts were added to the Regulatory Settings.
EE-41	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Under the ARCF GRR a study was conducted to determine the acceptability of the safety risk associated with the vegetation on the levees in the study area. This study is described in Section 1.4.5 of the draft EIS/EIR. The study resulted in a determination that it was an acceptable assumption that a variance to the vegetation policy is appropriate under this study, and therefore waterside vegetation can remain on the levees. Additionally, the sponsor has sent the Corps a Letter of Intent to apply for a SWIF for the levees in the study area. The combination of the SWIF and the variance allows the Corps to leave all vegetation outside of the construction footprint in place. As a result, the project is in compliance with WRRDA 2014 Section 3013(g)(1), because compliance with the vegetation policy is not a factor in funding or approving the ARCF GRR. While the SWIF does assume long-term compliance with the current ETL policies, it also allows for flexibility in adjusting to any change in vegetation policies that may occur.
EE-42	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Compliance	The National Park Service was added to the list of agencies that the Corps is coordinating with on this project.
EE-43	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Cumulative Effects	Concur. Changes in the BDCP were announced after public release of this EIS/EIR. The description of the BDCP has been updated for the final EIS/EIR.
EE-44	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation Impacts	The Corps is committed to reducing impacts to the maximum extent possible during the design phase. The impacts presented in this EIS/EIR were intended to be a worst-case scenario. When site-specific analysis is conducted during the design phase, we expect to be able to minimize impacts from those presented in this document.
EE-45	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	While this comparison may be helpful, the project features are based on a design flow of 160,000 cfs not necessarily a frequency or historical based event. Also, this comparison is best conducted under that Folsom Water Control Manual Update. The Water Control Manual EIS/EIR is tentatively scheduled for release in summer 2016.
EE-46	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Comments	All comments submitted are addressed in this appendix as part of the public review process.
EE-47	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	American River proposed measures would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.

EE-48	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
EE-49	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Editorial	The uncertainty in this statement is primarily related to how much erosion would occur, and how much bank would be lost in a single event. As stated in the No Action Alternative, because we cannot predict when and how large events will occur it would be speculative to assume at which time the berms will erode.
EE-50	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Filling in eroded portions of the bank would be necessary in cases where the bank has eroded away and could potentially undermine the levee foundation. This condition is more typical on the Sacramento River than the American River because there is less berm between the waterway and the levee.
EE-51	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Typically when we are referring to large vegetation vs small vegetation we are referring to trees versus shrubs or grasses.
EE-52	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Site specific designs for erosion protection will be completed in the design phase of this study, including any necessary hydraulic design of the bank protection sites.
EE-53	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The Corps will plant new trees as part of self-mitigating features on bank protection sites. New trees could be planted over time if the sites are not meeting their restoration criteria during the monitoring period, as established in the Mitigation and Monitoring Plan. Once the monitoring period has concluded, natural lifecycle processes are expected to occur.
EE-54	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Trees left in place are not expected to die. The Corps has been protecting trees in place as part of bank protection construction under the Sacramento River Bank Protection Project and the trees at these sites have had successful survival rates over the last decade.
EE-55	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The proposed project only impacts vegetation in the construction footprint, and proposes to protect existing trees in place whenever possible. Additionally, all trees removed from the construction footprint would be compensated for, in the case of the Parkway, on-site to the maximum extent practicable. As a result, while there would be a significant short term impact from vegetation removal, long-term vegetation in the parkway is expected to recover. As a result of these proposed measures, the conclusions presented in the draft EIS/EIR are appropriate.
EE-56	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Access ramps may not be needed in cases when there are already existing ramps developed that could be used during construction.
EE-57	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	A large berm made of large rocks. See Engineering Appendix for more details on the size and scope of the bank protection design.

EE-58	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Concur. The Corps will update figure 1 to ensure that the planting berm is shown.
EE-59	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Editorial	Thank you for pointing the error out. We have fixed this for the final EIS/EIR.
EE-60	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Editorial	Concur. The Corps has updated Figure 1 to ensure that the planting berm is shown.
EE-61	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	A design objective for the launchable rock trench was to reduce the launch distance and increase the reliability of the design. The proposed placement near bottom of the vadose zone does this and helps to reduce the overall rock quantity needed for this design.
EE-62	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The trench design will have soil placed with rock, however, it will not be thoroughly mixed due to the adverse affects to launching capability. Additionally, a geotextile wrap around the trench is proposed to limit the infiltration of soil into rock voids. Aspects to design features such as these will be refined in PED phase.
EE-63	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Excess fill that could not be used for project features would become available for borrow site mitigation or infill purposes at other restoration sites. Future coordination would be performed during PED phase.
EE-64	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Shrubs would be considered appropriate if it does not put undue burden on maintaining agencies, and if it is in locations that do not interfere with channel conveyance capacity.
EE-65	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The trench areas do have limitations as noted, however, they still offer an opportunity to partially/fully mitigate impacts. More specific analysis and coordination with maintenance agencies will be performed during PED phase to determine the mitigation capabilities of these sites.
EE-66	Friends of the River, Habitat 2020, and Save the American River Association	Letter	No Action	Yes, the No Action Alternative is based on past experience and is a forecast of what could transpire with large magnitude flood events.
EE-67	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The trench width is a function of existing topography, trench slopes, depth, and quantity of launchable rock. These aspects of the design will be analyzed in more detail within PED phase. For the purposes of this study and description of impacts, the 70 feet trench width, is considered to be conservative when applied to the extents shown in plates 3 and 4.
EE-68	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The acreage of impact was based on the construction footprint, including some additional areas like ramps and roads in the vegetation and wildlife section. Staging areas have not been determined at this time, because of the potential for changing conditions between this study and the implementation of the project, therefore this acreage was not included in current project estimates. Following authorization when site-specific design occurs, staging areas will be determined and if the impacts associated with those staging areas increase the environmental impacts disclosed in this EIS/EIR, then supplemental NEPA analysis would occur.

EE-69	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	For launchable rock trench, vegetation can not be deep rooted so that it does not interfere with the deployment (launching) of rock, plus, any vegetation other than grass and small shrubs needs to be placed 15 feet or more away from the waterside toe. Within the American River Parkway, this construction area is a very small percentage of the total area. On-site mitigation will be implemented to the maximum extent practicable.
EE-70	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The Corps anticipates restoring riparian vegetation both on and offsite, depending on site conditions and mitigation requirements. Plant establishment takes time. Typically most mitigation sites require up to 10 years of monitoring to ensure establishment that meets the restoration metrics established in the mitigation and monitoring plan. If sites are not meeting those criteria, they could require replanting, which could extend the establishment period. The only option for immediate mitigation/compensation would be purchasing credits at an off-site mitigation bank, which is an option being considered for some of the mitigation associated with the ARCF GRR.
EE-71	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-72	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Land Use	There is no permanent conversion of Parkway lands associated with the ARCF GRR. It is anticipated that all of the proposed erosion protection sites within the Parkway would remain a part of the Parkway, and would continue to be used by the public. This discussion regarding mitigation for permanent loss of Parkway lands has been removed from the final EIS/EIR.
EE-73	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Modeling results are a summarization of a Sacramento Bank Protection Regional Sediment Study. This is a challenging issue. In general, in the absence of bedrock or other erosion resistant materials, the LAR is degradational in nature down to about RM 4. Downstream of this location, the river is slightly aggradational. The erosion resistant layer has only been mapped between river miles 5.5 and 11.5 (approximate RM's). The vertical location of the resistant layer is unknown for the remainder of the river below Nimbus Dam. Despite the general trends, zones of local aggradation and degradation are observed to occur in both the prototype river channel as well as in numerical modeling simulations (e.g., HEC-6T). In the zone where the erosion resistant layer has been identified, it appears that continued wholesale lowering of the channel thalweg is unlikely; however, other portions of the channel cross section (e.g., channel terraces or berms) may continue to degrade over time.
EE-74	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The degradation analysis report did look at nick points developing into full head cuts that would move upstream and jeopardize levee stability. This study found that the only place that this was somewhat probable was in the vicinity of the Guy West bridge. That is the reason that study only recommended grade control in that vicinity. Further site specific design in PED will relook at this, likely in consultation with local stakeholder groups.
EE-75	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Draft results for the long-term simulation indicate that about 263,000 cy would be eroded for the without-project condition during the period simulated. For the without-project conditions, a volume of 304,000 cy would be eroded along the 22-mile study reach of the American River.

EE-76	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	When sediment is mobilized from along the American River or other rivers, it washes downstream. Ultimately, this sediment finds its way to the Suisun, San Pablo, and San Francisco Bay and ultimately to the Pacific Ocean.
EE-77	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Considerable sea level rise would be required to significantly impact the sediment transport ability of the reach of river in question. There are conditions where high stage on the Sacramento River causes backwater effects on the American River in the RM 5-7 stretch, but then there are other conditions where the backwater effect is not present but there are still significant flows coming down the American River causing higher rates of sediment transport including in the RM 5-7 range. Significant sea level rise would need to occur before the sediment transport capability of this reach of river would greatly reduce. However, this will be further studied in PED in consultation with local stakeholder groups.
EE-78	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	It is possible that if these rates of degradation are experienced, that hydraulic mining debris has been exhausted, but it does not have to occur that way. If this amount of degradation occurs, it will likely be because a nick point turns into a full head cut that moves upstream. This will further be analyzed however in PED in consultation with local stakeholder groups.
EE-79	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	We concur that naturally, upstream of RM 8 it is not a braided channel. But, artificially, because of the multiple channels associated with historic gravel mining, upstream of RM 8, sediment transport occurs as if it were a braided channel, which is why it is characterized this way. Further analysis in PED will address this further, likely in consultation with local stakeholder groups.
EE-80	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	In general, in the absence of bedrock or other erosion resistant materials, the American River is degradational in nature down to about River Mile 4. Downstream of this location, the river is slightly aggradational. The conclusions are not contradicting, but are referring to different reaches of the river. The erosion resistant layer has only been mapped between approximately River Miles 5.5 and 11.5. The vertical location of the resistant layer is unknown for the remainder of the river below Nimbus Dam. Despite the general trends, zones of local aggradation and degradation are observed to occur in both the prototype river channel as well as in numerical modeling simulations (e.g., HEC-6T). In the zone where the erosion resistant layer has been identified, it appears that continued wholesale lowering of the channel thalweg is unlikely; however, other portions of the channel cross section (e.g., channel terraces or berms) may continue to degrade over time.
EE-81	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Reference to RM 9.0R was only made as an example of where erosion is actively occurring, even at low discharges such as 7,000 cfs. The concern regarding the erosive trends in the LAR are not predicated on just this one location. A review of the performance of the LAR channel with regards to erosion reveals that multiple locations of the channel have experienced damaging erosion and have required repair following significant discharge event. The GRR and Section 3.4 of the EIS/EIR have been updated to show a comparison of erosion conditions in the channel at both the narrow RM 9 reach, and other lower velocity reaches.
EE-82	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Reference to RM 9.0R was only made as an example of where erosion is actively occurring, even at low discharges such as 7,000 cfs. The concern regarding the erosive trends in the LAR are not predicated on just this one location. A review of the performance of the LAR channel with regards to erosion reveals that multiple locations of the channel have experienced damaging erosion and have required repair following significant discharge event. The GRR and Section 3.4 of the EIS/EIR have been updated to show a comparison of erosion conditions in the channel at both the narrow RM 9 reach, and other lower velocity reaches.
EE-83	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Reference to RM 9.0R was only made as an example of where erosion is actively occurring, even at low discharges such as 7,000 cfs. The concern regarding the erosive trends in the LAR are not predicated on just this one location. A review of the performance of the LAR channel with regards to erosion reveals that multiple locations of the channel have experienced damaging erosion and have required repair following significant discharge event. The GRR and Section 3.4 of the EIS/EIR have been updated to show a comparison of erosion conditions in the channel at both the narrow RM 9 reach, and other lower velocity reaches.

EE-84	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Given the magnitudes of local shear and velocity along portions of the lower American River banks makes bio-engineering or other soft approaches for providing bank protection very challenging. Nonetheless, site specific designs for bank and erosion protection will be developed in the design phase of the study. As part of the Folsom Water Control Manual, additional Channel Stability Analyses are being conducted to further refine the designs.
EE-85	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	It is possible that sewer main undercrossing is contributing to the erosion concerns at RM 7. However, looking at the Ayres' velocity plots - the velocity at this location is high enough to be of concern with or without the sewer main undercrossing. Site specific designs for erosion protection will be completed in the design phase of this study and the sewer main undercrossing will be evaluated.
EE-86	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	It is possible that sewer main undercrossing is contributing to the erosion concerns at RM 7. However, looking at the Ayres' velocity plots - the velocity at this location is high enough to be of concern with or without the sewer main undercrossing. Site specific designs for erosion protection will be completed in the design phase of this study known as Preconstruction, Engineering and Design (PED) and the sewer main undercrossing will be evaluated. Given the magnitudes of local shear and velocity along portions of the lower American River banks makes bio-engineering or other soft approaches for providing bank protection very challenging. Nonetheless, site specific designs for bank and erosion protection will be developed in the next phase of the study (PED Phase). As part of the Folsom Water Control Manual, additional Channel Stability Analyses are being conducted to further refine the designs.
EE-87	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Concur, this text has been removed and the section has been reassessed.
EE-88	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The text has been revised to clarify that the discussion refers to surface runoff conditions, which are not expected to be impacted by implementation of the project. Erosion conditions will be addressed by the proposed measures.
EE-89	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	For the purposes of this study, the project features were designed with a flow of 160,000 cfs which is currently estimated to be a 200-year event.
EE-90	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The ARCF GRR used a conservative characterization of future flood management operations at Folsom Dam assuming the JFP auxiliary spillway and control structure are complete. The Folsom Dam future operations reflected in the ARCF GRR are based on the operations identified in the Folsom Dam Modification and Folsom Dam Raise Projects Post Authorization Change Report (2007) (JFP PACR). Evaluation of how the flow regime has changed to get to the Spillway and Dam raise in place is being done under the Folsom Water Control Manual Update.
EE-91	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Manual Update	The Folsom Dam Water Control Manual Update Draft Supplemental EIS/EIR is tentatively scheduled for release in the summer of 2016.
EE-92	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Use of launchable rock results in a layer of rock which provides erosion protection if/when the rock is launched. The design ensures that sufficient volume of rock is available to provide protection and takes into consideration that the layer is formed, underwater, primarily by gravity. Given the size and depth of the LAR, the layer of "launched" rock would not significantly impact the hydraulic conditions.

EE-93	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Use of launchable rock results in a layer of rock which provides erosion protection if/when the rock is launched. The design ensures that sufficient volume of rock is available to provide protection and takes into consideration that the layer is formed, underwater, primarily by gravity. Given the size and depth of the LAR, the layer of "launched" rock would not significantly impact the hydraulic conditions.
EE-94	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Tree surveys were conducted using the Sacramento County standards for tree measurements. Tree survey data is contained within GIS shape files and is available upon request from the Corps.
EE-95	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Thank you for your comment. The assumption that natural environments can be easily disturbed by heavy use is a standard methodology applied to impact assessment.
EE-96	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Thank you for your comment. Special-status species in the study area, such as the valley elderberry longhorn beetle, benefit from habitat connectivity, which can be achieved through the restoration of larger natural areas. Smaller restoration areas can fragment the habitat and provide less habitat values through most habitat assessment methodologies, than larger stands of natural habitat.
EE-97	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Section 1508.20 of NEPA defines mitigation as a term that encompasses: (1) Avoiding, (2) Minimizing, (3) Rectifying, (4) Reducing, or (5) Compensating for an impact. Compensation would consist of replacing impacted habitat.
EE-98	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Substantial effects are considered to be significant, unmitigatable effects, as described throughout Sections 3.6.4 and 3.6.5. Conflicting with a plan indicates not complying with the relevant goals and policies of that plan.
EE-99	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Citation to this reference from the Parkway Plan was added to the Final EIS/EIR.
EE-100	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Section 3.6 of the EIS/EIR has been updated to clarify habitat impacts under the proposed study.
EE-101	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
EE-102	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.

EE-103	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Footprints were developed for internal use only during the study process, primarily because they are intended to be the largest possible footprint and likely do not represent the refined/reduced footprint that will actually be implemented when the project reaches the construction phase. As site-specific designs are refined post-authorization, these more accurate footprints will be available for coordination and consultation purposes.
EE-104	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	65 acres of riparian habitat are estimated to be impacted by construction of the launchable rock trenches within the American River Parkway.
EE-105	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-106	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
EE-107	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-108	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.

EE-109	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Analysis was intended to address a worst-case scenario, therefore we should not be assuming more impacts than a potential worst-case scenario. If there are greater impacts than what is stated in the NEPA document, then a supplemental NEPA document would be required to address those increased impacts, and further coordination would be required under that supplemental analysis. Therefore, yes, increased impacts would require additional coordination.
EE-110	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The preferred alternative for erosion protection is a combination of both measures, based on site-specific conditions. Site specific designs for erosion protection will be completed in the design phase of this study.
EE-111	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The EIS/EIR assesses impacts and mitigation, including short term and long term impacts. The Mitigation and Monitoring Plan, which is appended to the Final EIS/EIR also includes more information regarding mitigation planning.
EE-112	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Trees left in place are not expected to die. The Corps has been protecting trees in place as part of bank protection construction under the Sacramento River Bank Protection Project and the trees at these sites have had successful survival rates over the last decade.
EE-113	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Trees left in place are not expected to die. The Corps has been protecting trees in place as part of bank protection construction under the Sacramento River Bank Protection Project and the trees at these sites have had successful survival rates over the last decade.
EE-114	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The planting berm/trench is discussed in the draft EIS/EIR Section 2.3.1 under "Bank Protection" in the 2nd and 4th paragraphs. Concur. The Corps will update figure 1 to ensure that the planting berm is shown.
EE-115	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Mitigation was estimated using a maximized footprint of potential impacts, which would be refined during the design phase of the project. The footprint was not minimized or reduced by any proposed mitigation, such as planting berms.
EE-116	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Design based on site-specific hydraulic and environmental conditions would occur during the design phase of the project to determine which erosion protection measure is appropriate at each location.
EE-117	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	A mitigation and monitoring plan was prepared and will be appended to the final EIS/EIR.
EE-118	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The Corps has conducted internal assessments during the planning phase to determine the feasibility of all mitigation commitments. The Corps has confidence that all American River vegetation impacts can be mitigated within the Parkway without compromising the integrity of the flood management system. The proposed alternatives have been designed in accordance with the American River Parkway Plan Flood Control Policies. During the preconstruction engineering and design phase of the project, site-specific designs will be conducted for each segment of the project, and will include the final design of all mitigative features, which would be implemented during project construction. If the Corps determines that proposed onsite mitigation is not feasible, credits may be purchased at a mitigation bank.

EE-119	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Trenches would be buried within the existing berm footprint and would not change the elevation of the berm in any way. Mitigation proposed for the trench surface would compensate for impacts from construction of the trench and would attempt to recreate similar habitat to the maximum extent practicable.
EE-120	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Mitigation proposed for the trench surface would compensate for impacts from construction of the trench and would attempt to recreate similar habitat to the maximum extent practicable. If habitat removed is not compatible with the trench, then offsite mitigation in the vicinity of the trench would be sought.
EE-121	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The launchable rock trench size was estimated as a conservative design based on a forecast of the potential for degradation of the channel and bank during a flood event. During the preconstruction engineering and design phase of the project this design will be refined based on site-specific conditions.
EE-122	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	130 acres of riparian mitigation is based on the 65 acre impact, mitigated on a 2:1 basis.
EE-123	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-124	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	An assumption was made for the purposes of mitigation planning that all elderberry shrubs are riparian because the Corps was evaluating effects based on a maximum impact scenario and riparian shrubs have more stringent mitigation requirements than non-riparian shrubs. During site-specific designs, each elderberry shrub will be evaluated on an individual basis and the mitigation will be adjusted, as needed, based on the existing conditions prior to construction.
EE-125	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	An assumption was made for the purposes of mitigation planning that all elderberry shrubs are riparian because the Corps was evaluating effects based on a maximum impact scenario and riparian shrubs have more stringent mitigation requirements than non-riparian shrubs. During site-specific designs, each elderberry shrub will be evaluated on an individual basis and the mitigation will be adjusted, as needed, based on the existing conditions prior to construction.
EE-126	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	The surveys were conducted prior to project design and include only 15 feet from the levee, both landside and waterside. There is the potential that there are more trees impacted by the trench than the survey results showed, which is why the impact associated with the trench is an acreage rather than a tree count. The footprint of the trenches is a maximum of 65 acres.
EE-127	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	The associated natives are based on the requirements established in the USFWS Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS, July 1999). The guidelines list and establish a number of species that are appropriate for VELB mitigation sites, including various species of willows, cottonwoods, oaks, box elder, etc.

EE-128	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Impacts to vegetation and wildlife within the project area are evaluated based on data collected from the tree surveys conducted in 2011, site visits, Google Earth, and the American River Parkway Plan. Engineering provided estimated construction footprints overlayed on aerial photos of the project area. The estimated acreage of impacts shown in the Final EIS/EIR was determined by overlaying the largest possible footprint of the erosion repair work proposed onto aerial photographs of the study area and calculating the habitat within the footprint. Additionally, the habitat maps appended to the Final EIS/EIR were reviewed to determine what other habitat types such as wetlands might be present.
EE-129	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
EE-130	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	The surveys were conducted prior to project design and include only 15 feet from the levee, both landside and waterside. There is the potential that there are more trees impacted by the trench than the survey results showed, which is why the impact associated with the trench is an acreage rather than a tree count. The footprint of the trenches is a maximum of 65 acres.
EE-131	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Effects	Analysis was intended to address a worst-case scenario, therefore we should not be assuming more impacts than a potential worst-case scenario. If there are greater impacts than what is stated in the NEPA document, then a supplemental NEPA document would be required to address those increased impacts, and further coordination would be required under that supplemental analysis. Therefore, yes, increased impacts would require additional coordination.
EE-132	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Yes, the tree surveys were conducted in 2011.
EE-133	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The launchable rock trench size was estimated as a conservative design based on a forecast of the potential for degradation of the channel and bank during a flood event. During the preconstruction engineering and design phase of the project this design will be refined based on site-specific conditions.
EE-134	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	The associated natives are based on the requirements established in the USFWS Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS, July 1999). The guidelines list and establish a number of species that are appropriate for VELB mitigation sites, including various species of willows, cottonwoods, oaks, box elder, etc.
EE-135	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.

EE-136	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Specific mitigation plans, including any lands needed, will be developed during the site-specific design process following Congressional authorization. It is possible that more Parkway lands could be needed for mitigation, however locations haven't been selected yet. Any decisions on locations of mitigation for this project would be developed in coordination with the Sacramento County Department of Parks and Recreation.
EE-137	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	See new impact summary tables in EIS/EIR Section 3.6. Sacramento River has greater impacts. American River effects are double counted in some locations because site-specific design won't occur until PED. Impacts were maximized to account for either erosion protection scenario.
EE-138	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Hawk Mitigation	On page 146 of the draft EIS/EIR, it states that a 0.25-mile buffer would be established between construction activities and active nests.
EE-139	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Proposed vegetation establishment at bank protection sites is applicable to all bank protection sites proposed within the study area, including the American River. The specific details of the vegetation establishment in the planting berm would be designed on a site-specific basis in the design phase of the project.
EE-140	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	On page 30 of the draft EIS/EIR in Section 2.3.1, the planting berm is described as follows: After revetment placement has been completed, a small planting berm would be constructed in the rock where feasible to allow for some revegetation of the site, outside of the vegetation free zone as required by ETL 1110-2-583. This vegetation will be designed on a site specific basis to minimize the O&M responsibility of the LMA and in such a way to not impact the hydraulic conveyance of the channel.
EE-141	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Riparian mitigation would include planting of a variety of species associated with this habitat type, including oaks, cottonwoods, willows, box elder, elderberries, etc. All plantings within the Parkway would be established in coordination with County Parks and per the approved Parkway plant list. Woodlake/Cal Expo could be used for riparian mitigation, however it is not a preferred location for mitigation within the Parkway, due to continued problems with wildfires in this portion of the Parkway. The Corps is not likely to support additional mitigation sites at this location.
EE-142	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	The removal of riparian habitat for construction would likely also include the removal of some trees (as described in Section 3.6.4) that provide nesting habitat for Swainson's Hawk.
EE-143	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Page 147 of the draft EIS/EIS states that 134 acres of riparian habitat supporting Swainson's hawks would be removed.
EE-144	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Coordination would occur between the Corps and County Parks to determine the appropriateness and availability of mitigation opportunities within the Parkway. The Corps and County Parks have a history of collaborating in this way (e.g, the creation of a number of existing restoration sites within the Parkway, including Cal Expo, Sailor Bar, and River Bend Park, among others).
EE-145	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Coordination	Coordination would occur between the Corps and County Parks to determine the appropriateness and availability of mitigation opportunities within the Parkway. The Corps and County Parks have a history of collaborating in this way for the creation of a number of existing restoration sites within the Parkway, including Cal Expo, Sailor Bar, and River Bend Park, among others. Mitigation for Swainson's hawk is guaranteed to occur due to stipulations in the USFWS Biological Opinion, which requires compensation for the removal of riparian trees due to impacts to the Western yellow-billed cuckoo.

EE-146	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Impacts	Typically, impacts from construction are considered to be temporary and short-term, because construction only occurs for a limited amount of time. In this case, since construction is proposed over a number of years, although in different parts of the parkway, the temporary disruption from construction is treated differently than a typical less-than-significant short term impact. This is why the determination resulted in a significant, unmitigatable effect on recreation.
EE-147	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Impacts	"Eliminate" indicates a permanent loss of recreation. "Restrictions" indicate more of a limitation in what recreation activity could occur. "Disruption" is more related to the impacts that occur to present recreationists using the facility, such as noise or dust from construction.
EE-148	Friends of the River, Habitat 2020, and Save the American River Association	Letter	No Action	The Parkway Plan has specifically identified policies for Flood Control project implementation. The Flood Control policies identified in Chapter 4 of the Parkway Plan are the relevant regulations for this action. Implementation of the project is consistent with these policies. Allowing the Parkway to erode away over time, as is assumed in the No Action Alternative, would not be consistent with these policies.
EE-149	Friends of the River, Habitat 2020, and Save the American River Association	Letter	No Action	Citations for the Parkway Plan quotes have been added to the Final EIS/EIR.
EE-150	Friends of the River, Habitat 2020, and Save the American River Association	Letter	No Action	The Parkway Plan has specifically identified policies for Flood Control project implementation. The Flood Control policies identified in Chapter 4 of the Parkway Plan are the relevant regulations for this action. The project is in compliance with these policies, as identified throughout the various sections of this EIS/EIR. This discussion has been expanded for the final report.
EE-151	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Recreation	Section 3.14 evaluates the effects of the project on recreational resources and establishes that significant effects from detours and possible closures of portions of the parkway during construction would conflict with the Parkway Plan.
EE-152	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Recreation	Section 3.14 evaluates the effects of the project on recreational resources and establishes that significant effects from detours and possible closures of portions of the parkway during construction would conflict with the Wild and Scenic Rivers Act.
EE-153	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Recreation	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-154	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Aesthetics	Concur. The Visual Resources No Action alternative has been updated to include full berm loss as a significant impact.

EE-155	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project Area	There is a total of 11 miles of erosion protection proposed for the Parkway.
EE-156	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The planting berm/trench is discussed in the draft EIS/EIR Section 2.3.1 under "Bank Protection" in the 2nd and 4th paragraphs. Concur. The Corps will update figure 1 to ensure that the planting berm is shown.
EE-157	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	There would be no planting berm under the launchable rock trench measure. The planting berm is only associated with bank protection measures. Under the trench scenario, on-site plantings would be above the trench.
EE-158	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Mitigation proposed for the trench surface would compensate for impacts from construction of the trench and would attempt to recreate similar habitat to the maximum extent practicable. If habitat removed is not compatible with the trench, then offsite mitigation in the vicinity of the trench would be sought.
EE-159	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	Elderberry shrubs estimated to be impacted by the project are contained within the acreage of riparian that are estimated to be mitigated. Elderberry mitigation requires the planting of associated riparian native plants. Mitigating for these two habitat types together is an effective and reasonable assumption for the project.
EE-160	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	An assumption was made for the purposes of mitigation planning that all elderberry shrubs are riparian because the Corps was evaluating effects based on a maximum impact scenario and riparian shrubs have more stringent mitigation requirements than non-riparian shrubs. During site-specific designs, each elderberry shrub will be evaluated on an individual basis and the mitigation will be adjusted, as needed, based on the existing conditions prior to construction.
EE-161	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	Elderberry shrubs removed from the riparian corridor are considered to be riparian, and on-site mitigation associated with these impacts would be designed to contribute to the riparian corridor.
EE-162	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Mitigation proposed for the trench surface would compensate for impacts from construction of the trench and would attempt to recreate similar habitat to the maximum extent practicable. If habitat removed is not compatible with the trench, then offsite mitigation in the vicinity of the trench would be sought.
EE-163	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Mitigation proposed for the trench surface would compensate for impacts from construction of the trench and would attempt to recreate similar habitat to the maximum extent practicable. If habitat removed is not compatible with the trench, then offsite mitigation in the vicinity of the trench would be sought.

EE-164	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	The Visual Resources No Action alternative has been updated to include full berm loss as a significant impact. Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-165	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Concur. The Corps will update figure 1 to ensure that the planting berm is shown.
EE-166	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The repair shown is a conceptual design that reflects actual construction on the American River as part of the Sac Bank sites repair. In PED, site specific design will occur that will take into account the hydraulic, geotechnical, topographical, environmental, and cultural aspects of each site. The Corps, in conjunction with stakeholders will address the constraints at individual sites to come up with the best design alternative for each site.
EE-167	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The repair shown is a conceptual design that reflects actual construction on the American River as part of the Sac Bank sites repair. In PED, site specific design will occur that will take into account the hydraulic, geotechnical, topographical, environmental, and cultural aspects of each site. The Corps, in conjunction with stakeholders will address the constraints at individual sites to come up with the best design alternative for each site.
EE-168	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The repair shown is a conceptual design that reflects actual construction on the American River as part of the Sac Bank sites repair. In PED, site specific design will occur that will take into account the hydraulic, geotechnical, topographical, environmental, and cultural aspects of each site. The Corps, in conjunction with stakeholders will address the constraints at individual sites to come up with the best design alternative for each site.
EE-169	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The Corps concurs that rock will be visible, even after revegetation has been established, particularly during low water years. It is anticipated that over time, as new vegetation establishes, the visibility of rock revetment will be greatly reduced. Section 3.15 of the EIS/EIR has been updated to acknowledge that rock will be visible.
EE-170	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The Corps concurs that rock will be visible, even after revegetation has been established, particularly during low water years. It is anticipated that over time, as new vegetation establishes, the visibility of rock revetment will be greatly reduced. Section 3.15 of the EIS/EIR has been updated to acknowledge that rock will be visible.
EE-171	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The Corps concurs that rock will be visible, even after revegetation has been established, particularly during low water years. It is anticipated that over time, as new vegetation establishes, the visibility of rock revetment will be greatly reduced. Section 3.15 of the EIS/EIR has been updated to acknowledge that rock will be visible.

EE-172	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The Sac Bank site shown is a worst case scenario with regards to the amount of bank protection being required and the revegetation that is included in the design. It is anticipated that during site specific design, the quantity of rock needed at most sites will be less than at this site. With this reduction in rock, and the ability to work around most existing vegetation, the extent of environmental impacts is expected to be reduced.
EE-173	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
EE-174	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
EE-175	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Impacts for the American River are as described in the document throughout Section 3.6. As described above, this estimate is based on the impacts to vegetation in the construction footprint and the level of impact would not change under a variance. American River proposed measures would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
EE-176	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Typically when we are referring to large vegetation vs small vegetation we are referring to trees versus shrubs or grasses.
EE-177	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Bank protection will be placed around large trees. If necessary, select trees will need to be removed for construction purposes such as the ability of a hydraulic excavator to place bank protection. Launchable rock protection will require complete removal of vegetation within the footprint of the trench. In all cases, vegetation is being removed for construction purposes and not because of hydraulic analysis.
EE-178	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Trees left in place are not expected to die. The Corps has been protecting trees in place as part of bank protection construction under the Sacramento River Bank Protection Project and the trees at these sites have had successful survival rates over the last decade.
EE-179	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Trees left in place are not expected to die. The Corps has been protecting trees in place as part of bank protection construction under the Sacramento River Bank Protection Project and the trees at these sites have had successful survival rates over the last decade.
EE-180	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The proposed project only impacts vegetation in the construction footprint, and proposes to protect existing trees in place whenever possible. Additionally, all trees removed from the construction footprint would be compensated for, in the case of the Parkway, on-site to the maximum extent practicable. As a result, while there would be a significant short term impact from vegetation removal, long-term vegetation in the parkway is expected to recover. As a result of these proposed measures, the conclusions presented in the draft EIS/EIR are appropriate.

EE-181	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	A large berm made of large rocks. See Engineering Appendix for more details on the size and scope of the bank protection design.
EE-182	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Concur. The Corps will update figure 1 to ensure that the planting berm is shown.
EE-183	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Design based on site-specific hydraulic and environmental conditions would occur during the design phase of the project to determine which erosion protection measure is appropriate at each location.
EE-184	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Shallow rooted trees could be planted on the trench surface. Trench configuration is described in Chapter 2 of the EIS/EIR.
EE-185	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Vegetation would be removed only from the construction footprint of the project. To the maximum extent practicable, mitigation would be conducted on site with the ultimate goal of returning on-site conditions to as close to pre-project conditions as possible. Further information on proposed mitigation is included in the Mitigation and Monitoring Plan, which is appended to the final EIS/EIR.
EE-186	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Site specific erosion protection analysis to be completed during the design phase could identify locations where better long term resource results and may be able to minimize short term impacts. These additional measures may have less substantial effects that result from site specific design.
EE-187	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Mitigation proposed for the trench surface would compensate for impacts from construction of the trench and would attempt to recreate similar habitat to the maximum extent practicable. If habitat removed is not compatible with the trench, then offsite mitigation in the vicinity of the trench would be sought.
EE-188	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The trench width is a function of existing topography, trench slopes, depth, and quantity of launchable rock. These aspects of the design will be analyzed in more detail within PED phase. For the purposes of this study and description of impacts, the 70 feet trench width, is considered to be conservative when applied to the extents shown in plates 3 and 4.
EE-189	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Concur. Under the No Action Alternative, with erosion not addressed, full berm loss in a major flood event is assumed, and this is considered to be a significant impact.
EE-190	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	The Corps has updated the No Action Alternative sections to indicate that full berm loss during a major flood event is considered to be a significant impact.

EE-191	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-192	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-193	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The planting berm/trench is discussed in the draft EIS/EIR Section 2.3.1 under "Bank Protection" in the 2nd and 4th paragraphs. Planting berms are associated with the bank protection design and not the launchable rock trench design. Trenches will be designed on a site-specific basis and would include shallow-rooted tree species.
EE-194	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	There would be no planting berm under the launchable rock trench measure. The planting berm is only associated with bank protection measures. Under the trench scenario, on-site plantings would be above the trench.
EE-195	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Section 2.3.1 includes revegetation through the planting berm at bank protection sites, and through planting shallow-rooted species on the surface of the trenches. This is consistent with the visual mitigation discussion. It should be noted that the conclusion of the visual resources section is that effects are significant and cannot be fully mitigated. This conclusion is primarily due to the temporal loss of vegetation while the new vegetation is establishing.
EE-196	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project Area	There is a total of 11 miles of erosion protection proposed for the Parkway.
EE-197	Friends of the River, Habitat 2020, and Save the American River Association	Letter	No Action	The No Action Alternative is based on past experience and is a forecast of what could transpire with large magnitude flood events in the future. It is based on best available information, but does not include specific qualitative estimates.

EE-198	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-199	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The trench width is a function of existing topography, trench slopes, depth, and quantity of launchable rock. These aspects of the design will be analyzed in more detail within PED phase. For the purposes of this study and description of impacts, the 70 feet trench width, is considered to be conservative when applied to the extents shown in plates 3 and 4.
EE-200	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	The acreage of impact was based on the construction footprint, including some additional areas like ramps and roads in the vegetation and wildlife section. Staging areas have not been determined at this time, because of the potential for changing conditions between this study and the implementation of the project, therefore this acreage was not included in current project estimates. Following authorization when site-specific design occurs, staging areas will be determined and if the impacts associated with those staging areas increase the environmental impacts disclosed in this EIS/EIR, then supplemental NEPA analysis would occur.
EE-201	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Modeling results are a summarization of a Sacramento Bank Protection Regional Sediment Study. This is a challenging issue. In general, in the absence of bedrock or other erosion resistant materials, the LAR is degradational in nature down to about RM 4. Downstream of this location, the river is slightly aggradational. The erosion resistant layer has only been mapped between river miles 5.5 and 11.5 (approximate RM's). The vertical location of the resistant layer is unknown for the remainder of the river below Nimbus Dam. Despite the general trends, zones of local aggradation and degradation are observed to occur in both the prototype river channel as well as in numerical modeling simulations (e.g., HEC-6T). In the zone where the erosion resistant layer has been identified, it appears that continued wholesale lowering of the channel thalweg is unlikely; however, other portions of the channel cross section (e.g., channel terraces or berms) may continue to degrade over time.
EE-202	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The degradation analysis report did look at nick points developing into full head cuts that would move upstream and jeopardize levee stability. This study found that the only place that this was somewhat probable was in the vicinity of the Guy West bridge. That is the reason that study only recommended grade control in that vicinity. Further site specific design in PED will relook at this, likely in consultation with local stakeholder groups.
EE-203	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Draft results for the long-term simulation indicate that about 263,000 cy would be eroded for the without-project condition during the period simulated. For the without-project conditions, a volume of 304,000 cy would be eroded along the 22-mile study reach of the American River.
EE-204	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	When sediment is mobilized from along the American River or other rivers, it washes downstream. Ultimately, this sediment finds its way to the Suisun, San Pablo, and San Francisco Bay and ultimately to the Pacific Ocean.

EE-205	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Considerable sea level rise would be required to significantly impact the sediment transport ability of the reach of river in question. There are conditions where high stage on the Sacramento River causes backwater effects on the American River in the RM 5-7 stretch, but then there are other conditions where the backwater effect is not present but there are still significant flows coming down the American River causing higher rates of sediment transport including in the RM 5-7 range. Significant sea level rise would need to occur before the sediment transport capability of this reach of river would greatly reduce. However, this will be further studied in PED in consultation with local stakeholder groups.
EE-206	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	We concur that naturally, upstream of RM 8 it is not a braided channel. But, artificially, because of the multiple channels associated with historic gravel mining, upstream of RM 8, sediment transport occurs as if it were a braided channel, which is why it is characterized this way. Further analysis in PED will address this further, likely in consultation with local stakeholder groups.
EE-207	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	This is a challenging issue. In general, in the absence of bedrock or other erosion resistant materials, the LAR is degradational in nature down to about RM 4. Downstream of this location, the river is slightly aggradational. The erosion resistant layer has only been mapped between river miles 5.5 and 11.5 (approximate RM's). The vertical location of the resistant layer is unknown for the remainder of the river below Nimbus Dam. Despite the general trends, zones of local aggradation and degradation are observed to occur in both the prototype river channel as well as in numerical modeling simulations (e.g., HEC-6T). In the zone where the erosion resistant layer has been identified, it appears that continued wholesale lowering of the channel thalweg is unlikely; however, other portions of the channel cross section (e.g., channel terraces or berms) may continue to degrade over time.
EE-208	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Reference to RM 9.0R was only made as an example of where erosion is actively occurring, even at low discharges such as 7,000 cfs. The concern regarding the erosive trends in the LAR are not predicated on just this one location. A review of the performance of the LAR channel with regards to erosion reveals that multiple locations of the channel have experienced damaging erosion and have required repair following significant discharge event.
EE-209	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Reference to RM 9.0R was only made as an example of where erosion is actively occurring, even at low discharges such as 7000 cfs. The concern regarding the erosive trends in the LAR are not predicated on just this one location. A review of the performance of the LAR channel with regards to erosion reveals that multiple locations of the channel have experienced damaging erosion and have required repair following significant discharge event.
EE-210	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	It is possible that sewer main undercrossing is contributing to the erosion concerns at RM 7. However, looking at the Ayres' velocity plots - the velocity at this location is high enough to be of concern with or without the sewer main undercrossing. Site specific designs for erosion protection will be completed in the design phase of this study known as Preconstruction, Engineering and Design (PED) and the sewer main undercrossing will be evaluated. Given the magnitudes of local shear and velocity along portions of the lower American River banks makes bio-engineering or other soft approaches for providing bank protection very challenging. Nonetheless, site specific designs for bank and erosion protection will be developed in the next phase of the study (PED Phase). As part of the Folsom Water Control Manual, additional Channel Stability Analyses are being conducted to further refine the designs.

EE-211	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	It is possible that sewer main undercrossing is contributing to the erosion concerns at RM 7. However, looking at the Ayres' velocity plots - the velocity at this location is high enough to be of concern with or without the sewer main undercrossing. Site specific designs for erosion protection will be completed in the design phase of this study known as Preconstruction, Engineering and Design (PED) and the sewer main undercrossing will be evaluated. Given the magnitudes of local shear and velocity along portions of the lower American River banks makes bio-engineering or other soft approaches for providing bank protection very challenging. Nonetheless, site specific designs for bank and erosion protection will be developed in the next phase of the study (PED Phase). As part of the Folsom Water Control Manual, additional Channel Stability Analyses are being conducted to further refine the designs.
EE-212	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The significance criteria in the Hydrology and Hydraulics section is based on the environmental checklist in Appendix G of the State CEQA Guidelines. Hydraulic effects are discussed throughout the section and the determination is that there would be no significant hydraulic effects associated with the project.
EE-213	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	Design based on site-specific hydraulic and environmental conditions would occur during the design phase of the project to determine which erosion protection measure is appropriate at each location.
EE-214	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The text has been revised to clarify that the discussion refers to surface runoff conditions, which are not expected to be impacted by implementation of the project. Erosion conditions will be addressed by the proposed measures. If trenches have launched, significant berm has been lost and channel geometry was highly altered by a major flood event. The launched trench would protect the levee. Erosion of the berm is not considered an impact of the project as it is part of the existing condition. Addressing the changed geometry post-flood event would be part of a collaborative effort during the recovery period.
EE-215	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	For the purposes of this study, the project features were designed with a flow of 160,000 cfs which is currently estimated to be a 200-year event. The ARCF GRR used a conservative characterization of future flood management operations at Folsom Dam assuming the JFP auxiliary spillway and control structure are complete. The Folsom Dam future operations reflected in the ARCF GRR are based on the operations identified in the Folsom Dam Modification and Folsom Dam Raise Projects Post Authorization Change Report (2007) (JFP PACR). Evaluation of how the flow regime has changed to get to the Spillway and Dam raise in place is being done under the Folsom Water Control Manual Update.
EE-216	Friends of the River, Habitat 2020, and Save the American River Association	Letter	H&H	The significance criteria in the Hydrology and Hydraulics section is based on the environmental checklist in Appendix G of the State CEQA Guidelines. Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.

EE-217	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The comment is unclear. Site-specific designs will be coordinated with County Parks during the PED phase of the project.
EE-218	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The EIS/EIR assesses impacts and mitigation, including short term and long term impacts. The Mitigation and Monitoring Plan, which is appended to the Final EIS/EIR also includes more information regarding mitigation planning.
EE-219	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Trees left in place are not expected to die. The Corps has been protecting trees in place as part of bank protection construction under the Sacramento River Bank Protection Project and the trees at these sites have had successful survival rates over the last decade.
EE-220	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Mitigation plans have been refined since the preparation of the draft EIS/EIR and are evaluated in more detail in the Mitigation and Monitoring Plan, which is appended to the Final EIS/EIR. These plans will be further evaluated in PED during site-specific engineering design and selection of any off-site mitigation sites. Some riparian plantings will occur on the trenches, however, at this time the Corps anticipates that not all required mitigation will occur on-site.
EE-221	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-222	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-223	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	An assumption was made for the purposes of mitigation planning that all elderberry shrubs are riparian because the Corps was evaluating effects based on a maximum impact scenario and riparian shrubs have more stringent mitigation requirements than non-riparian shrubs. During site-specific designs, each elderberry shrub will be evaluated on an individual basis and the mitigation will be adjusted, as needed, based on the existing conditions prior to construction.

EE-224	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	Mitigation requirements for VELB are established in the USFWS Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS, July 1999). The guidelines require that elderberries are planted along with a ratio of associated native plants. The Conservation Guidelines list and establish a number of species that are appropriate for VELB mitigation sites, including various species of willows, cottonwoods, oaks, box elder, etc.
EE-225	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	Trench footprints are part of the riparian corridor. They primarily consist of riparian forest and oak woodland habitat types. In some cases they would also impact ruderal herbaceous habitat areas. The acreage of impacts will be refined during the design phase and a more accurate assessment of the habitat impacts will be conducted at that time. It is not anticipated that trenches would impact SRA habitat.
EE-226	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	Existing mitigation sites within the American River Parkway contribute to the riparian corridor and therefore are generally considered to be riparian. When these sites reach full maturity they are expected to provide riparian habitat.
EE-227	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	The relationship between these mitigation types has not been established at this time. There is some overlap between the riparian mitigation and the required "associated natives " that must be planted for VELB mitigation. The final acreage of mitigation will be determined prior to construction and will be based on the recommendations in the USFWS CAR and the requirements of the Biological Opinion, as well as through coordination with County Parks.
EE-228	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-229	Friends of the River, Habitat 2020, and Save the American River Association	Letter	VELB	Elderberry impacts were based on the 2011 surveys. Because habitat will grow and could change significantly between 2011 and implementation of construction, surveys and counts will be conducted again prior to construction and mitigation implemented would be coordinated with USFWS prior to construction. Mitigation estimates were based on best available information during the planning phase. The project's cost estimate includes contingency costs to allow for potential future increases in mitigation. However, the expectation is that project footprints would decrease during construction and that impacts overall would likely be reduced.
EE-230	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
EE-231	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The draft EIS/EIR does not propose planting levee slopes. Smaller vegetation such as grasses and shrubs must be removed in order to construct bank protection sites, but large trees can be protected in place. Bank protection sites would include the establishment of a planting berm on the waterside toe of the levee. Figures in Chapter 2 will be updated for clarity and will show the planting berms in the Final EIS/EIR.

EE-232	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Smaller vegetation such as grasses and shrubs must be removed in order to construct bank protection sites, but large trees can be protected in place. Bank protection sites would include the establishment of a planting berm on the waterside toe of the levee. Figures in Chapter 2 will be updated for clarity and will show the planting berms in the Final EIS/EIR.
EE-233	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Design based on site-specific hydraulic and environmental conditions would occur during the design phase of the project to determine which erosion protection measure is appropriate at each location. Planting berms would include a soil cap to allow for establishment of new vegetation and long-term revegetation (see Figures 8-10 of the EIS/EIR showing vegetative features in bank protection sites near CSU Sacramento).
EE-234	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Design based on site-specific hydraulic and environmental conditions would occur during the design phase of the project to determine which erosion protection measure is appropriate at each location.
EE-235	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	The Corps has worked very closely with National Marine Fisheries Service under the Sacramento River Bank Protection Project (SRBPP) over the last 10-15 years to design self-mitigating bank protection sites, which include various types of planting berms to account for impacts to SRA habitat. Under the ARCF GRR, the Corps proposes to evaluate each bank protection site during the design phase to apply the appropriate SRBPP design to minimize and mitigate for effects to habitat.
EE-236	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	An estimate of impacts and mitigation for the American River erosion protection work is included in the EIS/EIR in Sections 3.6 and 3.8 and in the Mitigation and Monitoring Plan, which is appended to the Final EIS/EIR. The final mitigation acreage will be coordinated following authorization once site-specific surveys and designs have been completed. At that time, coordination with County Parks and the resource agencies would occur and the final required mitigation would be established.
EE-237	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	The removal of riparian habitat for construction would likely also include the removal of some trees (as described in Section 3.6.4) that provide nesting habitat for Swainson's Hawk.
EE-238	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Woodlake/Cal Expo could be used for Swainson's/riparian mitigation, however it is not a preferred location for mitigation within the Parkway, due to continued problems with wildfires in this portion of the Parkway. The Corps is not likely to support additional mitigation sites at this location.
EE-239	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Habitat impacts have been clarified in Section 3.6 and 3.8 of the Final EIS/EIR. Additional information is also included in the Mitigation and Monitoring Plan, which is appended to the Final EIS/EIR.
EE-240	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.

EE-241	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Project Area	There is a total of 11 miles of erosion protection proposed for the Parkway.
EE-242	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The planting berm/trench is discussed in the draft EIS/EIR Section 2.3.1 under "Bank Protection" in the 2nd and 4th paragraphs. Concur. The Corps updated Figure 1 to show the planting berm.
EE-243	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	There would be no planting berm under the launchable rock trench measure. The planting berm is only associated with bank protection measures. Under the trench scenario, on-site plantings would be above the trench.
EE-244	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	Deep-rooted trees would not be permitted on the trench, but shallow-rooted trees and shrubs could be planted in these areas.
EE-245	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	There would be no planting berm under the launchable rock trench measure. The planting berm is only associated with bank protection measures. Under the trench scenario, on-site plantings would be above the trench.
EE-246	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Mitigation	Elderberry impacts are included within the riparian impacts estimated. These two habitat types are inter-related and would be mitigated in coordination with one another.
EE-247	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Environmental Effects	The Visual Resources No Action alternative has been updated to include full berm loss as a significant impact. Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
EE-248	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Vegetation	Figures throughout Chapter 2 will be updated to include planting berms. During site-specific design, the Corps will evaluate each site and determine which planting berm designs is appropriate based on existing conditions. The Corps anticipates being able to implement some level of vegetative features at every bank protection site. If a planting berm is infeasible, this could include planting willow poles, or installing IWM for fish habitat.

EE-249	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The repair shown is a conceptual design that reflects actual construction on the American River as part of the Sac Bank sites repair. In PED, site specific design will occur that will take into account the hydraulic, geotechnical, topographical, environmental, and cultural aspects of each site. The Corps, in conjunction with stakeholders will address the constraints at individual sites to come up with the best design alternative for each site.
EE-250	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The repair shown is a conceptual design that reflects actual construction on the American River as part of the Sac Bank sites repair. In PED, site specific design will occur that will take into account the hydraulic, geotechnical, topographical, environmental, and cultural aspects of each site. The Corps, in conjunction with stakeholders will address the constraints at individual sites to come up with the best design alternative for each site.
EE-251	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Design	The repair shown is a conceptual design that reflects actual construction on the American River as part of the Sac Bank sites repair. In PED, site specific design will occur that will take into account the hydraulic, geotechnical, topographical, environmental, and cultural aspects of each site. The Corps, in conjunction with stakeholders will address the constraints at individual sites to come up with the best design alternative for each site.
EE-252	Friends of the River, Habitat 2020, and Save the American River Association	Letter	Visual	The Corps concurs that rock will be visible, even after revegetation has been established, particularly during low water years. It is anticipated that over time, as new vegetation establishes, the visibility of rock revetment will be greatly reduced. Section 3.15 of the EIS/EIR has been updated to acknowledge that rock will be visible.
FF-1	Save the American River Association	Letter	Design	It is agreed that the reach of the American River between Howe Ave. and Paradise Beach is the worst stretch of the river with regards to the applied velocity. This reach however is not an anomaly with regards to erosion. Erosion has occurred in this reach and has been repaired (Sac Bank site 4, ARCF site 6.4L, 6.9L, and site 7.0R). Erosion has also occurred downstream and upstream of this reach and has been repaired (Sac Bank sites 1, 2, 3, and 5, ARCF sites 1.8L, 4.0L, 10.0L 10.2R, plus the 1986 emergency repair upstream of the Capital City Freeway). The velocity within the Howe to Paradise Beach reach is 12 to 13 fps for flows ranging from 115,000 cfs to 160,000 cfs. Upstream and downstream of this reach, velocities are often in the 6 to 7 fps range. Bare soil can withstand 1.5 to 2.5 fps and soil with a good turf cover can withstand 3.5 to 8 fps depending on the class of turf. The American River does not offer good turf conditions. This is a reason why we have experienced erosion in reaches downstream and upstream of the Howe to Paradise Beach reach. Text to explain conditions both upstream and downstream of the Howe to Paradise Beach reach has been added to section 2.3.1 of the GRR and Section 3.4 of the EIS/EIR.
FF-2	Save the American River Association	Letter	Design	It is agreed that the reach of the American River between Howe Ave. and Paradise Beach is the worst stretch of the river with regards to the applied velocity. This reach however is not an anomaly with regards to erosion. Erosion has occurred in this reach and has been repaired (Sac Bank site 4, ARCF site 6.4L, 6.9L, and site 7.0R). Erosion has also occurred downstream and upstream of this reach and has been repaired (Sac Bank sites 1, 2, 3, and 5, ARCF sites 1.8L, 4.0L, 10.0L 10.2R, plus the 1986 emergency repair upstream of the Capital City Freeway). The velocity within the Howe to Paradise Beach reach is 12 to 13 fps for flows ranging from 115,000 cfs to 160,000 cfs. Upstream and downstream of this reach, velocities are often in the 6 to 7 fps range. Bare soil can withstand 1.5 to 2.5 fps and soil with a good turf cover can withstand 3.5 to 8 fps depending on the class of turf. The American River does not offer good turf conditions. This is a reason why we have experienced erosion in reaches downstream and upstream of the Howe to Paradise Beach reach. Text to explain conditions both upstream and downstream of the Howe to Paradise Beach reach has been added to section 2.3.1 of the GRR and Section 3.4 of the EIS/EIR.

FF-3	Save the American River Association	Letter	Design	Figure 4-5 has been modified to include the previously installed erosion repair sites.
FF-4	Save the American River Association	Letter	Design	The cross sections shown in all documents are conceptual and do not represent exactly what will occur at any given site. Design will occur at individual sites and will take into account the geotechnical, hydraulic, environmental constraints at the site. Covering rock with soil is now an established practice. To the extent practicable, rock placed above the normal summer water surface will be covered with soil.
FF-5	Save the American River Association	Letter	Engineering Appendix History	Agree that history should be updated in said attachment. However, the Mayhew improvements from 2008 addressed levee height and seepage/stability, and not erosion protection. Our study indicates that Mayhew area is in need of an erosion protection to handle the future without project conditions which the Mayhew seepage/stability and raise project did not account for. However, the necessity of bank protection and the design details of this feature will be further analyzed in PED.
FF-6	Save the American River Association	Letter	Design	Figure 2-6 has been updated to reflect the more current understanding of the potential erosion sites which corresponds with the recommended erosion protection sites.
FF-7	Save the American River Association	Letter	Design	The following text has been added to Chapter 2 of the GRR to describe how areas were identified for erosion protection. Additionally, maps showing the velocity contours of the entire leveed reach of the lower American River have been added to further illustrate this analysis. "Figure 2-7 shows the velocities for a discharge of 115,000 cfs which average about 6 to 8 ft/sec in the channel with maximum velocities ranging up to about 12 ft/sec. Figure 2-8 shows the velocities for a discharge of 160,000 cfs which average about 5 to 9 ft/sec in the channel with maximum velocities ranging up to about 13 ft/sec. Of concern in both of these figures are the proximities of the relatively high velocities to the levees along the Lower American River. Additionally, the range of the computed velocities is of concern since the magnitude of the velocities is great enough to erode many of the relatively fine grained material present in the channel lining. The results of the analysis indicate that the large discharge events are capable of eroding the material typically found lining the Lower American River channel." Additionally, the following language has been added to Chapter 4: "The rationale used to determine where erosion protection was required involved consideration of several factors. The most important factors included: 1) the velocity computed by the hydraulic modeling (Ayres 2004) for a discharge of 160,000 cfs, 2) the erodibility of the material near the levee prism, and 3) the past performance of the levee segment with respect to erosion."
FF-8	Save the American River Association	Letter	Alternatives	The recommended plan in the GRR has identified areas along the American River where potential high flow velocities are within a proximity to the levee which would cause concern for potential levee failure. This footprint of erosion work represents the largest area that the initial studies have identified. These sites will be further investigated during the design phase and the extent of levee work would possibly be reduced as a result of the future analysis. Additionally, the recommendations in the GRR would be constructed in a worst-first sequence, meaning that the areas considered to be the highest risk would be constructed first. Since the GRR would need to wait for both authorization and then annual appropriations from Congress, it could be many years until the funding is in place for construction for those areas considered to be lower risk.

FF-9	Save the American River Association	Letter	General	A description of the final report approval process has been added to Chapter 4 of the GRR. That approval process is as follows: The Project Delivery Team (PDT) has responded to the comments on the Draft GRR & EIS/EIR and Appendices received during concurrent Public Review, Agency Technical Review (ATR), Independent External Peer Review (IEPR) and HQUSACE Policy Review and revised the documents as appropriate. The Final GRR &EIS/EIR and Appendices are transmitted to the South Pacific Division (SPD) for endorsement and then forwarded to HQUSACE. Once the documents are received at HQUSACE, a Civil Works Review Board (CWRB) is convened. The purpose of the CWRB is to determine if the final GRR &EIS/EIR and appendices, along with the proposed Report of the Chief of Engineers, are ready to be released for State and Agency review, as required by the Flood Control Act of 1944, as amended (33U.S.C. 701-1). Upon a successful conclusion of the CWRB meeting, the Deputy Commanding General for Civil and Emergency Operations (DCG-CEO) will approve release of the documents for State and Agency review and final NEPA review. After State and Agency review, comments are incorporated in to the documents as appropriate and a Final Chief's Report will be signed by the Chief of Engineers. The Chief's Report will then be sent to the chairpersons of the Senate Committee in Environment and Public Works and the House of Representative Committee on Transportation and Infrastructure. The Chief's Report, along with the GRR, EIS/EIR and appendices will then be sent to the Assistant Secretary of the Army for Civil Works (ASA(CW)) for review and approval. After approval by the ASA(CW), the documents will be sent to the Office of Management and Budget (OMB) for review.
FF-10	Save the American River Association	Letter	LPP	The acronym "LPP" has been added to the list of acronyms at the front of the report. The LPP was developed by the project delivery team which consists of USACE and sponsor staff. It has been endorsed by USACE Headquarters, the Assistant Secretary of the Army for Civil Works (ASA(CW)), the Central Valley Flood Protection Board and the SAFCA Board of Directors.
GG-1	James Morgan	Letter	NEPA	During the preconstruction engineering and design phase of the project, the Corps will be designing each phase of the project on a site-specific basis. During this site-specific design, an analysis will be conducted to determine whether the impacts are consistent with those described in this EIS/EIR or whether supplemental NEPA analysis would need to occur.
GG-2	James Morgan	Letter	Alternatives	A lot of levee improvement work has already taken place along the American River. The remaining problem is the potential for erosion to cause a levee failure. Sites have been identified along the American River where high velocity flows could cause potential levee erosion. Several different construction techniques have been identified to address the erosion potential. These techniques will be refined on a site specific basis during the design phase.
GG-3	James Morgan	Letter	Communication	The information presented at the Lower American River Task Force was meant to highlight the risk of erosion in the length of river between Paradise Beach and Watt Ave. We regret any misunderstanding this might have caused.
GG-4	James Morgan	Letter	Alternatives	The recommended plan in the GRR has identified areas along the American River where potential high flow velocities are within a proximity to the levee which would cause concern for potential levee failure. This footprint of erosion work represents the largest area that the initial studies have identified. These sites will be further investigated during the design phase and the extent of levee work would possibly be reduced as a result of the future analysis. Additionally, the recommendations in the GRR would be constructed in a worst-first sequence, meaning that the areas considered to be the highest risk would be constructed first. Since the GRR would need to wait for both authorization and then annual appropriations from Congress, it could be many years until the funding is in place for construction for those areas considered to be lower risk.
GG-5	James Morgan	Letter	Design	Concur, the bank protection graphic on page 32 should have soil cover for the rocks areas which are above the summer mean water surface elevation.

HH-1	Gay Jones	E-mail	Coordination	The Corps of Engineers is committed to working with stakeholders during the design and construction process. Previous bank protection constructed working with the LARTF is a good example that the Corps is supportive of using as a working model.
HH-2	Gay Jones	E-mail	Scope	As part of the ongoing effort to reduce the flood risk for the City of Sacramento, many studies have been conducted to gain a better understanding of the nature of the risk and possible ways to reduce the risk. These efforts have greatly expanded the understanding of the extent of the risk, including the potential for erosion of not only the banks of the American River, but the levees as well.
HH-3	Gay Jones	E-mail	Alternatives	The recommendations included in the GRR will be refined during the design phase of the project, at which time, site specific surveys and details would be taken into account.
HH-4	Gay Jones	E-mail	Alternatives	The levees along the American and Sacramento River could fail during a flood event due to four main factors. These factors include 1) flood water seeping through and under the levee, 2) levee instability, 3) flood waters overtopping a levee during a flood event, and 4) erosion of the levee. The first three factors have been addressed by prior work along the American River, however, the risk of significant levee erosion still remains as a possible cause of levee failure. Several erosion sites have been repaired and this work, along with all the other previous work, was accounted for during the development of the recommended plan for the GRR. The analysis conducted as part of the GRR identified additional areas where there is a high likelihood of erosion during large flood events.
HH-5	Gay Jones	E-mail	Parkway Plan	The majority of the Parkway Plan quotes in the document are directly out of Chapter 4 of the Parkway Plan, which identifies the goals and regulations for flood control actions in the Parkway. The EIS/EIR has been updated with citations to Chapter 4 of the Parkway Plan.
HH-6	Gay Jones	E-mail	Vegetation	The Corps does not propose to construct any new levees under the ARCF GRR. The project proposes to improve known problems in the existing levee system that could lead to a failure, damages, and loss of life. In order to complete this important public safety project, there would be significant impacts on the environment. The mitigation proposed in the EIS/EIR is expected to provide a similar habitat value long-term, however the short-term effects would be significant and unavoidable. The Corps intends to do what it can in site-specific design to minimize these significant effects, however, protecting habitat is not the purpose of the project.
II-1	State Water Resources Control Board	Letter	Alternatives	A wide variety of possible alternatives was analyzed as part of the study. Because the levees surrounding the City are in such poor condition, the study concluded that the most effective way to reduce the flood risk for the City of Sacramento is to improve the levees. A setback levee with a seepage berm is recommended for the Sacramento Bypass north levee which would approximately double the width of the floodplain area in the Sacramento Bypass. The remainder of the levees are adjacent to urban development with little to no available land for a levee setback.
II-2	State Water Resources Control Board	Letter	Water Quality	The CVRWQCB Basin Plan for the Sacramento and San Joaquin River Basins is referred to throughout Section 3.5, and the thresholds identified within the Basin Plan are cited throughout as the regulatory level applicable to the project for various water quality issues such as dissolved oxygen, water temperature, pH, and turbidity. Mitigation is proposed to comply with these thresholds, and monitoring would be conducted during in-water work to ensure that these thresholds are not exceeded. Further coordination with the CVRWQCB would occur during the design phase prior to construction to ensure that all appropriate permits (i.e., Section 401 Water Quality Certification) is met and any additional mitigation required will be coordinated with the board through that process.
II-3	State Water Resources Control Board	Letter	Water Quality	The Corps will ensure that prior to initiation of construction, a Section 401 Water Quality Certification is obtained, as necessary, for impacts to waters of the U.S. Through the Water Quality Certification process, the Corps will consult with the Water Boards, as required.
II-4	State Water Resources Control Board	Letter	Water Quality	Section 3.5 of the EIS/EIR has been updated to identify beneficial uses of surface waters and to analyze the impacts that could occur to these water uses.

II-5	State Water Resources Control Board	Letter	Alternatives	A wide variety of possible alternatives was considered, including features throughout the watershed, to find ways to reduce the flood risk to the City of Sacramento. USACE has developed a hydraulic model of the Sacramento River which allows us to analyze the effects of modifications to the flood management system. Because the levees surrounding the City are in such poor shape, the analysis showed that most effective plan to reduce the flood risk is to improve the existing levees. A setback levee is recommended for the north levee of the Sacramento Bypass which would approximately double it's floodplain area. The remainder of the levees are adjacent to urban development with little to no available land for a levee setback. The ongoing Central Valley Integrated Flood Management Study (CVIFMS) is a multi-purpose watershed study that is considering the larger, regional scale benefits associated with flood risk management, ecosystem restoration and other water resource related purposes. SAFCA is a local cost sharing partner on the study and has been in close coordination with USACE on the development of the GRR and the proposed work along the Sacramento River and the North Area Streams. The recommendations of the GRR are considered integral to the Lower Sacramento River Feasibility Study that is being developed as part of the Central Valley Flood Protection Plan (CVFPP).
II-6	State Water Resources Control Board	Letter	Vegetation	As detailed in Section 1.4.5 of the EIS/EIR, the Corps has conducted an analysis to determine the feasibility of acquiring a vegetation variance. The analysis determined that receipt of a variance is a reasonable assumption for the project and therefore all effects analyses assumed the variance is in place. If a variance is not granted by USACE HQ, then the Corps will conduct further NEPA/CEQA analysis at that time to analyze the effects of compliance with ETL 1110-2-583. The variance application process will be conducted following Congressional authorization during the preconstruction engineering and design phase of the project.
II-7	State Water Resources Control Board	Letter	SAFCA projects	SAFCA has informed the Corps that they will be seeking both permission to alter the Federal Flood Management Project (Section 408) and Credit Consideration (Section 221) for levee improvement work they intend on constructing prior to implementation of the ARCF GRR recommended project. Section 221 of the Flood Control Act of 1970 as amended by Section 2003 of the Water Resources Development Act (WRDA) of 2007 (42 U.S.C. 1962d-5b) allows the sponsor to seek credit for the study, design and construction of Federally authorized water resources development projects that are carried out after the execution of an agreement with the ASA(CW). Where there is a cost sharing agreement, the sponsor may provide in-kind contributions in accordance with the terms of the applicable agreement. The sponsor has indicated that they intend to construct portions of the levee improvements recommended by the GRR that are considered the highest risk areas and seek credit for those improvements. These actions will not be considered part of the without project condition however, in order that the sponsor may receive credit consideration in the future.
II-8	State Water Resources Control Board	Letter	Water Quality	Section 3.5 of the EIS/EIR has been updated to identify beneficial uses of surface waters and to analyze the impacts that could occur to these water uses.
II-9	State Water Resources Control Board	Letter	Vegetation	If a variance is not granted by USACE HQ, then the Corps will conduct further NEPA/CEQA analysis at that time to analyze the effects of compliance with ETL 1110-2-583.
II-10	State Water Resources Control Board	Letter	Vegetation	The variance application process will be conducted following Congressional authorization during the preconstruction engineering and design phase of the project.
II-11	State Water Resources Control Board	Letter	Vegetation	The SWIF Plan will be prepared by the local sponsors. It is anticipated that this will be acknowledged within the SWIF plan, as it is a key assumption associated with the vegetation variance and SAFCA's ongoing vegetation management efforts under the Levee Accreditation Program.
II-12	State Water Resources Control Board	Letter	Vegetation	The regulatory setting sections refer to the laws and regulations that are applicable to the proposed projects. These laws are further described in Chapter 5, including details on which agencies must be consulted with and what actions the Corps must take in order to achieve full compliance.

II-13	State Water Resources Control Board	Letter	Wetlands	The second bullet in the Significance Criteria for Section 3.6 states: "Substantial effects on a sensitive natural community, including Federally protected wetlands and other waters of the U.S., as defined by Section 404 of the Clean Water Act.".
II-14	State Water Resources Control Board	Letter	Water Quality	In Section 3.6, the EIS/EIR acknowledges the significant impacts that result from the temporal loss of vegetation, including riparian trees. Additionally, in Section 1.4.5 the EIS/EIR describes the project's approach to vegetation removal and protection under the Corps' levee safety policies. Section 1.4.5 describes the vegetation variance, which will allow the Corps to leave mature vegetation in place along the waterways, preserving the SRA habitat in the study area. Additionally, the Corps proposes to plant additional waterside habitat through the construction of planting berms at bank protection sites. Through these measures, the project would not result in a significant impact on water temperature. The Water Quality section will be updated for the final EIS/EIR to include this analysis.
II-15	State Water Resources Control Board	Letter	Mitigation	Mitigation planning efforts are ongoing and are discussed in greater detail in the Mitigation and Monitoring Plan, which is appended to the Final EIS/EIR.
II-16	State Water Resources Control Board	Letter	Mitigation	Mitigation planning efforts are ongoing and are discussed in greater detail in the Mitigation and Monitoring Plan, which is appended to the Final EIS/EIR.
II-17	State Water Resources Control Board	Letter	Mitigation	The Corps will comply with all applicable State and Federal regulations. Further coordination with the CVRWQCB will occur following project authorization to ensure that the Corps is conducting all mitigation and monitoring in accordance with the applicable guidance.
II-18	State Water Resources Control Board	Letter	Vegetation	As detailed in Section 1.4.5 of the EIS/EIR, the Corps has conducted an analysis to determine the feasibility of acquiring a vegetation variance. The analysis determined that receipt of a variance is a reasonable assumption for the project and therefore all effects analyses assumed the variance is in place. If a variance is not granted by USACE HQ, then the Corps will conduct further NEPA/CEQA analysis at that time to analyze the effects of compliance with ETL 1110-2-583. The variance application process will be conducted following Congressional authorization during the preconstruction engineering and design phase of the project.
JJ-1	Sacramento County	Letter	Environmental Effects	The Final EIS/EIR has been updated with an effort to be more specific about habitat impacts.
JJ-2	Sacramento County	Letter	Recreation	Recreational access points, boat launches, parks, and recreation sites such as the Campus Commons Golf Course would remain open to the greatest extent practicable. If construction equipment and material delivery requires full closure of revenue generating facilities, compensation would be discussed during PED phase when such closures are determined to be required.
JJ-3	Sacramento County	Letter	Recreation	Impacts to the Golf Course will be included in the Final EIS/EIR.
JJ-4	Sacramento County	Letter	Recreation	Construction of the project would not take place in all areas of the Parkway at one time, and there may be viable detours for equestrians during construction. However, communication about where the construction would take place would enable equestrian riders to determine the best route to take in order to avoid equestrian startlement and confusion. These efforts would be further discussed during PED phase.
JJ-5	Sacramento County	Letter	Recreation	Construction of the project would not take place in all areas of the Parkway at one time. There is the potential for bank-side access points near construction sites to be closed or limited during construction, but construction would not substantially limit the ability for recreationists to do water-based activities.
JJ-6	Sacramento County	Letter	Recreation	Closures and detours of the recreational trail could impact multiple events such as Eppie’s Great Race, the American River Parkway Half Marathon, the Jed Smith Ultra Classic, and multiple other fun runs and events. Coordination during PED phase would reduce impacts to these events to the greatest extent practicable. Recreational access points, boat launches, parks, and recreation sites such as the Campus Commons Golf Course would remain open to the greatest extent practicable. If any construction would require full closure, compensation of lost revenue would be considered during the design phase.

JJ-7	Sacramento County	Letter	Recreation	Construction contractors are required to restore the area to pre-construction conditions. If unofficial public trails are created due to project impacts, the eroded areas would be included in project impacts and restored to pre-construction conditions.
JJ-8	Sacramento County	Letter	Recreation	Coordination with Park staff would be conducted during design phase in order to reduce impacts to recreation to the greatest extent practicable. If detours, closures, and other disturbances to recreation are determined to be necessary in order to complete the project, public outreach would be conducted in conjunction with State and local outreach efforts.
JJ-9	Sacramento County	Letter	Borrow	Thank you, we will consider in PED phase.
JJ-10	Sacramento County	Letter	Borrow	The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction.
JJ-11	Sacramento County	Letter	Vegetation	Typically when we are referring to large vegetation vs small vegetation we are referring to trees versus shrubs or grasses.
JJ-12	Sacramento County	Letter	Vegetation	Design based on site-specific hydraulic and environmental conditions would occur during the design phase of the project to determine which erosion protection measure is appropriate at each location.
JJ-13	Sacramento County	Letter	Vegetation	More information about vegetation habitats has been included in the Final EIS/EIR and the Mitigation and Monitoring Plan.
JJ-14	Sacramento County	Letter	Vegetation	Trees left in place are not expected to die. The Corps has been protecting trees in place as part of bank protection construction under the Sacramento River Bank Protection Project and the trees at these sites have had successful survival rates over the last decade.
JJ-15	Sacramento County	Letter	Design	Concur. The Corps will update figure 1 to ensure that the planting berm is shown.
JJ-16	Sacramento County	Letter	Vegetation	Proposed measures on the American River would only impact vegetation within the construction footprint. For the launchable rock trench measure, the construction footprint includes the lower waterside slope. Since the vegetation variance only applies to the lower waterside slope, it cannot be applied to this measure. The bank protection measure on the American River does not involve the levee slope, and therefore, a vegetation variance is not necessary. The Corps will minimize impacts to vegetation in the Parkway to the maximum extent possible during construction.
JJ-17	Sacramento County	Letter	Vegetation	Impacts for the American River are as described in the document throughout Section 3.6. As described above, this estimate is based on the impacts to vegetation in the construction footprint and the level of impact would not change under a variance. No ETL compliance is necessary for the measures proposed under this project on the American River. It remains the responsibility of the local maintaining agency.
JJ-18	Sacramento County	Letter	Vegetation	The appropriateness of where replantings occur would be determined on a site-specific basis during the preconstruction engineering and design phase of the project. For example, following construction on the Sacramento River levees, new trees would not be installed in the levee prism, as it would conflict with State and Federal vegetation policies, but they would be installed in planting berms, while levees would be reseeded with native grasses.
JJ-19	Sacramento County	Letter	No Action	As part of the Folsom Water Control Manual update, additional Channel Stability Analyses are being conducted to further refine channel widening and deepening.
JJ-20	Sacramento County	Letter	Design	The trench width (top) is a function of existing topography, trench slopes, depth, and quantity of launchable rock. These aspects of the design will be analyzed in more detail within PED phase. For the purposes of this study and description of impacts, the 70 feet trench width is considered to be conservative when applied to the extents shown in plates 3 and 4.

JJ-21	Sacramento County	Letter	Design	Berm erosion is part of the existing condition and is not an impact of project implementation or operation. Additionally, since a combination of bank protection and trench is proposed, the project does prevent the full berm loss that is considered significant under the No Action alternative. Erosion of the bank/berm is a natural process that is continually occurring, but is exacerbated when extreme precipitation results in high releases from Folsom Dam. The decision to construct launchable rock trench as opposed to bank protection does not change these erosion conditions, but rather prevents the erosion from causing a levee failure. The construction of a trench rather than bank protection in some locations also allows for some natural sediment transport processes to continue. The balance of these two measures reduces the potential significant impacts that would occur if either one was implemented on its own. During PED, a more substantial design analysis will be conducted, working with stakeholders. This more substantial design analysis will look at site specific conditions to better inform the decision on bank protection versus launchable rock.
JJ-22	Sacramento County	Letter	NEPA	Section 1.1 of the EIS/EIR describes the process for evaluating site-specific conditions in the design phase of the project and determining whether any supplemental NEPA/CEQA analysis will need to be conducted prior to construction.
JJ-23	Sacramento County	Letter	Coordination	As part of the ongoing coordination for the ARCF GRR, site-specific designs would be shared when they are developed during the Design Phase.

DEPARTMENT OF DEFENSE

Department of the Army; Army Corps of Engineers

Notice of Intent To Prepare an Environmental Impact Statement for 408 Permission and 404 Permit to Three Rivers Levee Improvement Authority for the Feather River Levee Repair Project, California, Segment 2

AGENCY: Department of the Army, U.S. Army Corps of Engineers, DoD.

ACTION: Notice of intent.

SUMMARY: The action being taken is the preparation of an Environmental Impact Statement (EIS) for the issuance of both the 408 permission to the Central Valley Flood Protection Board and 404 Permit to Three Rivers Levee Improvement Authority (TRLIA) for their work on the Feather River Levee Repair Project (FRLRP). Under 33 U.S.C. 408, the Chief of Engineers grants permission to alter an existing flood control structure if it is not injurious to the public interest and does not impair the usefulness of such work. Under section 404 of the Clean Water Act, the District Engineer permits the discharge of dredged or fill material into waters of the United States if the discharge meets the requirements of the Environmental Protection Agency's 404(b)(1) guidelines and is not contrary to the public interest. The FRLRP is located in Yuba County, CA. TRLIA is requesting this permission and permit in order to complete construction along the east levee of the Feather River.

DATES: A public scoping meeting will be held March 10, 2008, 6:30 to 8:30 at the Yuba County Government Center, 915 8th Street, Marysville, CA. Send written comments by April 9, 2008 to the address below.

ADDRESSES: Send written comments and suggestions concerning this study to Mr. John Suazo, U.S. Army Corps of Engineers, Sacramento District, Attn: Planning Division (CESPK–PD–R), 1325 J Street, Sacramento, CA 95814. Requests to be placed on the mailing list should also be sent to this address.

FOR FURTHER INFORMATION CONTACT: Questions about the proposed action and EIS should be addressed to John Suazo at (916) 557–6719, e-mail: *john.suazo@usace.army.mil* or by mail to (see **ADDRESSES**).

SUPPLEMENTARY INFORMATION:

1. *Proposed Action.* The U.S. Army Corps of Engineers is preparing an EIS to analyze the impacts of the work proposed by TRLIA from the implementation of the FRLRP, Segment 2. The FRLRP, Segment 2 is being constructed by TRLIA to improve flood protection to portions of Yuba County and Reclamation District (RD) 784.

2. *Alternatives.* The EIS will address an array of flood control improvement alternatives along Segment 2. Alternatives analyzed during the investigation will include a combination of one or more flood protection measures. These measures include seepage berms, stability berms, setback levees, seepage cutoff walls, and relocation of a pump station.

3. *Scoping Process.* a. The Corps has initiated a process to involve concerned individuals, and local, State, and Federal agencies. A public scoping meeting will be held on March 10, 2008 to present information to the public and to receive comments from the public.

b. Significant issues to be analyzed in depth in the EIS include effects on hydraulic, wetlands and other waters of the U.S., vegetation and wildlife resources, special-status species, cultural resources, land use, fisheries, water quality, air quality, transportation, and socioeconomics; and cumulative effects of related projects in the study area.

c. The Corps is consulting with the State Historic Preservation Officer to comply with the National Historic Preservation Act, and the National Marine Fisheries Service and the U.S. Fish and Wildlife Service to comply with the Endangered Species Act. Coordination with the National Marine Fisheries Service has been completed; coordination with U.S. Fish and Wildlife Service is still ongoing.

d. A 45-day public review period will be provided for individuals and agencies to review and comment on the draft EIS. All interested parties are encouraged to respond to this notice and provide a current address if they wish to be notified of the draft EIS circulation.

4. *Availability.* The draft EIS is scheduled to be available for public review and comment in early 2008.

Dated: February 22, 2008.

Thomas C. Chapman,

COL, EN, Commanding.

[FR Doc. E8–3919 Filed 2–28–08; 8:45 am]

BILLING CODE 3710–EZ–P

DEPARTMENT OF DEFENSE

Department of the Army; Army Corps of Engineers

Notice of Intent To Prepare an Environmental Impact Statement for the American River Common Features General Reevaluation Report, Sacramento, CA

AGENCY: Department of the Army, U.S. Army Corps of Engineers; DOD.

ACTION: Notice of intent.

SUMMARY: The action being taken is the preparation of an environmental impact statement (EIS) for the American River Common Features General Reevaluation Report (GRR). The Common Features Project GRR will re-evaluate the currently authorized plan as well as develop and evaluate other viable alternatives, including a locally-preferred plan, with the goal of identifying a comprehensive plan that will lower the risk of flooding in and around the City of Sacramento. The Common Features Project GRR is located in Sacramento, Sutter and Yolo Counties, CA.

DATES: A series of public scoping meetings will be held as follows:

1. March 5, 2008, 5 to 7 p.m. at The Elk's Lodge.

2. March 6, 2008, 5 to 7 p.m. at Arden Park Community Center, Room A.

3. March 10, 2008, 3 to 6 p.m. at The Library Galleria East Meeting Room.

4. March 13, 2008, 5 to 7 p.m. at The Sierra Health Foundation.

Send written comments by April 11, 2008 to the address below.

ADDRESSES: Written comments and suggestions concerning this study may be submitted to Ms. Elizabeth Holland, U.S. Army Corps of Engineers, Sacramento District, Attn: Planning Division (CESPK–PD–R), 1325 J Street, Sacramento, CA 95814. Requests to be placed on the mailing list should also be sent to this address. The location of the public meetings is as follows; The Elks Lodge, 6446 Riverside Blvd., Sacramento, CA; Arden Park Community Center, 1000 La Sierra Drive, Sacramento, CA; Library Galleria, 828 ''I'' Street, Sacramento, CA; and Sierra Health Foundation, 1321 Garden Highway, Sacramento, CA.

FOR FURTHER INFORMATION CONTACT: Questions about the proposed action and EIS should be addressed to Liz Holland at (916) 557–6763, e-mail *Elizabeth.g.holland@usace.army.mil* or by mail to (see **ADDRESSES**).

SUPPLEMENTARY INFORMATION:

1. *Proposed Action.* The U.S. Army Corps of Engineers is preparing an EIS

to analyze the impacts of a range of alternatives that would lessen the risk of flooding in and around the City of Sacramento.

2. *Alternatives.* The EIS will address an array of flood control improvement alternatives that are intended to reduce flood risk within the project area. Alternatives analyzed during the investigation will include a combination of one or more flood protection measures. These measures include levee improvements (e.g., seepage berms, adjacent setback levees, seepage wells, seepage cutoff walls), revisions to system hydraulics through setbacks, levee raises, and/or more diversion of flow into the bypass system, and possible use of upstream lands for detention.

3. *Scoping Process.* a. A series of public scoping meeting will be held in early March, 2008 to present information to the public and to receive comments from the public. These meetings are intended to initiate the process to involve concerned individuals, and local, State, and Federal agencies.

b. Significant issues to be analyzed in depth in the EIS include effects on hydraulics, wetlands and other waters of the U.S., vegetation and wildlife resources, special-status species, esthetics, cultural resources, recreation, land use, fisheries, water quality, air quality, transportation, and socioeconomics; and cumulative effects of related projects in the study area.

c. The Corps is consulting with the State Historic Preservation Officer to comply with the National Historic Preservation Act and the U.S. Fish and Wildlife Service and National Marine Fisheries Service to comply with the Endangered Species Act. The Corps is also coordinating with the U.S. Fish and Wildlife Service to comply with the Fish and Wildlife Coordination Act.

d. A 45-day public review period will be provided for individuals and agencies to review and comment on the draft EIS. All interested parties are encouraged to respond to this notice and provide a current address if they wish to be notified of the draft EIS circulation.

4. *Availability.* The draft EIS is scheduled to be available for public review and comment in spring 2010.

Dated: February 15, 2008.

Thomas C. Chapman,

COL, EN, Commanding.

[FR Doc. E8–3922 Filed 2–28–08; 8:45 am]

BILLING CODE 3710–EZ–P

DEPARTMENT OF DEFENSE

Department of the Navy

Meeting of the Ocean Research and Resources Advisory Panel

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: The Ocean Research and Resources Advisory Panel (ORRAP) will meet to discuss National Ocean Research Leadership Council (NORLC) and Interagency Committee on Ocean Science and Resource Management Integration (ICOSRMI) activities. All sessions of the meeting will be open to the public.

DATES: The meeting will be held on Tuesday, April 15, 2008 from 8 a.m. to 5:30 p.m. and Wednesday, April 16, 2008 from 8 a.m. to 1:30 p.m.

ADDRESSES: The meetings will be held at the Consortium for Ocean Leadership located at 1201 New York Ave, Suite 420, Washington, DC.

FOR FURTHER INFORMATION CONTACT: Dr. Charles L. Vincent, Office of Naval Research, 875 North Randolph Street, Suite 1425, Arlington, VA 22203–1995, telephone: 703–696–4118.

SUPPLEMENTARY INFORMATION: This notice is provided in accordance with the provisions of the Federal Advisory Committee Act (5 U.S.C. App. 2). The meeting will include discussions on ocean research to applications, ocean observing, professional certification programs, and other current issues in the ocean science and resource management communities. In order to maintain the meeting time schedule, members of the public will be limited in their time to speak to the Panel. Members of the public should submit written comments at least one week prior to the meeting to Dr. Charles L. Vincent, Office of Naval Research, 875 North Randolph Street, Suite 1425, Arlington, VA 22203–1995, telephone: 703–696–4118.

Dated: February 22, 2008.

T.M. Cruz,

Lieutenant, Office of the Judge Advocate General, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. E8–3893 Filed 2–28–08; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF DEFENSE

Department of the Navy

[USN–2008–0008]

Privacy Act of 1974; System of Records

AGENCY: Department of the Navy, DoD.

ACTION: Notice to Amend a System of Records.

SUMMARY: The Department of the Navy is amending a system of records notice in its existing inventory of record systems subject to the Privacy Act of 1974, (5 U.S.C. 552a), as amended.

DATES: This proposed action will be effective without further notice on March 31, 2008 unless comments are received which result in a contrary determination.

ADDRESSES: Send comments to the Department of the Navy, PA/FOIA Policy Branch, Chief of Naval Operations (DNS–36), 2000 Navy Pentagon, Washington, DC 20350–2000.

FOR FURTHER INFORMATION CONTACT: Mrs. Doris Lama at (202) 685–6545.

SUPPLEMENTARY INFORMATION: The Department of the Navy systems of records notices subject to the Privacy Act of 1974, (5 U.S.C. 552a), as amended, have been published in the **Federal Register** and are available from the address above.

The specific changes to the record system being amended are set forth below followed by the notice, as amended, published in its entirety. The proposed amendments are not within the purview of subsection (r) of the Privacy Act of 1974, (5 U.S.C. 552a), as amended, which requires the submission of a new or altered system report.

Dated: February 25, 2008.

L.M. Bynum,

Alternate OSD Federal Register Liaison Officer, Department of Defense.

N01000–3

SYSTEM NAME:

Navy Individual Service Review Board (ISRB) Proceedings Application File (March 18, 1997, 62 FR 12806).

CHANGES:

SYSTEM NAME:

Delete entry and replace with ''DoD Civilian/Military Service Review Board.''

SYSTEM LOCATION:

Delete entry and replace with ''Navy Personnel Command (PERS–312), 5720

DEPARTMENT OF TRANSPORTATION
DISTRICT 3 – SACRAMENTO AREA OFFICE
VENTURE OAKS, MS 15
P. O. BOX 942874
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Flex your power!
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March 26, 2008

08SAC0046
03-SAC- 5 / 160 / 50 / 51 / 80
American River Common Features General Evaluation Report
Notice of Preparation
SCH# 2005072046

Ms. Annalena Bronson
Central Valley Flood Protection Board
3310 El Camino Avenue, Room LL-40
Sacramento, CA 95821

Dear Ms. Bronson:

We have reviewed the American River Common Features General Re-evaluation Report Notice of Preparation documentation. Our comments are as follows:

- Caltrans' prior comments in our letters of July 27, 2005 and October 3, 2002 (copies enclosed) are still valid.

- In carrying out this project's levee improvement activities, it is very likely that truck haul routes used in transporting soil, rock, borrow and cleared vegetation disposal materials to and from the various proposed sites along the American and Sacramento Rivers and Natomas Cross Canal and Natomas East Main Drainage Canal could involve the use of Interstate 5, State Route (SR) 160, U.S. 50, SR51, and I-80. We note on page 2 in the "Study Area" discussion and on Page 6's map of the project levee areas that this "project's" scope is quite large. Clarification should be made regarding which of the multiple levee improvement areas will use trucks and which will use waterside barges to transport work materials.

- If off-site levee materials are being transported by truck to these work sites to modify levee bank areas and are using adjoining State roadway facilities, a project Traffic Management Plan (TMP) will be necessary. The TMP should be prepared for our review and include appropriate strategies to mitigate construction traffic impacts to the nearby roadway intersections, freeway interchanges, and mainlines. Truck haul routes and points of access to State roadway facilities used should be clarified in the plan. If Garden Highway will be used as an access to some of the improvement areas, the TMP should explain how Garden Highway is to be accessed, whether from I-5 or via a local road network. The project's individual levee site work plan dates should also be provided, if known, and the truck trip volumes. We recommend truck-hauling operations avoid peak traffic periods (6-10 AM and 3-7 PM) whenever possible. The Caltrans TMP Guidelines are enclosed for your use. For assistance, please contact Paul Wilkinson, the Caltrans District 3 Traffic Manager (DTM), at (916) 859-7978.

- If electronic warning signs are provided within State right-of-way at work sites to alert the traveling public of trucks entering or leaving State highways, an encroachment permit will be required. For permit assistance, please contact Julio Elvir at (530) 741-4204.

- Caltrans is interested in the work zone proximity of this project's planned levee improvements on the Sacramento River near the system of relief wells and piezometer installations near the downtown Sacramento I-5 freeway and within State property. Freeway Post Mile locations may have been established for these well and piezometer locations when they were installed to help prevent levee seepage near the subgrade section of Interstate 5 (more commonly called, "the Boat Section"). The distance of well locations from freeway bridge footings might have been specified as well to help locate where they are. We understand that Encroachment Permit # 0304-NMC-0918 was obtained from Caltrans District 3 in prior years when this installation work was done. Caltrans wishes to make sure that these wells and piezometer locations are not disturbed during the levee bank work. Preliminary planning installation maps, showing where the wells and piezometers were located in relation to our right-of-way lines and freeway facilities, and "As Built" maps, were prepared for Caltrans to update its right of way records of the Interstate 5 freeway corridor.

If you have any questions regarding these comments, please contact Ken Champion at (916) 274-0615.

Sincerely,

Dawn Cheser, Office Chief
Office of Transportation Planning - South

Enclosure

c: Scott Morgan, State Clearinghouse

DEPARTMENT OF TRANSPORTATION
DISTRICT 3 – SACRAMENTO AREA OFFICE
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P. O. BOX 942874
SACRAMENTO, CA 94274-0001
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TTY (530) 741-4509

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July 27, 2005

05SAC0112
03-SAC- 99 PM 35.370
American River Watershed Project Common Features
Sacramento River East Levee & Natomas Cross Canal Levee Modifications
Notice of Preparation
SCH# 2005072046

Ms. Annalena Bronson
The Reclamation Board
3310 El Camino Avenue, Room 110
Sacramento, CA 95821

Dear Ms. Bronson:

We have reviewed the Sacramento River East and Natomas Cross Canal Levee Modifications Project Notice Of Preparation documentation. We look forward to reviewing the draft Environmental Impact Report. Our comments are as follows:

- Our comments provided in our letter of October 3, 2002 (copy enclosed) are still valid.

- The document map of the Sacramento River work site shows Elverta and Power Line Roads as potential access roadways. If off-site levee materials are being transported by truck to this work site to modify these levees and are using adjoining State roadway facilities, a project Traffic Management Plan (TMP) will be necessary. The TMP should be prepared for our review and include appropriate strategies to mitigate construction traffic impacts to the nearby State Route 99/Elverta Road intersection and other nearby freeway interchanges. The TMP should also clarify whether Interstate 5 would be used via Power Line Road. The Caltrans TMP Guidelines are enclosed for your use. Truck haul routes and points of access to State roadway facilities used should be clarified in the plan. The planned project initiation and completion dates should also be noted, as well as truck trip volumes, daily hours of operations, and whether electronic warning signs are provided to alert the traveling public. We recommend truck hauling operations during non-peak traffic periods.

Please provide our office with a copy of the draft TMP requested above. If you have any questions regarding these comments, please contact Ken Champion at (916) 274-0615.

Sincerely,

ORIGINAL SIGNED BY
KATHERINE EASTHAM, Chief
Office of Transportation Planning - Southwest

Enclosures

c: Scott Morgan, State Clearinghouse

Sutter County Community Services
1130 Civic Center Boulevard, Suite E
Yuba City, CA 95993

bc: John Holzhauser, Office of Traffic Operations – Sacramento
Michelle Millette, District 3 – Sutter County LDR Coordinator
Ken Champion, District 3 – Sacramento County LDR Coordinator

KC/ kc

DEPARTMENT OF TRANSPORTATION
DISTRICT 3 – Sacramento Area Office
Venture Oaks, MS 15
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FAX (916) 274-0648
TTY (530) 741-4509

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October 3, 2002

02SAC0114
03-SAC- 99
American River Watershed Project (Common Features)
California Sacramento River East Levee/Natomas Cross Canal Levee Modifications
Notice of Preparation
SCH#1999052026

Ms. Karen Enstrom
Reclamation Board
1416 Ninth Street, Room 1601
Sacramento, CA 95814

Dear Ms. Enstrom:

Thank you for the opportunity to comment on the above mentioned project. Our comments are as follows:

- The project documentation should provide a map (s) describing the project "activity areas" and any nearby State highway facilities in order to clarify the scope of project and potential impacted highway and bridge structure areas.

- Any flood control improvements and protection measures located near State right-of-way should be identified and Caltrans should be notified. Any work conducted within State right-of-way will require an encroachment permit. For assistance, Bruce Capaul at (530) 741-4408 should be contacted.

- Haul routes for transporting soil and construction materials and any State highways used should be provided in the project discussion.

Please provide our office with the requested information, a copy of the DEIR, copies

of draft mitigation measures, and any further action regarding this project. If you have any questions regarding these comments, please contact Ken Champion at (916) 274-0615.

Sincerely,

ORIGINAL SIGNED BY:

JEFFREY PULVERMAN, Chief
Office of Regional Planning

bc: John Holzhauser, Office of Traffic Operations – Sacramento
Karen Peneschi, Office of Advance and System Planning
Steve Hetland, Special Funded - Sacramento
Jim Adams, Office of Right of Way Engineering
Tom Ganyon, Office of Right of Way-Local Assistance
Dennis Jagoda, Hydraulics
Bruce Capaul, Permits
KenChampion, District 3 – Sacramento County LDR Coordinator

KC/ kc

Posters from March 2008 Scoping Meetings

About the Re-evaluation Report

Flooding is a long-standing problem facing the Sacramento area. The recent floods of 1986 and 1997 devastated several communities, including homes, businesses, orchards and farmlands. In 1996 the Water Resources Development Act authorized the American River Common Features Project (CFP), designed to lessen flood risks in Sacramento. Since the authorization of the CFP 12 years ago, a great deal of progress has been made to improve the flood control system. However, new information and issues have been identified and new engineering standards have been instituted. As a result, there are continuing concerns about the integrity of Sacramento's flood control management system.

As a result, the U.S. Army Corps of Engineers plans to conduct a re-evaluation report called the American River Common Features General Re-evaluation Report (Common Features GRR) that will look at the existing CFP with the purpose of identifying alternatives to lower the risk of flooding to the City of Sacramento. The Common Features GRR will examine the City's flood management system as a whole, rather than on a site-by-site, project-by-project basis.

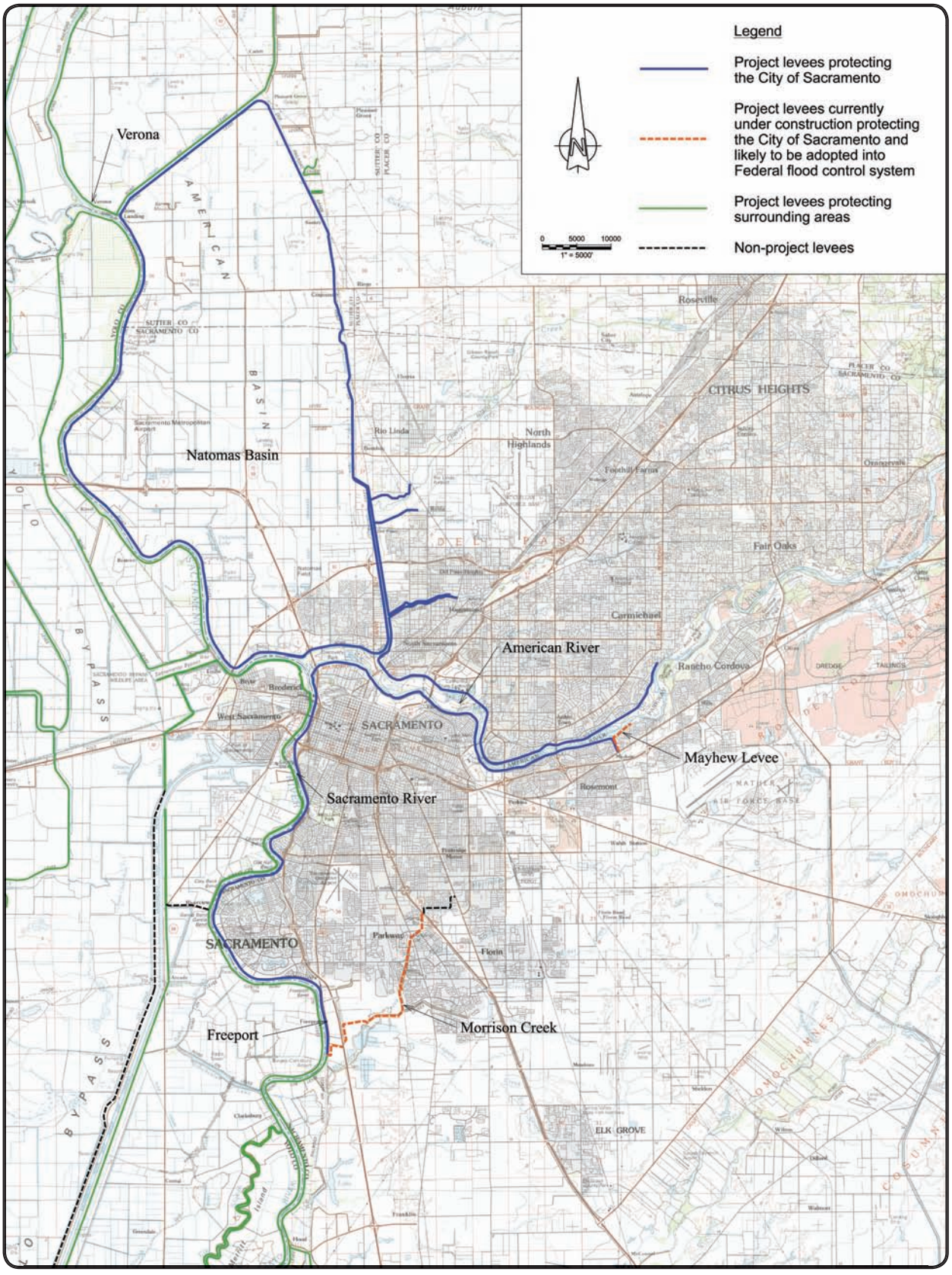
The purpose of the Common Features GRR is to review the CFP with the aim of making recommendations for changes or additions that will effectively and efficiently reduce flood risks within the American River Watershed. This includes the flood control features along the American and Sacramento Rivers that provide protection to the City of Sacramento and surrounding areas.

In a separate effort, the Sacramento Area Flood Control Agency (SAFCA) is currently working on a flood control program specific to Natomas to provide the area with 100-year flood protection as soon as possible, and ultimately, in cooperation with this study, 200-year protection. These improvements could be completed before the Common Features GRR is conducted because of the high risk of catastrophic flooding in Natomas. It is anticipated that SAFCA's program will eventually be incorporated into the Common Features GRR.

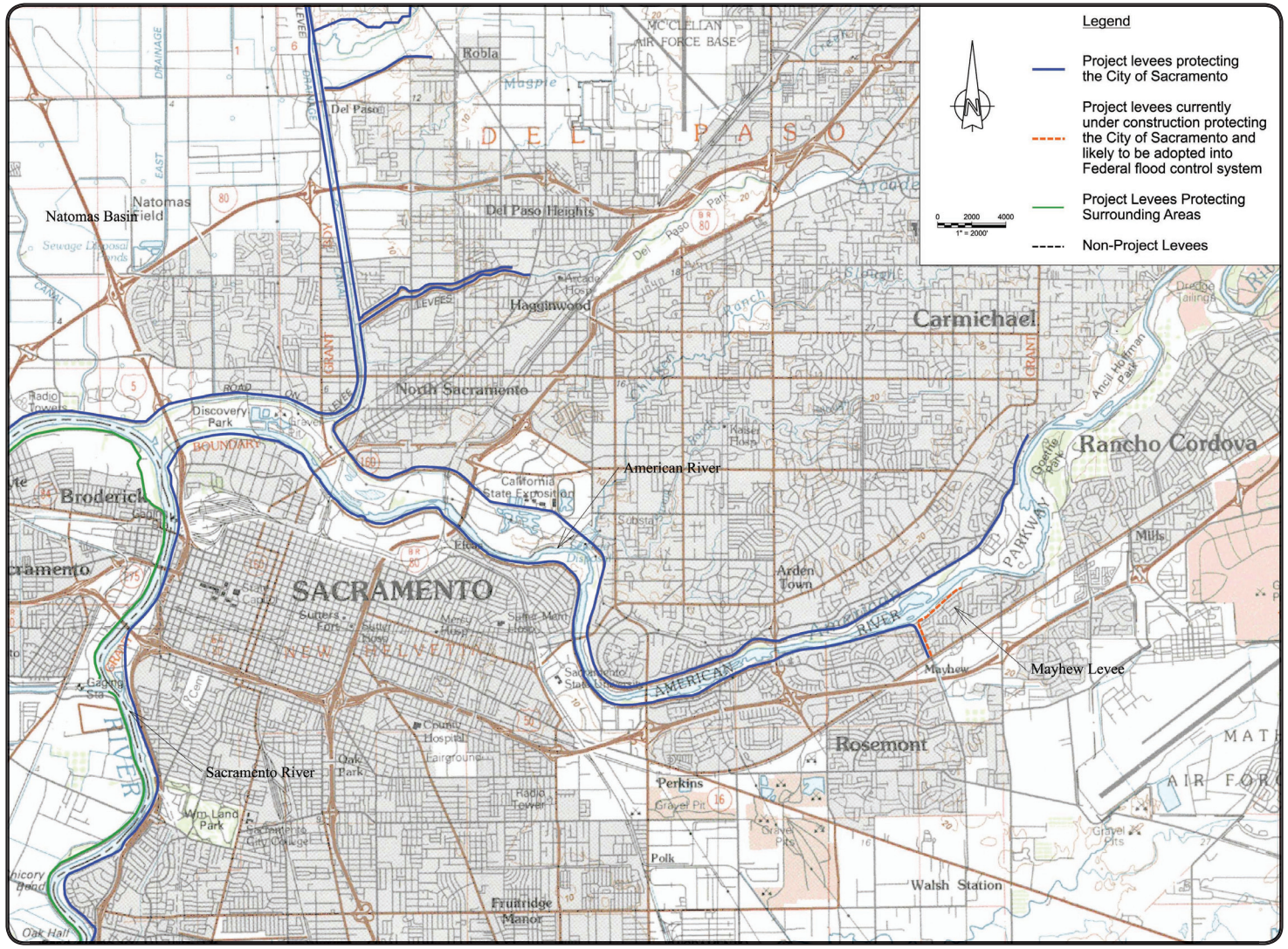
US Army Corps of Engineers Sacramento District

SAFCA

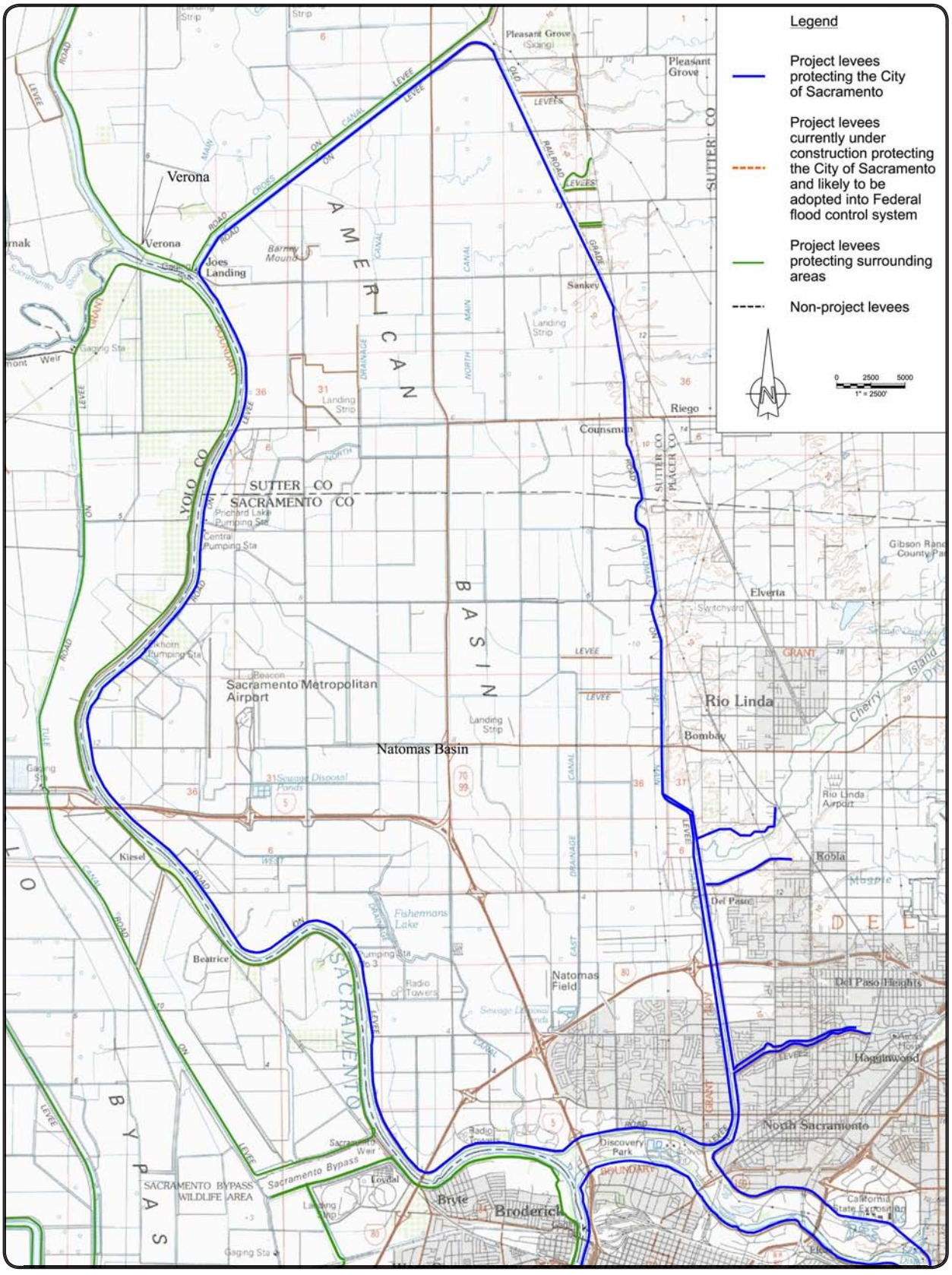
Study Area


Legend
Project levees protecting the City of Sacramento
Project levees currently under construction protecting the City of Sacramento and likely to be adopted into Federal flood control system
Project levees protecting surrounding areas
Non-project levees
0 5000 10000
1" = 5000'
Verona
Natomas Basin
American River
Mayhew Levee
Sacramento River
Freeport
Morrison Creek
SACRAMENTO
CITRUS HEIGHTS
Roseville
Rio Linda
North Highlands
Fair Oaks
Carmichael
Rancho Cordova
Elk Grove
AMERICAN BASIN
BYPASS

Lower American River



Natomas Basin

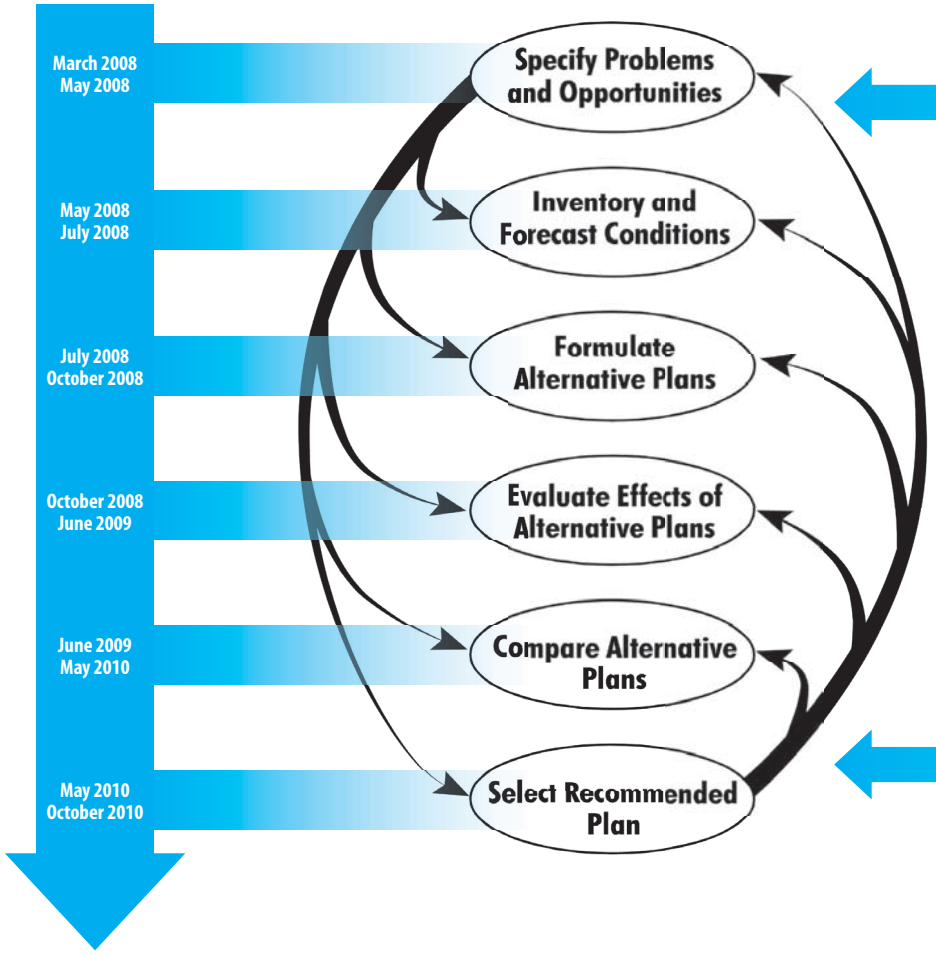


Sacramento River from American River to Freeport

Planning Process

The Corps' "Beehive" diagram represents the six planning steps and the iterative process of Corps project planning.

Corps decision making is generally based on the accomplishment and documentation of all of these steps. It is important to stress the iterative nature of this process. As more information is acquired and developed, it may be necessary to reiterate some of the previous steps. The six steps, though presented and discussed in a sequential manner for ease of understanding, usually occur iteratively and sometimes concurrently. Iterations of steps are conducted as necessary to formulate efficient, effective, complete and acceptable plans.



Previous investigations and ongoing/completed projects will inform the Common Features GRR

Completed and Ongoing Projects

A great deal of progress has been made since the major flood events in 1986 and 1997. The projects listed below are examples of recent efforts to increase the level of flood protection in the Sacramento area. These efforts will inform and be coordinated with the Common Features GRR planning process.

American River Common Features Projects

- Slurry Wall Construction along the Lower American River (24 miles completed)
- Upstream Telemetry Gages (completed)
- Erosion Protection (4 sites completed)
- Jet Grouting/Alternative Methods (ongoing)
- Seepage Remediation along the Sacramento River (completed)
- Mayhew Levee Raise and Drain Closure (under construction)
- Levee Raising and Strengthening (various sites remaining)

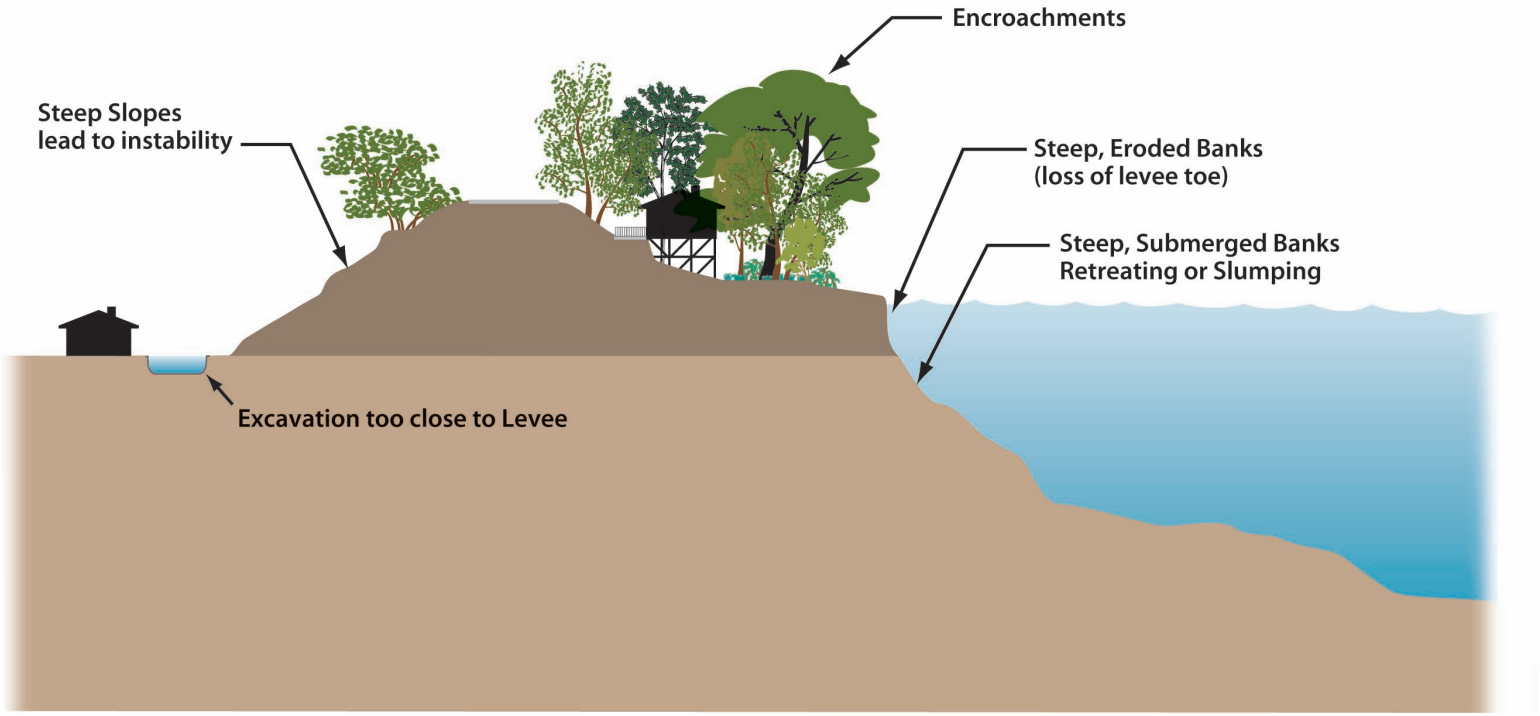
Other Major Flood Protection Projects

- Folsom Dam Reoperation (ongoing)
- Natomas Levee Improvement Project (ongoing)
- Sacramento River Bank Protection Project (Corps/CVFPB) (ongoing)
- West Sacramento Levee Improvement Project (Corps/City of West Sacramento) (ongoing)
- South Sacramento Streams Group Project (Corps/SAFCA) (ongoing)
- Joint Federal Project at Folsom Dam (Corps/Bureau of Reclamation/CVFPB/SAFCA)

US Army Corps of Engineers Sacramento District

SAFCA

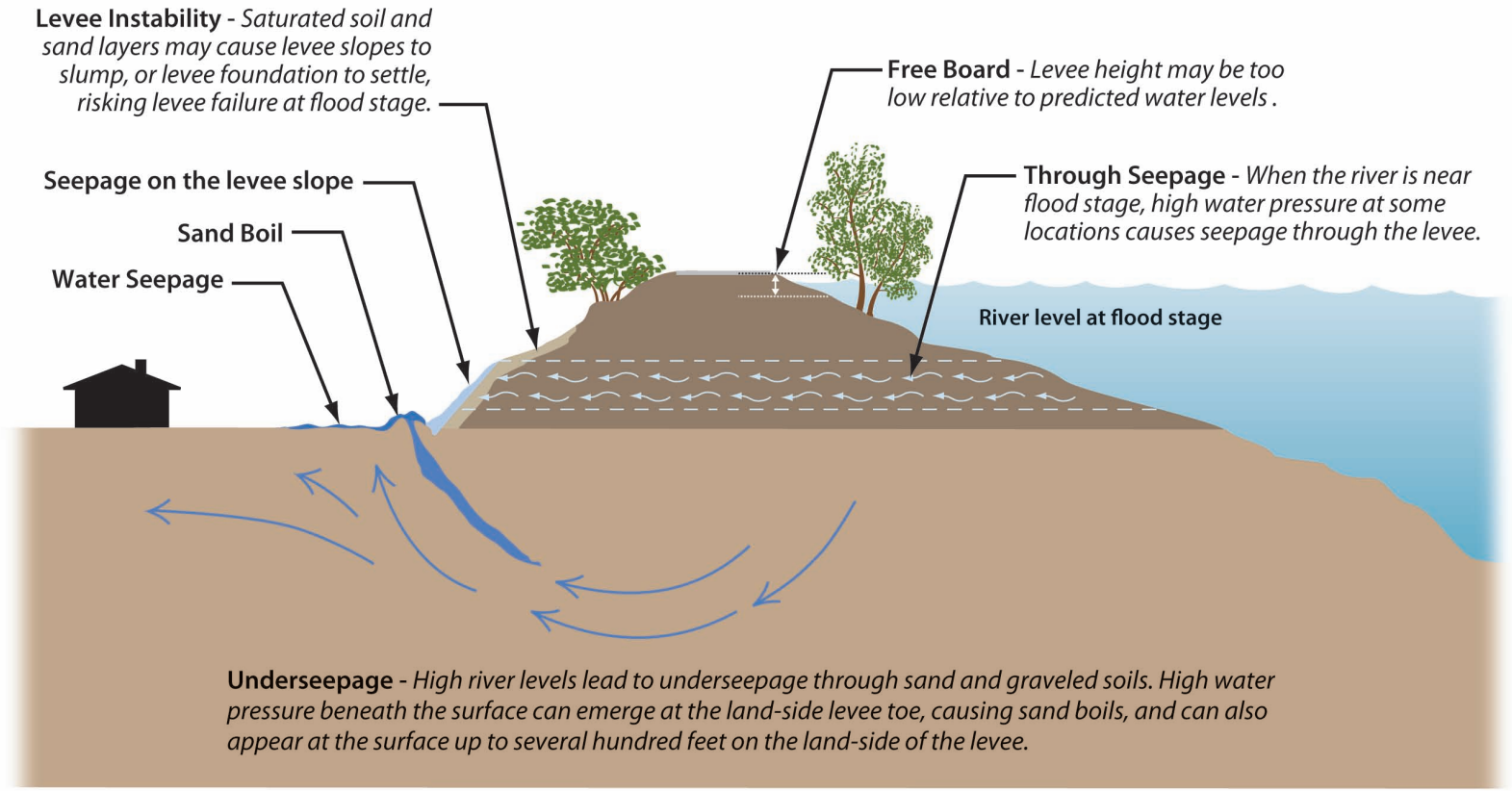
Encroachments, Unstable Slopes, Erosion



- Unstable Slopes - irregular or overly steep slopes compromise the levee structure
- Encroachments including pools, homes, vegetation
- Erosion - water flow, wakes and waves, remove soil material, degrading the levee

Typical Levee Deficiencies

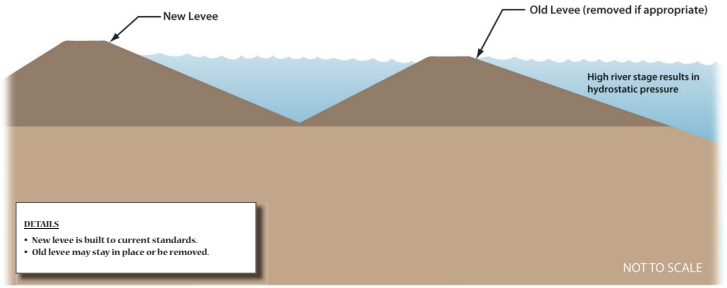
Seepage and Inadequate Freeboard



- Inadequate Freeboard - levee height may be too low relative to predicted water levels

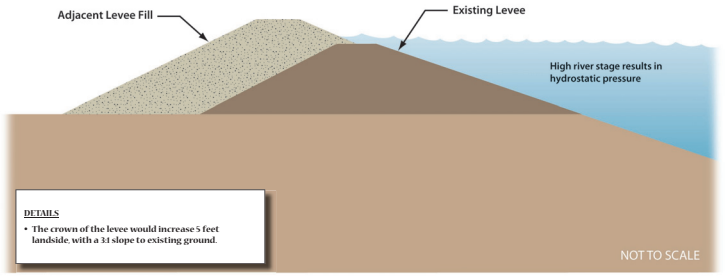
IMPROVEMENTS TO FLOOD CONTROL FEATURES THAT ADDRESS STABILITY, EROSION AND FREEBOARD

Setback Levee (stability, seepage, & freeboard)



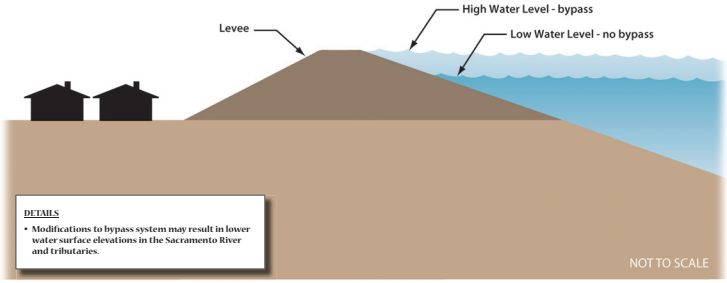
Concept:
A new levee is built toward the landside of an existing levee where the existing levee is not readily repairable or where more flooding capacity is desired.

Adjacent Levee Raise (stability, seepage, & freeboard)



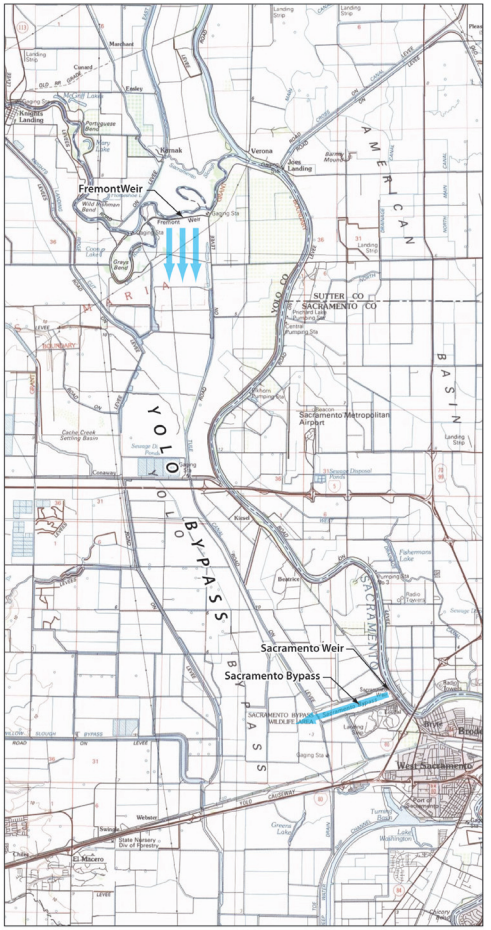
Concept:
A new embankment strengthens the existing levee and enlarges the slopes.

Diversion to Bypass System (seepage, stability, & freeboard)



Concept:
Reducing water surface elevations by modifying diversion to the bypass system may also reduce seepage and stability issues by reducing hydrostatic pressure. Lower water surface elevations will also alleviate freeboard issues.

Diversion to Bypass System (seepage, stability, & freeboard)



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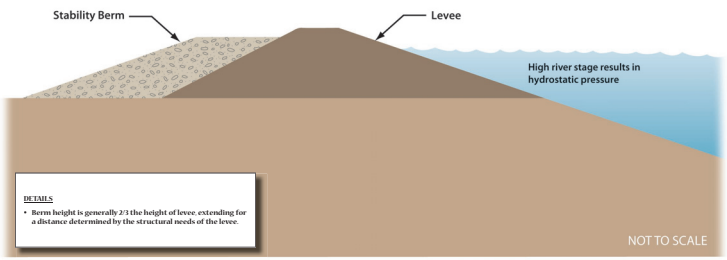
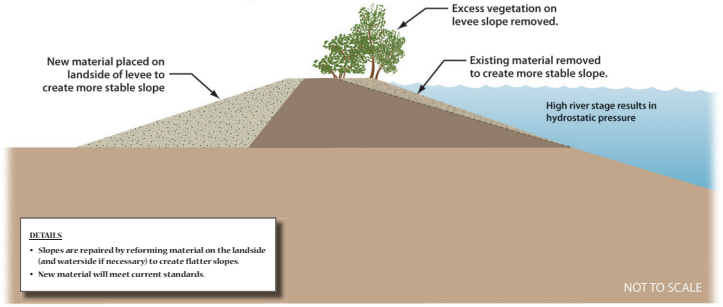
IMPROVEMENTS TO LEVEES THAT ADDRESS STABILITY, EROSION AND FREEBOARD

Stability Berm (stability)



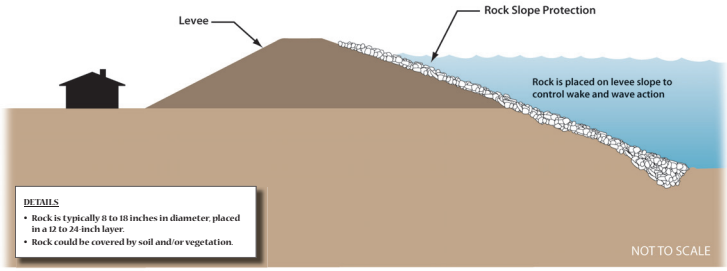
Concept:
Provides additional support to levee to increase strength.

Slope Flattening (stability)



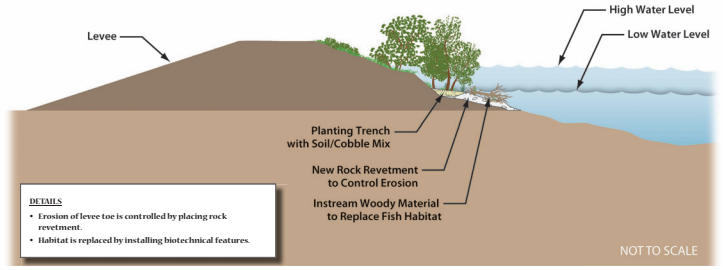
Concept:
Flatter slopes are more stable and less susceptible to erosion. Excess vegetation may inhibit levee maintenance and performance monitoring.

Rock Slope Protection (erosion)



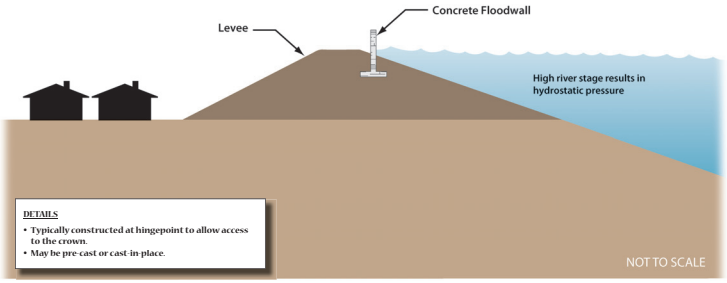
Concept:
Water-side erosion is prevented by placement of rock.

Biotechnical Erosion Protection (erosion)



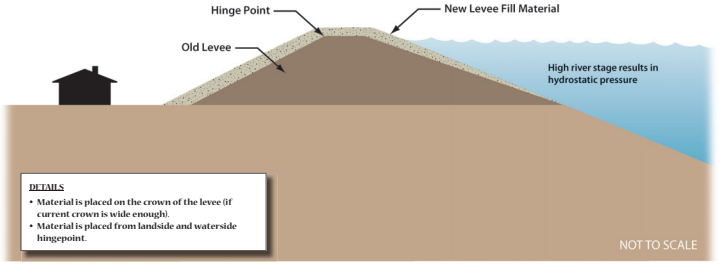
Concept:
Placing rock revetment at toe of eroding levee controls erosion. Installing biotechnical features replaces habitat and further controls erosion.

Flood Wall (freeboard)



Concept:
Additional levee height may be achieved through construction of a concrete wall on the levee crown.

In-Place Levee Raise (freeboard)



Concept:
Flood protection is increased by adding material to crown and levee slope (land or water side).

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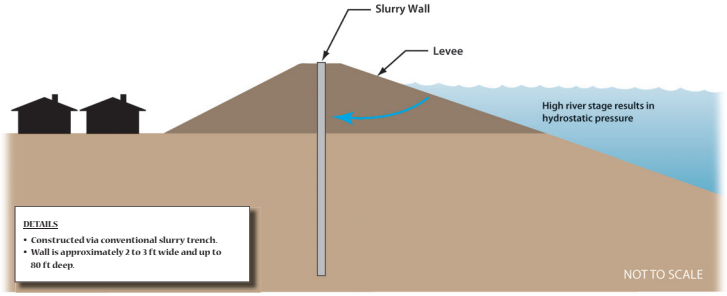
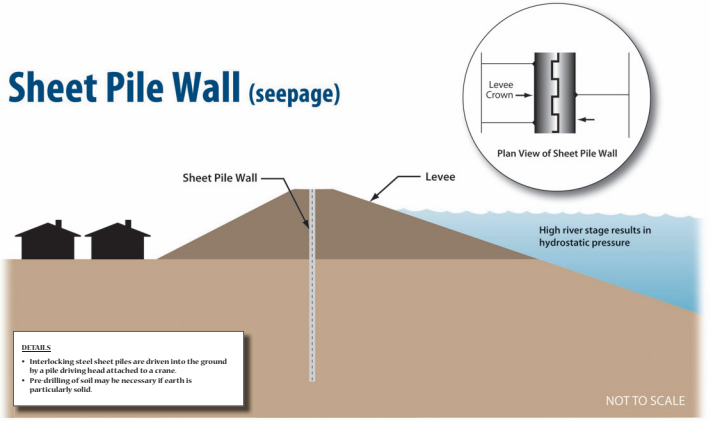
IMPROVEMENTS TO LEVEES THAT ADDRESS SEEPAGE

Slurry Wall (seepage)



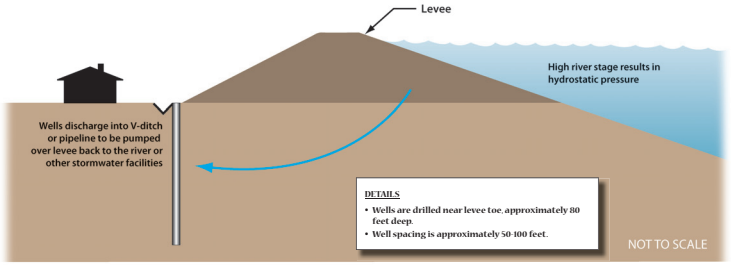
Concept:
Water pressure is contained and dispersed by a low-permeability wall constructed within the levee cross section.

Sheet Pile Wall (seepage)



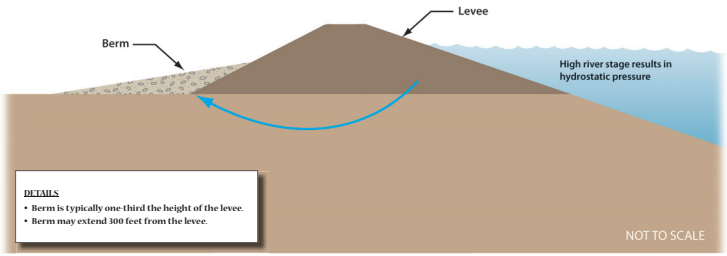
Concept:
Steel panels are driven into the levee core to provide a seepage barrier.

Relief Well (seepage)



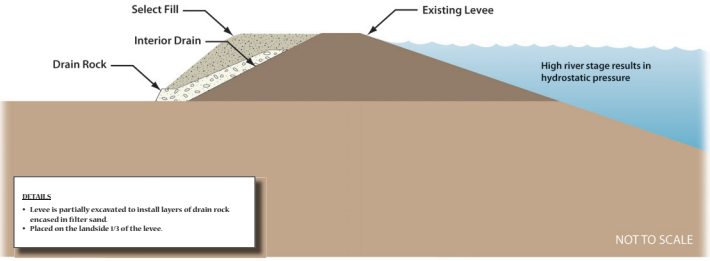
Concept:
Water pressure is relieved via passive wells, which control water discharge into a collection system.

Seepage Berm (seepage)



Concept:
Water pressure is contained and dispersed by a thickened soil layer.

Interior Drain (seepage)



Concept:
Capture any through-seepage and direct it away from the face of the levee.

U.S. Army Corps of Engineers

SAFCA

The process of determining the scope, focus and content of an EIS/EIR is known as "scoping". Scoping is a part of the NEPA/CEQA process in which the general public, interested agencies and stakeholders provide comments to the Lead Agency to help identify the key issues, range of actions, alternatives, and environmental affects to be analyzed in the EIS/EIR.

The following issues related to this project have been identified to date:

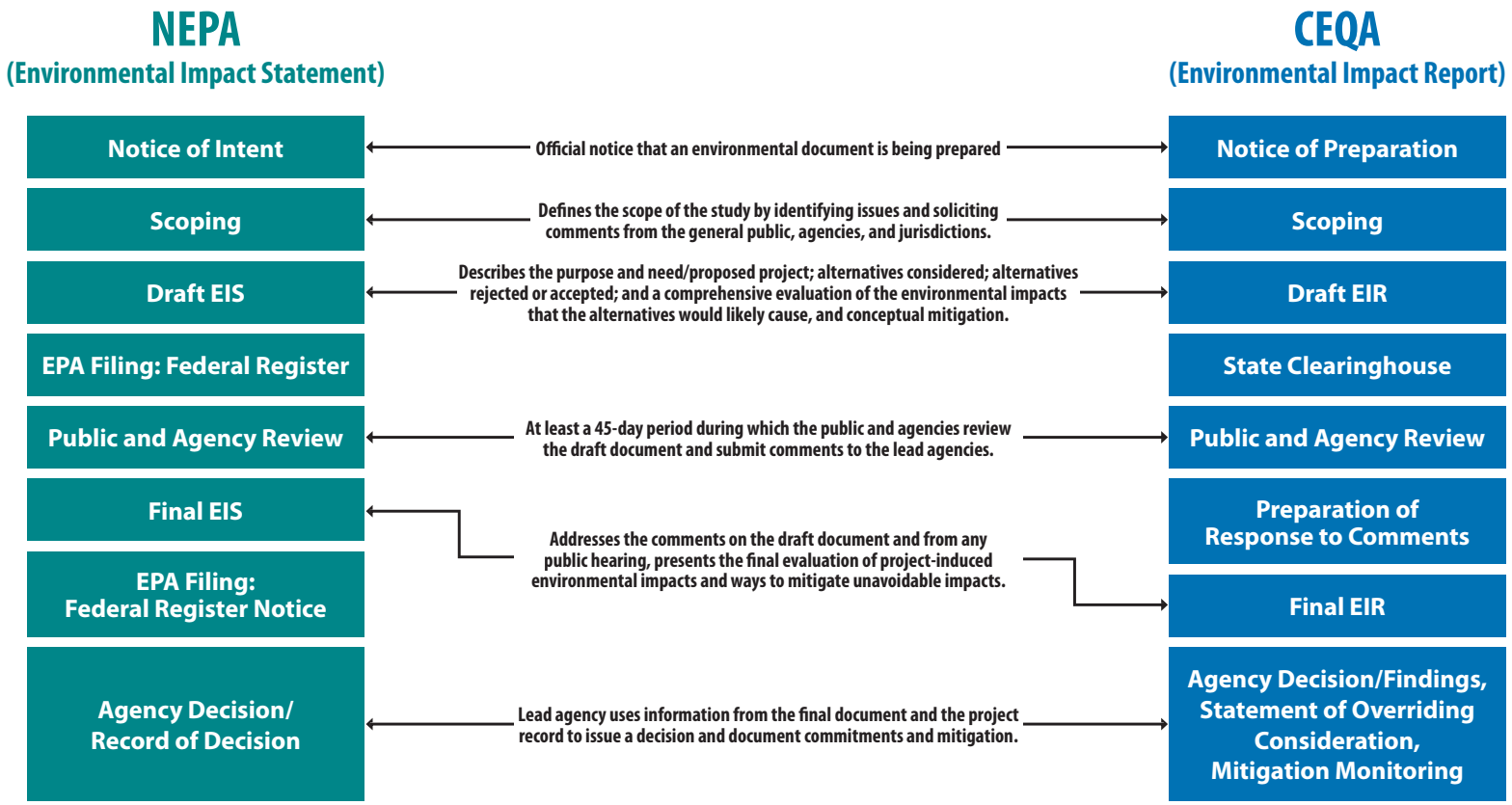
- Riparian vegetation and habitat effects;
- Cultural resources;
- Flood control and river hydraulic effect;
- Location of flood control infrastructure and effects on land use and access;
- Construction related effects such as those related to transportation, noise, and air quality;
- Economic issues

NEPA/CEQA Compliance

What is an EIS/EIR?

An EIS (Environmental Impact Statement) and an EIR (Environmental Impact Report) are documents that are required to comply with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA), respectively. The purpose of these documents is to analyze and disclose a project's potential effects on the natural and human environment and identify conservation measures and alternatives to avoid significant effects.

An EIS is prepared when there is Federal involvement in the project and an EIR is prepared when the project is subject to State or local jurisdiction. A joint document, an EIS/EIR, may be prepared when both a Federal and State agency are involved. The major steps to complying with both acts are outlined below.



Biological Assessment

American River Common Features
General Reevaluation Report

North Sacramento Streams Levee Improvement Project

September 2015

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American River Common Features Project
North Sacramento Streams Levee Improvement Project
Biological Assessment

1.0 Introduction

The U.S. Army Corps of Engineers (Corps) is requesting consultation with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Federal Endangered Species Act (ESA) to evaluate, on a biological assessment (BA) level, potential effects associated with levee modifications proposed under the American River Common Features (ARCF) General Reevaluation Report (GRR) Project. In addition, the Sacramento Area Flood Control Agency (SAFCA) is proposing to implement some segments of the ARCF GRR in advance of the Federal project. This BA addresses the overarching ARCF GRR project, and SAFCA's North Sacramento Streams Levee Improvement Project (NSS), a subset of the ARCF GRR. The purpose of this BA is to meet Section 7 consultation requirements as well as requirements of the Magnuson-Stevens Fishery Conservation and Management Act of 1997 (NMFS 1997). This BA was prepared in accordance with the Corps' Engineering Regulation 1105-2-100 (Corps 2000a).

Section 7 of the ESA requires Federal agencies to conserve listed species and their critical habitat, and to consult with USFWS and NMFS (the Services) to ensure that actions they fund, authorize, or perform do not jeopardize the existence of any listed species or result in the destruction or adverse modification of their designated critical habitat. The actions covered in this BA are associated with future levee modifications proposed for the ARCF GRR Project (Figure 1).

The Magnuson-Stevens Fishery Conservation and Management Act of 1997 (MSA) governs the conservation and management of commercially harvested ocean fisheries. The purpose of the Act is to take immediate action to conserve, protect, and manage U.S. coastal fishery resources, anadromous species, and Essential Fish Habitat (EFH). EFH is the aquatic habitat (water and substrate) that is necessary for fish to spawn, breed, feed, or mature, and that allows production levels needed to: (1) support a long-term, sustainable commercial fishery, and (2) contribute to a healthy ecosystem (NMFS 1997). The ARCF study area is designated as EFH habitat for Pacific salmon under Section 305(b)(2) of the MSA. Species to be addressed in this BA include:

- Fish species with designated EFH under the MSA;
- Listed species under the Federal Endangered Species Act; and
- Species with designated critical habitat under the ESA.

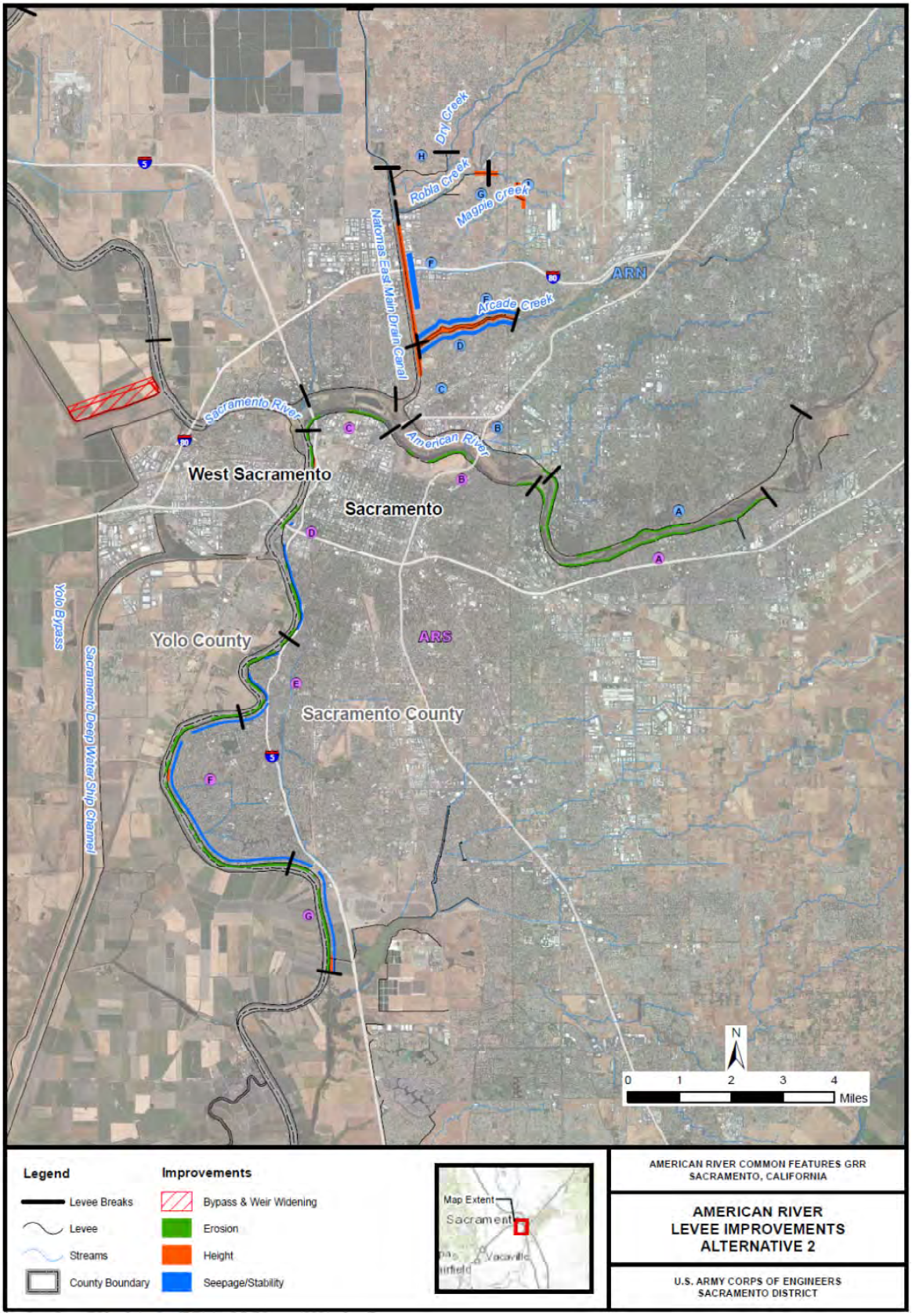

Figure 1. American River Common Features Study Area.

1.1 American River Common Features Study Area and Action Area

The study area is located within the Sacramento and American River Watersheds. The Sacramento River watershed covers approximately 26,000 square miles in central and northern California. Major tributaries of the Sacramento River include the Feather, Yuba, and American Rivers. The American River Watershed covers about 2,100 square miles northeast of the city of Sacramento and includes portions of Placer, El Dorado, Alpine, and Sacramento counties. The American River watershed includes Folsom Dam and Reservoir; inflowing rivers and streams, including the North, South, and Middle forks of the American River; and the lower American River downstream of Folsom Dam to its confluence with the Sacramento River in the city of Sacramento. The Sacramento and American Rivers, in the Sacramento area, form a flood plain covering roughly 110,000 acres at their confluence. The flood plain includes most of the developed portions of the city of Sacramento. Figure 1 shows the study area.

The city of Sacramento is the capitol of California, and thus is the government center for the state, which by itself has the 9th largest economy in the world. Many state offices located in downtown Sacramento, including the State Capitol building, are in areas that could be affected by flood events. Disruption of government services, and effects to emergency services and transportation corridors could have far ranging effects including life safety.

The ARCF study area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Dry, Robla, and Arcade Creeks and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento (Figure 1). This BA analyzes the effects of repairing the levees in the Sacramento area and widening the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass and alleviate the need to raise levees along the Sacramento River downstream of the bypass.

The action area for the ARCF GRR project includes the American River from below Folsom Dam to the confluence with the Sacramento River and the Sacramento River from the Sacramento Bypass down to below Freeport. In addition the action area includes the East Side Tributaries: the NEMDC, Dry, Robla, and Arcade Creeks, and the Magpie Creek Diversion Channel. The SAFCA NSS project includes approximately 5 miles of Arcade Creek and NEMDC, as well as an associated borrow site and staging areas. More information about these sites is included in the project description below.

The erosion repairs within the project area is likely to somewhat reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment perspective, the bank material we are protecting in the project

reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather and especially the Yuba River systems. All of the available sediment in the American River watershed is being contained behind Folsom Dam. For velocity, the site specific designs will be constrained from allowing any velocity increases outside the erosion repair site. Sediment impacts due to the bypass widening are not known at this time, except to say that the study would constrain the design to minimize impacts to sediment transport. Further studies associated with the Bypass widening would be conducted during the preconstruction engineering and design phase of the project, and any impacts to listed species that are discovered during these studies would be coordinated with the resource agencies at that time. The action area for the project is directly related to the study area where construction activities would occur.

The project is designed to allow for the release of 160,000 cubic feet per second (cfs) from Folsom Dam. The levees along the American River are unable to withstand these maximum flows for extended periods of time without increased risk of erosion and potential failure. The exact location where erosion would occur and to what extent erosion would occur during any given event is unknown. Erosion within the American River Parkway is being addressed as part of the Folsom Dam Water Control Manual Update currently under evaluation and a biological assessment is being prepared to initiate Section 7 consultation with both USFWS and NMFS. Therefore, the affects of erosion due to changes in operations from Folsom Dam are not analyzed in this BA because construction of the American River and Sacramento Bypass measures for the ARCF GRR, which are dependant on releases from Folsom Dam, would not occur until after a Biological Opinion is received for the Water Control Manual Update. Sacramento River and East Side Tributaries measures would be necessary to improve the flood risk management system in the Sacramento area regardless of the change in operation at Folsom Dam and are not dependant on Folsom Dam operations for their implementation. As a result, construction in these areas could occur regardless of the Folsom Dam Water Control Manual Update schedule.

The American River Common Features General Reevaluation Report (ARCF GRR) is being completed in accordance with the principles that have been outlined in the Corps' SMART Planning Guide (May 2012). SMART Planning requires that all feasibility studies should be completed within a target of 18 months (to no more than three years at the greatest), at a cost of no more than $3 million, utilizing 3 levels of vertical team coordination, and of a "reasonable" report size. The SMART Planning methodology and framework were developed to facilitate more efficient, effective, and consistent delivery of Planning Decision Documents. As a result of this effort, team members and decision makers are required to accept a lower level of detail and higher level of uncertainty during the pre-authorization study phase. All designs associated with this project are therefore preliminary, with the largest footprint considered for analysis of maximum affects to listed species and designated critical habitat. As design refinements and more site specific data becomes available, where practicable, it is anticipated that there will be reductions in effects to listed species and designated critical habitat.

On-going coordination with the Services will occur as the project progresses to the preliminary engineering design phase to ensure compliance with Section 7. The Corps would coordinate potential design refinements with the Services to avoid, minimize, and compensate for affects to listed species

and reinitiate consultation if necessary. The study area includes the protected species and critical habitat listed in Table 1, as well as fall-/late fall–run Chinook salmon, which has EFH within the study area.

Table 1. Federally Protected Species and Critical Habitat Addressed in this Biological Assessment.

Common Name	Scientific Name	Federal Status
Threatened and Endangered Species		
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	T
Sacramento River winter-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	E/MSA
Central Valley spring-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	T/MSA
Central Valley steelhead DPS	*Oncorhynchus mykiss*	T
Delta smelt	*Hypomesus transpacificus*	T
Green sturgeon southern DPS	*Acipenser medirostris*	T
Giant garter snake	*Thamnophis gigas*	T
Vernal pool fairy shrimp	*Branchinecta lynchi*	T
Vernal pool tadpole shrimp	*Lepidurus packardi*	E
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	T
Critical Habitat		
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	
Sacramento River winter-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	
Central Valley spring-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	
Central Valley steelhead DPS	*Oncorhynchus mykiss*	
Delta smelt	*Hypomesus transpacificus*	
Green sturgeon southern DPS	*Acipenser medirostris*	

Note: ESU = Evolutionarily Significant Unit, DPS = Distinct Population Segment, T = Threatened, E = Endangered, MSA = Magnuson-Stevens Fishery Conservation and Management Act.

1.2 Project Background and Authority

1.2.1 Authority

The ARCF project was authorized by Section 106(a)(1) of the Water Resources Development Act (WRDA) of 1996, (Public Law [PL] 104-303) (110 Stat. 3658, 3662-3663), as amended by Section 130 of the Energy and Water Development and Related Agencies Appropriations Act of 2008, (PL 110-161) (121 Stat. 1844, 1947). Additional authority was provided in Sections 366 and 566 of WRDA 1999, (PL 106-53), (113 Stat. 269, 319-20). Section 366 directed the Secretary to include specific levee improvement features in the overall project and Section 566(b) directed the Secretary to undertake additional study of American and Sacramento River levee modifications. Significant changes to the project cost were recommended in the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works, but before it could be forwarded to Congress, Section 129 of the Energy and Water Development Appropriations Act of 2003, (PL 108-137), (117 Stat. 269, 1839) increased the authorized total cost of the project to $205,000,000. The current estimated

cost of the authorized project is $274,100,000. In accordance with Section 902 of WRDA 1986 (Pub. L. 99-662, § 902, Nov. 17, 1986, 100 Stat. 4183), the allowable cost limit is $284,000,000.

To implement the NSS Levee Improvements Project, SAFCA would request permission from the Corps for:

- Alteration of Federal project levees, pursuant to Section 14 of the Rivers and Harbors Act of 1899 (33 USC 408, referred to as "Section 408"); and
- Placement of fill in jurisdictional waters of the United States, pursuant to Section 404 of the Clean Water Act (33 USC 1344, referred to as "Section 404").

1.2.2 Background

After the flood of 1986, Congress directed the Corps to investigate the feasibility of reducing flood risk of the city of Sacramento. The Corps completed feasibility studies in 1991 and 1996, recommending a concrete gravity flood detention dam on the north fork of the American River at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features." Thus, the ARCF Project was authorized in WRDA 1996 and a decision on Auburn Dam was deferred to a later date. Major construction components for ARCF in the WRDA 1996 authorization include construction of seepage remediation along approximately 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas.

Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5. In addition, both the north and south bank of the American River from RM 0 to approximately RM 11.4 experienced seepage. Seepage on the Sacramento River was so extensive that Congress, soon after the 1986 flood event, funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport.

Shortly thereafter, the Sacramento Valley experienced a flood event in 1997. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was to be expected because remediation had yet to be constructed, but the occurrence of significant seepage on the Sacramento River in the reach remediated as part of the Sac Urban project was alarming and confirmed that deep underseepage was also of significant concern. As a result of this

conclusion, seepage remediation on the American River (then in the late 1990s in the design phase) would need to be designed to remediate both through- and deep underseepage.

In 1999, Congress decided not to authorize Auburn Dam but instead to authorize improvements for Folsom Dam. By doing this, improvements to levees downstream of Folsom Dam could be fine tuned to work closely with the Folsom Dam improvements being discussed by Congress. Therefore, the ARCF project was modified by WRDA 1999 to include additional necessary features for the American River so that it could safely convey the proposed emergency release of 160,000 cfs from Folsom Dam. Major construction components for the ARCF project in the WRDA 1999 authorization include construction of seepage remediation and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of Natomas Cross Canal levee in Natomas. All American River features authorized in WRDA 1996 and 1999 have been constructed or are in design analysis for construction within a year or two.

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress throughout the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a general reevaluation study would be required for at least the Natomas Basin portion of the ARCF project. This general reevaluation started in 2006.

At approximately the same time that the reevaluation study was beginning, the Folsom Dam Post Authorization Change report (PAC) was being completed by the Sacramento District. Results of this study showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to truly capture the benefits of the Folsom Dam projects. These levee improvements consisted primarily of addressing erosion concerns on the American River and seepage, stability, erosion, and height concerns on the Sacramento River below the American River. However, the full extent of the levee improvements necessary to address these concerns was not known. With the construction of the Sac Urban project, it was thought that the seepage and stability problems had been addressed. However, the 1997 flood event proved otherwise. Because of this, it was realized that additional reevaluation studies are also needed to include the additional two basins comprising the city of Sacramento, as well as the Natomas Basin.

The purpose of the ARCF project is to reduce the flood risk for the city of Sacramento. The following problems were identified within the Sacramento levee system:

- Seepage and Underseepage;
- Levee Erosion;
- Levee Stability;
- Levee Overtopping;
- Access for Maintenance and Flood Fighting;
- Vegetation and Encroachments;
- Releases from Folsom Dam;
- Floodplain Management; and
- Additional Upstream Storage from Existing Reservoirs.

1.3 Future Consultation Approach

In order to evaluate the maximum affects to listed species this BA looks at the largest foreseeable footprint. The Corps will consult on Alternative 2 (Proposed Alternative) which is the tentatively selected plan and the Locally Preferred Plan. Following project authorization as the Corps begins the design phase of the project, footprint refinements will likely reduce the effects to listed species. Coordination with the resource agencies will continue into the design phase to obtain input to avoid, minimize, or compensate for affects to listed species. The Corps would consult with the resource agencies of any project footprint changes, including potential reductions of impacts prior to the initiation of construction. This future coordination would attempt to reduce any mitigation required for the project and also would determine if additional consultation is needed for the project.

In addition, SAFCA, the project's local sponsor, is proposing to implement some reaches of the ARCF GRR in advance of the Federal project. SAFCA would seek permission from the Corps pursuant to 33 USC §408 (Section 408) for alteration of the Federal levee system. Additionally, SAFCA would seek credit from the Corps under Section 221 of the Flood Control Act of 1970. This BA supports implementation of SAFCA's NSS Levee Improvement Project.

2.0 Description of the Action and Project Evaluation Approach

2.1 Introduction

The ARCF GRR has identified a number of problems associated with the flood risk management system protecting the city of Sacramento and surrounding areas. There is a high probability that flows in the American and Sacramento Rivers will stress the network of levees protecting Sacramento to the point that levees could fail. The consequences of such a levee failure would be catastrophic, since the area inundated by flood waters is highly urbanized and the flooding could be up to 20 feet deep.

The majority of the Sacramento River levee within the study area requires seepage, slope stability, height, and erosion improvements in order to meet Corps criteria. Construction of the levee improvement measures will require complete vegetation removal within the construction footprint required to install the cutoff wall and raise the levee for approximately one mile. On the waterside, where construction does not remove vegetation, on the lower one-half of the slope to 15 feet waterward of the waterside levee toe, the vegetation will be left in place and a Vegetation Variance (VV) will be sought by the Sacramento District. To show that the safety, structural integrity, and functionality of the levee would be retained, an evaluation of underseepage and waterside embankment slope stability was completed given that a tree fell resulting in scouring of the root ball area.

An analyses section/index point was chosen for the VV analyses which was considered to be representative of the most critical channel and levee geometry and the without project analyses showed the section does not meet underseepage and slope stability criteria. The cross-section geometry of the index point incorporated tree fall and scour by using a maximum depth of scour for cottonwoods as approximately 11.0 feet; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets Corps seepage and slope stability criteria considering the seepage and stability improvement measures are in place (“with project” conditions). Therefore, it is a reasonable conclusion that a VV to allow vegetation to remain would not jeopardize the safety, structural integrity, and functionality of the Sacramento River levee. The Sacramento Weir and Bypass levees would be constructed in compliance with the Corps ETL as these would be new levees. No vegetation removal would be required within the existing or expanded Sacramento Bypass. Table 2 below summarizes the project reaches and whether or not a variance would be requested outside of the construction footprint.

Table 2. Summary of ETL Compliance Method by Waterway.

	Vegetation Variance	SWIF
Sacramento River (lower ½ of levee slope which is outside construction footprint)		
Waterside	X	
Landside		X
American River		
Trench Landside[1]		X
Bank Protection		X
North Area Tributaries[2]		
NEMDC	X	X
Dry/Robla Creeks	X	X
Arcade Creek	X	X
Magpie Creek[3]	X	X

1 The waterside footprint for the trench construction would require removal of vegetation and therefore compliance with the ETL.
2 A variance is included for these tributaries waterside slopes outside of the construction footprint, and a SWIF would be prepared by the non-Federal partners for the landside slopes and access.
3 The new levee constructed along Raley Boulevard would be constructed in compliance with the ETL.

2.1.1 Alternative Formulation and Screening

A wide variety of management measures were developed to address the planning objectives. These measures were evaluated and then screened using the Corps planning process. Formulation strategies were then developed to address various combinations of the planning objectives and planning constraints. Based upon these strategies, various combinations of the measures were assembled to form an array of preliminary plans. The preliminary plans were then evaluated, screened and reformulated, resulting in a final array of alternatives.

The formulation strategies used to address the objectives and constraints included:

- Measures to reduce flood stages;
- Measures to address seepage and underseepage;
- Measures to address stability;
- Measures to achieve the urban levee level of protection;
- Measures to address erosion;
- Measures to address maintenance and emergency response access; and
- Non-structural measures.

Approximately 35 different measures were developed to address these formulation strategies. The measures then went through a preliminary screening process prior to combining them into alternatives. This screening was done by evaluating the measures against the four planning criteria established in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies: completeness, efficiency, effectiveness, and acceptability. In addition, the local sponsor identified a planning criterion of ability to implement the project.

2.1.2 Measures Considered, But Eliminated From Future Consideration

Some measures originally identified that could contribute to addressing Sacramento's flood problems and needs were reviewed and dropped from further consideration. These measures included:

- Upstream storage on the American River (Auburn Dam);
- Transitory storage in upstream basins;
- Yolo Bypass improvements;
- Reoperation of upstream reservoirs: and
- Construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River.

The Corps has a long history of studying upstream storage on the American River. Auburn Dam was proposed for authorization by the Corps in both 1991 and 1996, with no authorization granted by Congress. Since that time, Congress has consistently directed the Corps to focus on downstream elements rather than upstream storage under the scope of this study, as levee improvements are considered to be the first increment necessary to improve the overall system. As a result, this alternative was eliminated from consideration under this study. However, upstream storage may be considered to be a viable measure to further reduce the level of risk to the flood risk management system under future studies.

The I Street Bridge diversion structure was proposed to limit flood flows through the city of Sacramento and push excess flows into the Yolo Bypass in order to limit the need for levee repairs downstream of the structure. This measure was not carried forward for a variety of reasons. The estimated implementation time would leave the urban Sacramento River at risk for an unacceptably long period of time. Operation of the structure would inundate the Yolo Bypass more frequently than current operations, causing an unknown disruption to the Yolo County agricultural economy. In addition, the construction of a permanent structure in the Sacramento River channel is inconsistent with the goals and objectives of the Central Valley Flood Protection Plan, a key planning effort by the State of California; moving forward with a measure that is inconsistent with this plan could risk the partnership between the Corps and the State for the ARCF GRR.

The remaining three measures listed above include upstream transitory storage, Yolo Bypass improvements, and reoperation of upstream reservoirs. These three measures were all eliminated from further consideration because none would reduce flood stages to a low enough level to eliminate the need for downstream levee repairs. As a result, the downstream levee repairs remain the common element between these measures and remain the primary focus of Alternative 2, the tentatively selected plan, detailed in Section 2.2 below.

In addition, some non-structural measures were considered, and eliminated, including flood proofing individual structures, relocating residents out of the flood plain, and raising structures to above the floodplain. All of these non-structural measures were eliminated because the sheer number of residents in the floodplains, particularly in the American River South study area in the Pocket and Meadowview neighborhoods, made this alternative cost-prohibitive when compared to the proposed alternatives.

2.2 Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass

Alternative 2, the tentatively selected plan, involves the construction of fix-in-place levee remediation measures to address seepage, stability, erosion, and height concerns identified for the American River levees, NEMDC, Arcade, Dry/Robla, and Magpie Creeks. The levees along the Sacramento River would be improved to address identified seepage, stability, erosion, and a minimal amount of height concerns. Most height concerns along the Sacramento River would be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass. A summary of the measures proposed under this study are included in Table 3.

Table 3. Proposed Measures for the American River Common Features Project.

Waterway/Location	Extent of Action	Proposed Measure
American River	North and south levees from the confluence with the Sacramento River upstream for approximately 12 miles.	• Construct bank protection or launchable rock trenches
Sacramento River	East levee from the American River to Morrison Creek.	• Install cutoff walls • Construct bank protection • Construct levee raise
NEMDC	East levee from Dry/Robla Creek to the American River	• Install cutoff walls • Construct floodwalls
Arcade Creek	North and south levees from NEMDC to Marysville Boulevard	• Install cutoff walls • Raise floodwalls
Dry/Robla Creek		• Raise floodwalls
Magpie Creek Diversion Canal	Upstream of Raley Boulevard	• Construct floodwalls
Magpie Creek area	South of Raley Boulevard	• Construct new levee
Magpie Creek area	East of Raley Boulevard	• Acquire property to create a flood detention basin • Widen the Raley Boulevard/Magpie Creek bridge and raise the elevation of the roadway • Remove the Don Julio Creek culvert
Sacramento Weir and Bypass	North bypass levee to 1,500 feet north.	• Widen the Sacramento Weir and Bypass by approximately 1,500 feet • Construct a new section of weir and levee • Remove the existing Sacramento Bypass north levee

All proposed measures are detailed in Sections 2.2.1 through 2.2.4 below. Due to the urban nature and proximity of existing development within the American River North and South basins, Alternative 2 proposes fix in place remediation. The purpose of this alternative would be to improve the flood damage reduction system to safely convey flows to a level that maximizes net benefits. Table 4 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 4. Alternative 2 - Proposed Remediation Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall	Bank Protection	Sacramento Bypass and Weir Widening, Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall
Arcade Creek	Cutoff Wall	Cutoff Wall	---	Floodwall
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek[2]	---	---	---	Floodwall, Levee Raise

1 American River seepage, stability, and overtopping measures were addressed in the American River Common Features, WRDA 1996 and 1999 construction projects.

2 In addition to the Floodwall, Magpie Creek will include construction of a new levee along Raley Boulevard south of the creek, and construction of a detention basin on both sides of Raley Boulevard. In addition, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek Bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

2.2.1 Vegetation and Encroachments

In addition to the proposed levee improvements measures shown in Table 3, the following measures and policies would be addressed during construction:

- Utility encroachments will be brought into compliance with Corps policy as a part of project construction activities. Utilities that penetrate the levee would be removed during excavation of the levee and replaced with one of two fixes as construction commences. These two fixes include: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.
- Private encroachments such as fences and stairs in the levee shall be removed by the non-federal sponsor prior to construction.

The Corps' Engineering Technical Letter (ETL) 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures, calls for the removal of wild growth, trees, and other vegetation, which might impair levee integrity or flood-fighting access in order to reduce the risk of flood damage. The vegetation requirements include a 15 foot waterside, landside, and vertical vegetation-free zone. In certain instances, to further enhance environmental values or to meet state or Federal laws and/or regulations, a variance can be requested from the standard vegetation guidelines set forth in this ETL.

The ARCF GRR has identified significant and extensive seepage, stability, overtopping, and erosion problems with the levees that increase the risk of flooding for the Sacramento area. Due to the potential for catastrophic consequences associated with a levee failure in this urban area, all identified problems, including vegetation and encroachments, require correction in order to reduce the flood risk to an acceptable level. However, risk reduction measures must be implemented in a "worst first" manner in order to immediately maximize the amount of risk reduction for each increment of investment. The engineering analysis conducted to date generally indicates that seepage and erosion concerns pose a significantly higher risk of levee failure than those associated with vegetation and encroachments. However, specific instances of vegetation and encroachment problems have been identified as high risk and require resolution concurrent with other high risk issues.

In the case of construction associated with the recommended plan, vegetation and encroachment removal is secondary to the primary flood risk management measures (i.e. seepage cutoff barrier, levee raise, slope flattening). In an effort to modernize the levee system to meet current engineering standards, vegetation and encroachment issues (including landside levee access) in the study area will be resolved through a combination of construction actions associated with implementation of the recommended plan and formal agreements. The formal agreements involve the integrated use of a SWIF agreement with the local maintaining agency (LMA) and a variance from vegetation standards in ETL 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures.

System Wide Improvement Framework

The SWIF is an agreement between the Corps and the non-Federal sponsor that allows the LMA to defer compliance with ETL 1110-2-583. Under the SWIF agreement, the LMA would address landside vegetation and encroachment issues (including landside levee access) through the implementation of their standard operation and maintenance (O&M) actions over time. Therefore, vegetation not impacted by project construction would be addressed by the LMA in accordance with the State's Levee Vegetation Management Strategy in the Central Valley Flood Protection Plan (CVFPP) over the next 20 to 40 years. The SWIF will be planned and implemented by the non-Federal sponsor and includes the following criteria:

- An engineering inspection and evaluation shall be conducted to identify trees and other woody vegetation (alive or dead) on the levee and within 15 feet of the levee toe that pose an unacceptable threat to the integrity of the levee. Identified trees shall be removed and associated root balls and roots shall be appropriately remediated. Based on the engineering inspection and evaluation, trees and other woody vegetation that do not pose an unacceptable threat need not be removed.

- In cases of levee repair or improvement projects, vegetation within the project footprint shall be removed as part of construction activities.
- Trees and other woody vegetation that are not removed must be monitored as part of routine levee maintenance to identify changed conditions that cause any of these remaining trees and other woody vegetation to pose an unacceptable threat to levee integrity. Otherwise, such trees and woody vegetation are to be maintained according to the levee vegetation management criteria included in the CVFPP which establish a vegetation management zone (including the landside levee slope, crown and upper 1/3 of the waterside slope) in which trees are trimmed up to 5 feet above the ground (12-foot clearance above the crown road) and thinned for visibility and access while brush, trees and other woody vegetation less than four inches in diameter at breast height, weeds or other such vegetation over 12 inches high are to be removed in an authorized manner.

Vegetation Variance

A vegetation variance would be sought during the preconstruction engineering and design phase before construction to allow vegetation to remain on the lower 2/3 of the waterside slope and out 15 feet from the waterside toe. If granted, the variance would allow for vegetation to remain in these areas. To show that the safety, structural integrity, and functionality of the levee would be retained with a variance, an evaluation of underseepage and waterside embankment slope stability was completed by Corps geotechnical engineers.

This evaluation was completed for the section/index point at levee mile (LM) 5.92 on the Sacramento River. This index point was chosen for the variance analyses because it was considered to be representative of the most critical channel and levee geometry, underseepage and slope stability conditions, and vegetation conditions. The cross-section geometry of the index point incorporated tree fall and scour by using maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets Corps seepage and slope stability criteria considering the seepage and stability improvement measures are in place ("with project" conditions). Therefore, it is a reasonable conclusion that by allowing vegetation to remain as stated above, the safety, structural integrity, and functionality of the Sacramento River levee would be retained.

The vegetation variance request would be developed during the design phase to allow for vegetation to remain on the lower portion of the waterside levee slope (Figures 8 and 9). Vegetation on the upper waterside levee slope would be removed as part of project construction. If a variance is not approved, the recommendations for this portion of the project will be reformulated and further environmental compliance efforts would be required.

Construction of Alternative 2 is proposed to take approximately 13 years. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that would occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. The tentative schedule of construction is shown in Table 5. The project reaches are shown in Figure 2 below.

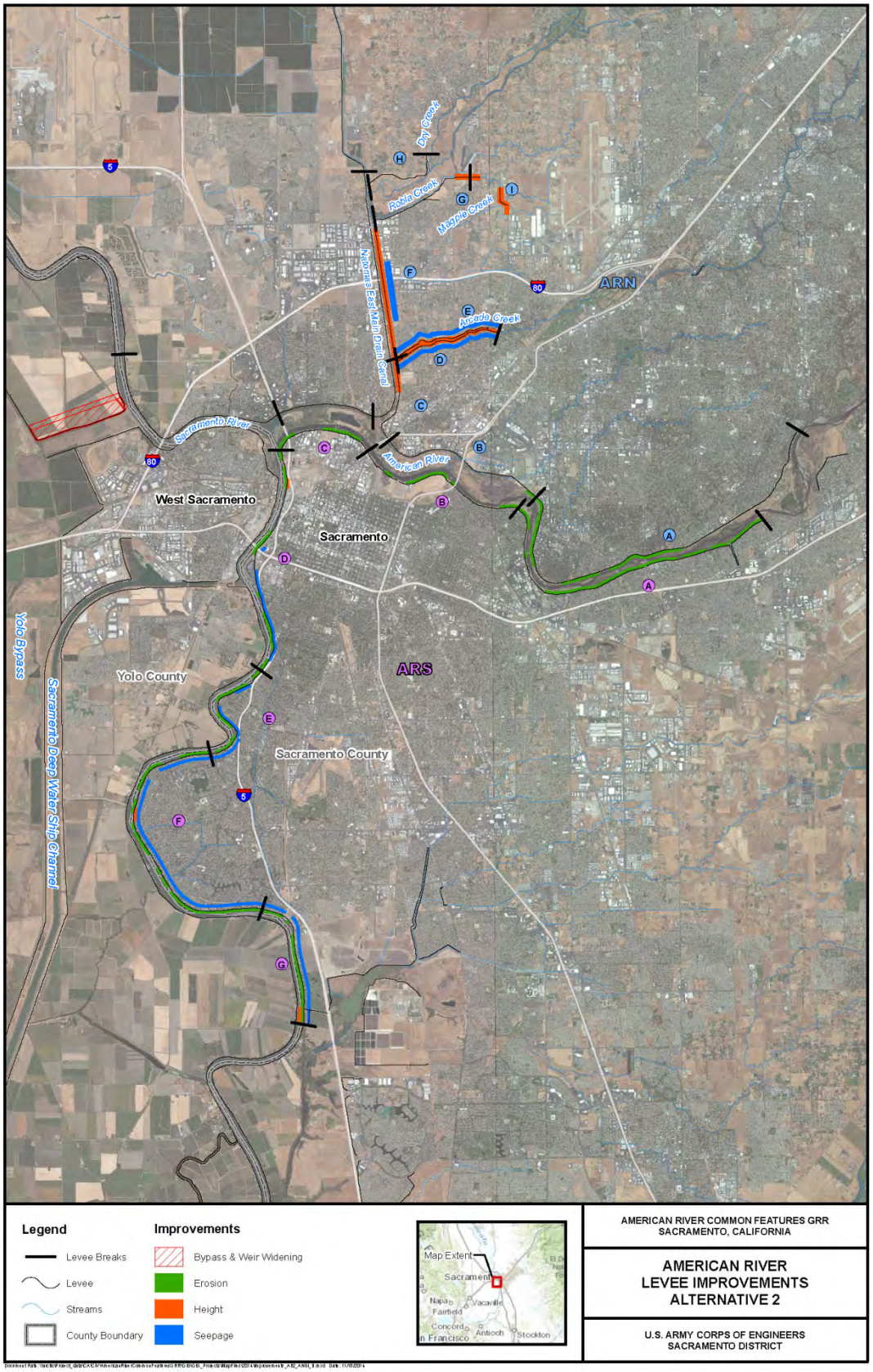

Figure 2. Individual Reach Identification in the ARCF Study Area.

Table 5. Tentative Construction Schedule for Alternative 2.

PRIORITY	WATERWAY	REACH[1]	YEAR OF PROJECT CONSTRUCTION												
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	Sacramento River	ARS F													
2	Sacramento River	ARS E													
3	American River	ARS A													
4	Sacramento River	ARS G													
5	Sacramento River	ARS D													
6	American River	ARS B													
7	American River	ARN A													
8	American River	ARS C													
9	American River	ARN B													
10	Sacramento Weir & Bypass	--													
11	Arcade Creek	ARN D													
12	NEMDC	ARN F													
13	Arcade Creek	ARN E													
14	NEMDC	ARN C													
15	Dry/Robla Creek	ARN G													
16	Magpie Creek	ARN I													

[1] Individual reach ID's can be seen in Figure 2.

2.2.2 Borrow Sites, Haul Routes, and Staging Areas

Borrow Sites

It is estimated that a maximum of 1 million cubic yards (cy) of borrow material could be needed to construct the project. Because this project is in the preliminary stages of design, detailed studies of the borrow needs have not been completed. Actual volumes exported from any single borrow site would be adjusted to match demands for fill. Borrow sites would be selected that do not cause an impact to endangered species or their habitat and therefore, consultation for borrow sites is not required.

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. These potential borrow locations are shown on Figure 3. Borrow sites would be lands that are the least environmentally damaging and would be obtained from willing sellers. The criteria used to determine potential locations were based on current land use patterns and soil types from the Natural Resources Conservation Service (NRCS). The data from land use maps and NRCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 20 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

The excavation limits on the borrow sites would provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation would be no steeper than 3H:1V. Excavation depths from the borrow sites would be determined based on available suitable material. The borrow sites would be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites would be returned to their existing use whenever possible, or these lands could be used to mitigate for project impacts, if appropriate.

Clean rock would be commercially acquired in order to construct the American and Sacramento River bank protection sites. For the Sacramento River, it is assumed that the rock would be acquired from a commercial source in the Bay Area and barged up the Sacramento River to the construction sites. Rock for the American River sites would be acquired from a commercial source within a 50-mile radius and would be hauled in trucks to the construction sites.

Haul routes would be determined during the design phase and would be dependant on what borrow sites and staging areas are selected for project construction. To the maximum extent feasible, haul routes would be selected based on existing commercial haul routes and levee roads and would avoid impacts to Federally listed species.

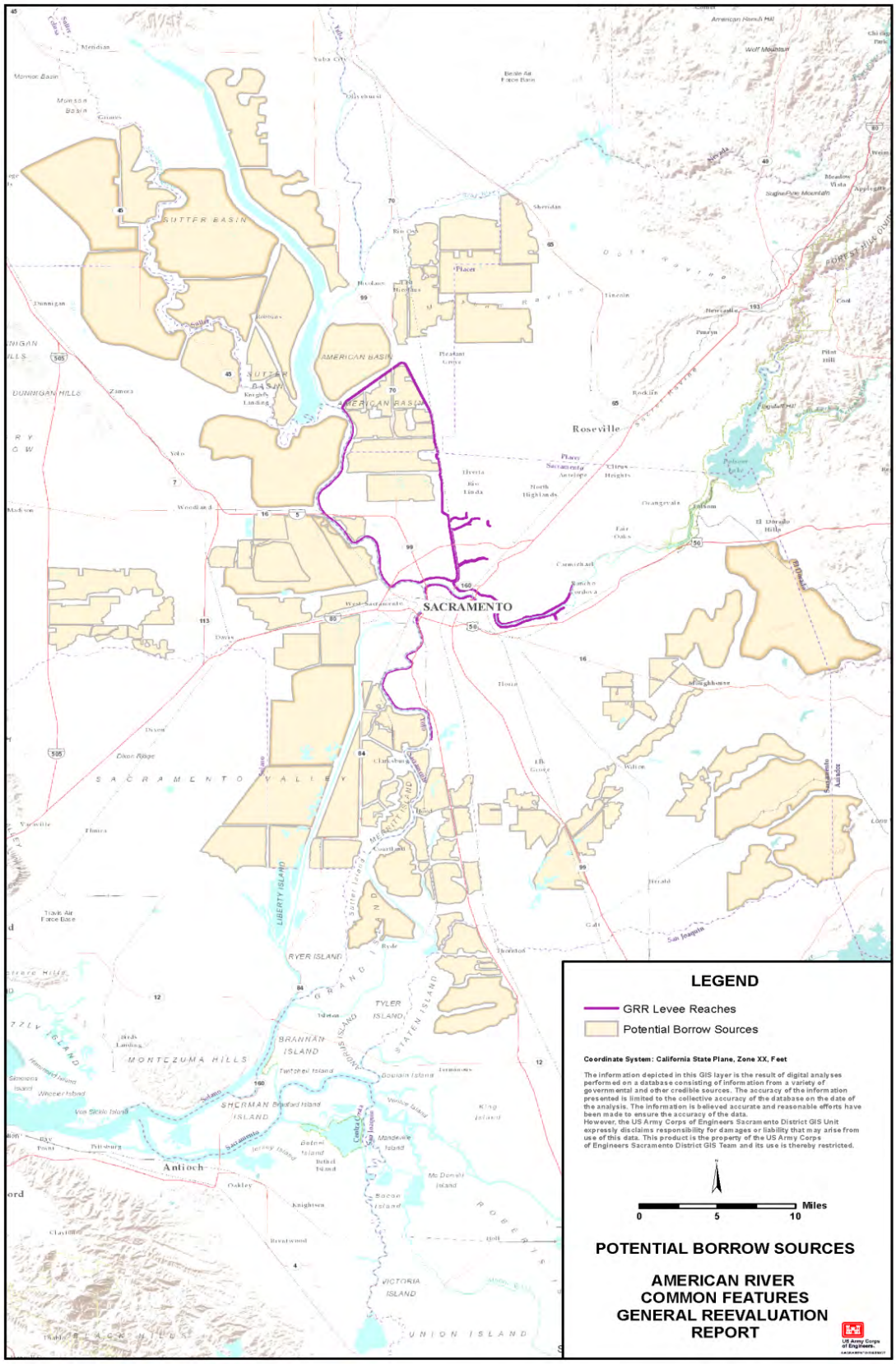

Figure 3. Potential Borrow Sites within 20-miles of Study Area.

SAFCA has selected a borrow site to provide suitable material for the NSS Levee Improvements based on proximity to the project area. The preferred borrow source, Borrow Site 2/Site 2K is shown in Figure 4. Approximately 27,000 cy of material will be excavated from the 5.5-acre borrow site in order to construct the levee improvements. Borrow Site 2 would be returned to pre-project conditions following construction activities.

SAFCA's goal in selecting haul routes is to use existing levee crowns for hauling wherever possible (Figure 5). However, there are locations where hauling on paved public roads is the best available option because the levee crown is already paved for public use or because there is inadequate room on the waterside of the levee to develop a temporary toe road without affecting standing water or low flow channels. Final haul routes would be selected based on constraints, the construction schedule, and in coordination with the City.

Borrow Site 2 is in close proximity to the NEMDC levee and East Levee Road located on the levee crown. From these two sites, haul trucks would use East Levee Road from the borrow site down to a point just north of the existing Del Paso/Main Avenue Bridge over NEMDC. At this point, haul trucks would divert off the road, down the levee slope, and pass under the bridge on an existing road. Just downstream of the Del Paso/Main Avenue Bridge, a short span temporary bridge would cross a narrow section of the low flow NEMDC channel. A temporary culvert crossing of the low flow channel is also possible. From the temporary bridge (or culvert) crossing, the haul trucks would proceed up a new sloping ramp constructed on the waterside of the NEMDC east levee to the levee crown. Trucks would then continue down the levee crown to the Arcade Creek north levee. At the Arcade Creek north levee, trucks would cross the existing Union Pacific Railroad (UPRR) tracks at the existing at-grade crossing and proceed along the north levee crown to the improvement sites.

To access the Arcade Creek south levee and the work proposed on the NEMDC east levee, haul trucks would continue south following an access ramp down the levee slope to Arcade Creek. At the creek, a short temporary bridge would be constructed to cross the low flow channel. A temporary culvert crossing of the low flow channel is also possible. From the temporary bridge (or culvert) crossing, the haul trucks would proceed up a new sloping ramp constructed on the waterside of the NEMDC east levee to the levee crown in the vicinity of the existing railroad at-grade crossing near the existing City of Sacramento Pump Station. Trucks would then proceed up the Arcade Creek south levee crown, or south to the improvement sites on the NEMDC east levee south of Arcade Creek.

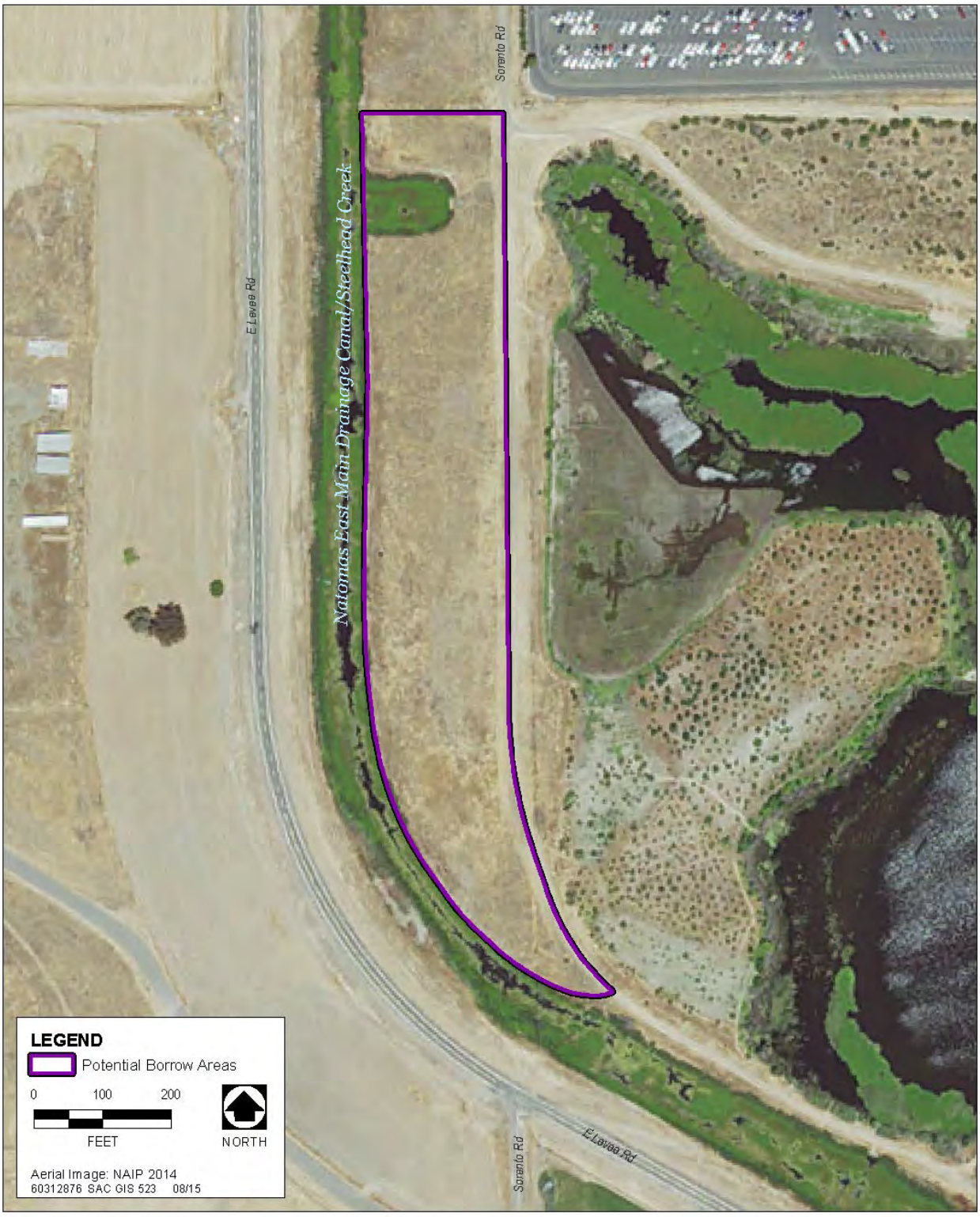

Figure 4. North Sacramento Streams Borrow Site 2/Site 2K.

Figure 5. North Sacramento Streams Haul Routes.

Along the proposed haul routes, there are many opportunities to make use of existing undeveloped toe roads or develop new toe roads without affecting channel areas to facilitate truck passage and to avoid active work sites. Several temporary bridge crossings of the low-flow channel may also be needed to connect the north and south side levee waterside toe roads on Arcade Creek to facilitate movement of material and equipment around active work areas. Railroad car undercarriages on temporary abutment supports would be one option for temporary bridge crossings. Spans of up to 85 feet are possible. Locations for toe roads, ramps on levee slopes, and temporary bridge crossings would be finalized as part of final project design. Gravel on levee crowns along haul routes would be maintained as needed during periods of hauling, including watering for dust control and periodic grading to control rutting.

Storm Water Pollution Prevention Plan (SWPPP) requirements would apply to haul routes during construction. Following construction, temporary ramps would be removed, temporary bridges and abutments would be removed, and all disturbed areas would be revegetated.

Staging Areas

While staging areas have not been identified at this point in the planning phase, sites will be selected that do not require the removal of large vegetation or habitat that is valuable for endangered species. Staging areas would be selected that do not cause an impact to federally listed species or their habitat and therefore, this BA does not address staging areas and consultation for staging areas is not anticipated. Prior to construction, any staging areas would be cleared, grubbed, and stripped.

For SAFCA's NSS project, four potential staging areas have been identified for potential use to support construction (Figure 6). Several of these areas have been used previously to support levee improvements along Arcade Creek. The areas would require little preparation other than surface stripping, and temporary connection roads and ramps to the levee crown. The primary use for the staging areas would be for temporary trailers, parking, and material staging and for stockpiling and blending of excavated soils with imported borrow to make the excavated soils suitable for use in levee reconstruction. This would involve stockpiles of material to be processed, a processing area where excavated soils and imported soils would be spread out and processed to mix and moisture condition the material, and stockpiles of processed material. Importing, processing, and exporting material for levee reconstruction would all be continuous activities once the work flow is established during the start of the construction season. Other disturbed areas would be also be stabilized. Staging areas would be returned to pre-project conditions following construction activities unless the owner agrees to some grade raising to help dispose of excess construction soils.

Figure 6. North Sacramento Streams Staging Areas.

The following sections contain more detailed information on the specific measures proposed under this alternative for the American River North and South study areas.

2.2.3 American River

Levees along the American River under Alternative 2 require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion to the river bank and levee, which could potentially undermine the levee foundation. There are two measures proposed for the American River levees: (1) a maximum of 31,000 linear feet (LF) of bank protection, and (2) a maximum of 65 acres/45,000 LF of launchable rock trench. Both of these measures are described in detail in the subsections below. These numbers are maximized because there is some overlap identified to account for the uncertainty of site-specific conditions. For example, for some reaches both bank protection and launchable rock trench impacts were estimated even though both measures would not be constructed in the same reach. Figure 7 shows the erosion protection locations on the American River.

Bank Protection

The Corps conducts ongoing erosion repairs to sites on the Sacramento River levees under the Sacramento River Bank Protection Project (SRBPP). As part of the SRBPP NMFS Biological Opinions, the Corps is required to conduct post-construction monitoring in order to evaluate the relative success of on-site habitat features that are incorporated into the repairs. Under the SRBPP, bank protection designs have been constantly evolving, as the results of the monitoring help inform engineers to adapt the designs to optimize for site-specific conditions in meeting the objective of the habitat features. The Corps will use the best available information and SRBPP design templates as a basis for designing site-specific bank protection repairs for this project. As a result, the bank protection measure described below is a basic example of a typically designed bank protection site.

This measure consists of placing rock revetment on the river's bank to prevent erosion. This measure entails installing revetment along the stream bank based on site-specific analysis (Figure 7). When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping of loose material and understory growth prior to construction. In most cases large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked on site.

The placement of rock onto the bank will occur from a land based staging area using long reach excavators and loader. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the water side of the levee.

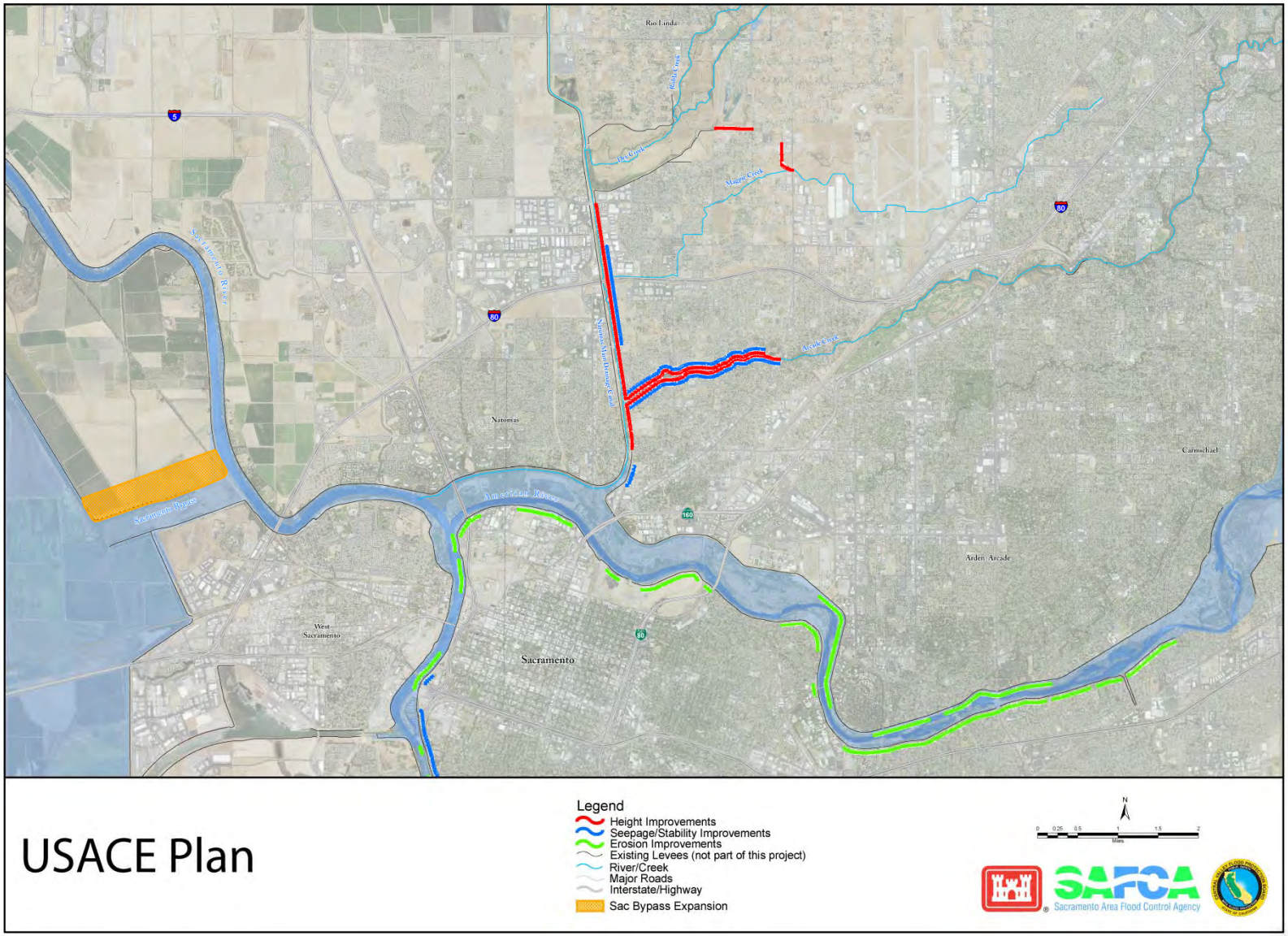

Figure 7. American River and East Side Tributaries Proposed Measures.

The revetment would be placed on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a planting berm would be constructed in the rock to allow for revegetation of the site. The planting berm varies in width from 5 to 15 feet (Figure 8). In all cases the planting will occur outside the vegetation free zone as required by the ETL.

Riparian vegetation installed on the planting berm would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), and valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo var. californicum*); shrub-scrub species such as elderberry (*Sambucus* spp.), redbud (*Cercis Canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitus californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.).

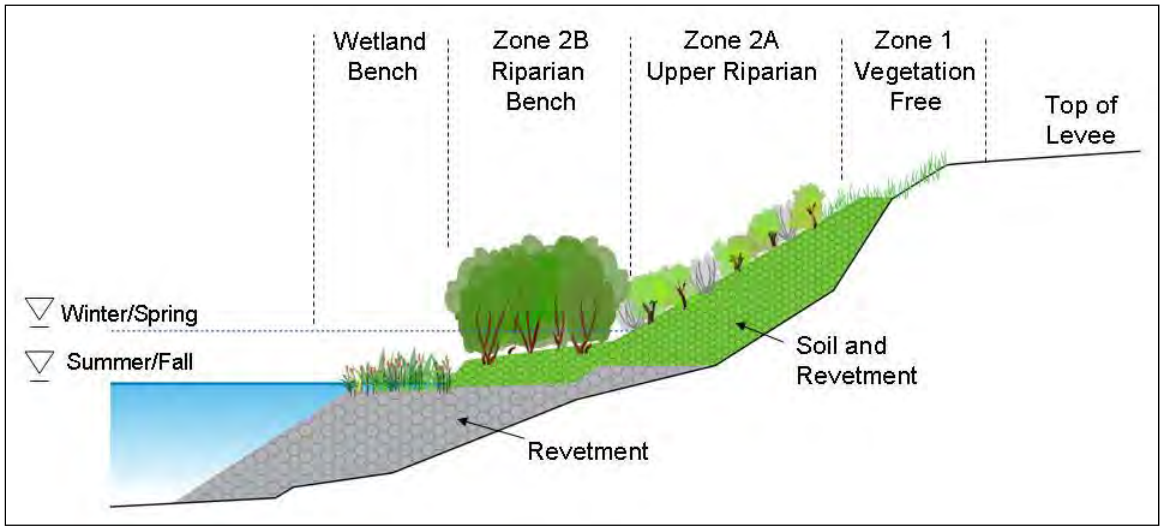

Figure 8. Planting Berms with Vegetation and Wetland Bench.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it (Figure 9). All launchable rock trenches would be constructed outside of the natural river channel. The vegetation would be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration would include a 2:1 landslide slope and 1:1 waterside slope and would be excavated at the toe of the existing levee. All soil removed during trench excavation would be stockpiled for potential reuse. The bottom of the trench would be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench would be filled with revetment that would be imported from an offsite location. After rock placement the trench would be covered with a minimum of 3 feet of the stockpiled soil for a planting berm. Rock placed on the levee slope would be covered with 2 feet of stockpiled soil. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Trees and shrubs could be permitted on the berm if planted outside the specified vegetation free zone as required by the ETL. This alternative would not increase flows in the American River that would cause additional erosion along the banks. If flow changes occur that could cause loss of floodplain between the levee and the existing natural channel (the Parkway land) it will be addressed under the Folsom Reoperation Biological Assessment and EIS/EIR if applicable.

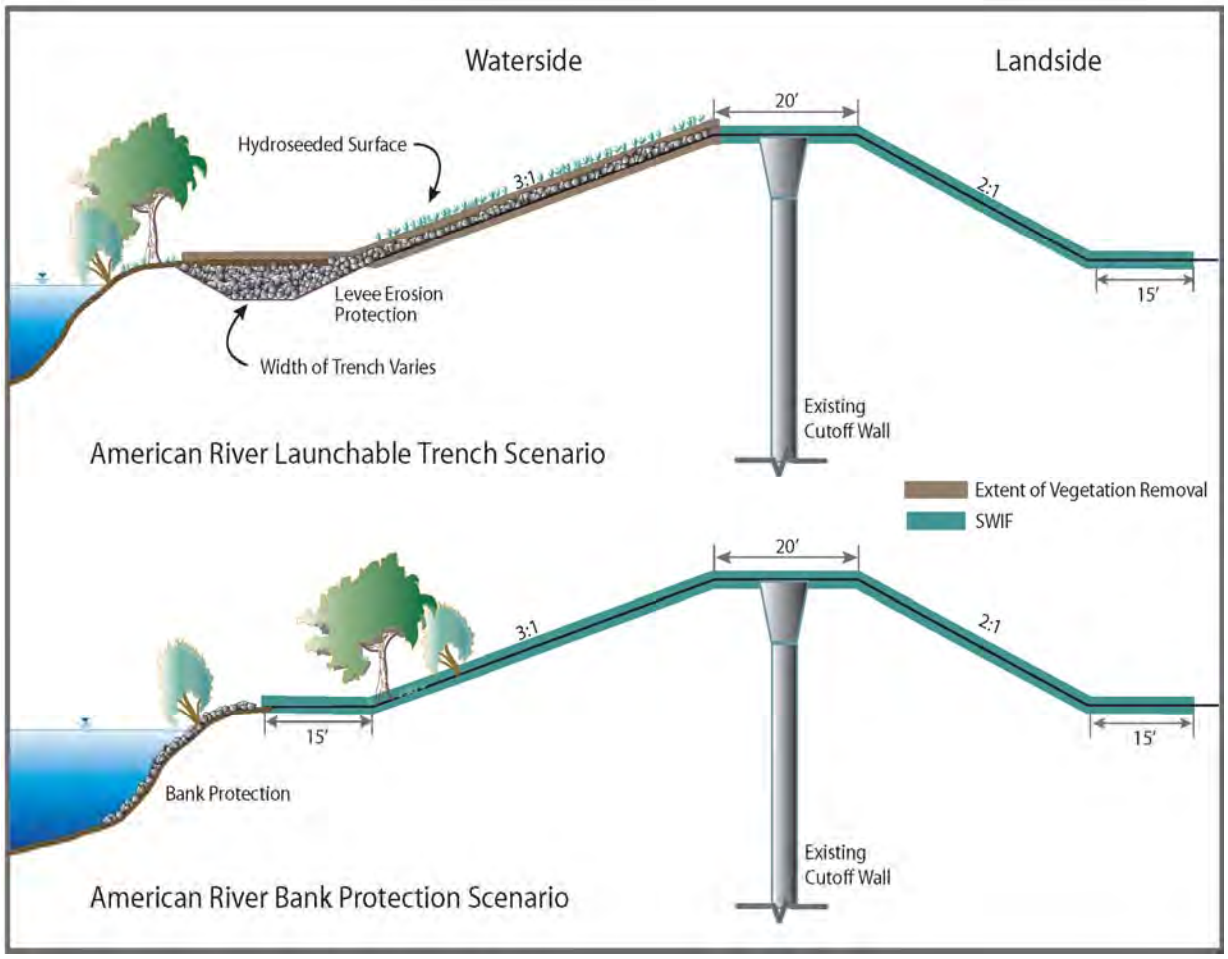

Figure 9. Erosion Protection – Launchable Rock Trench and Bank Protection Scenarios.

2.2.4 Sacramento River

Levees along the Sacramento River require improvements to address seepage, stability, and erosion. Approximately 50,300 LF of bank protection and cutoff wall or slope stability work is proposed for the Sacramento River. In addition, these levees require a total of one mile of intermittent height improvements in order to convey additional flows that exceed current design levels. Figure 10 shows the proposed measures for the Sacramento River.

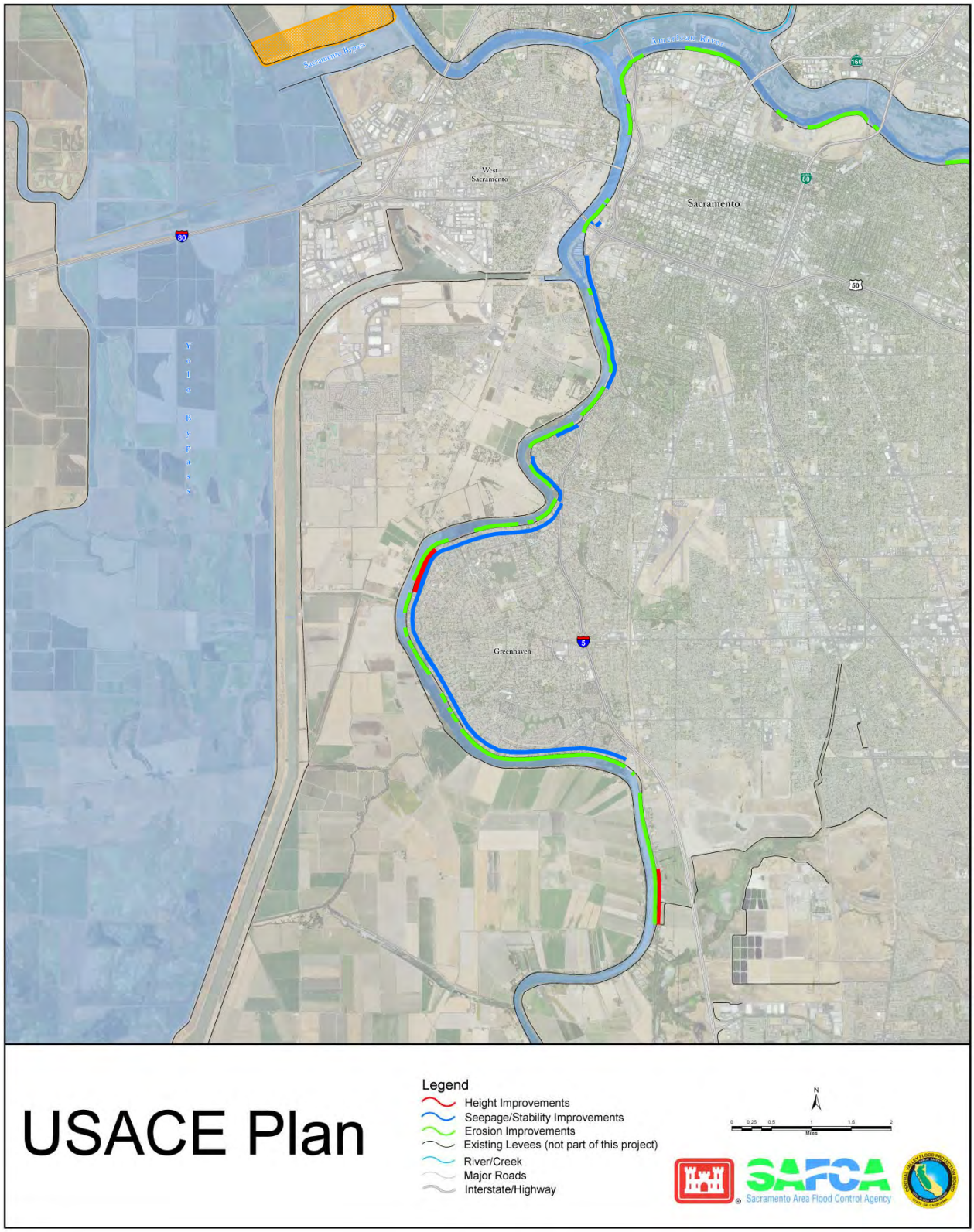

Figure 10. Sacramento River Proposed Measures.

Where the existing levee does not meet the levee design requirements, as discussed in Section 2.2 above, slope flattening, crown widening, and/or a minimal amount of levee raise is required. This improvement measure addresses problems with slope stability, geometry, height and levee crest access and maintenance. To begin levee embankment grading, loose material and vegetation understory would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) would be stockpiled at staging areas. Haul trucks and front end loaders would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans.

The levee would be raised approximately 1 to 3 feet which would result in the levee footprint extending out a maximum of 5 feet on the landside from the existing levee. The levee crown patrol road would be re-established at the completion of construction. A typical design for these levees is shown in Figure 11 below.

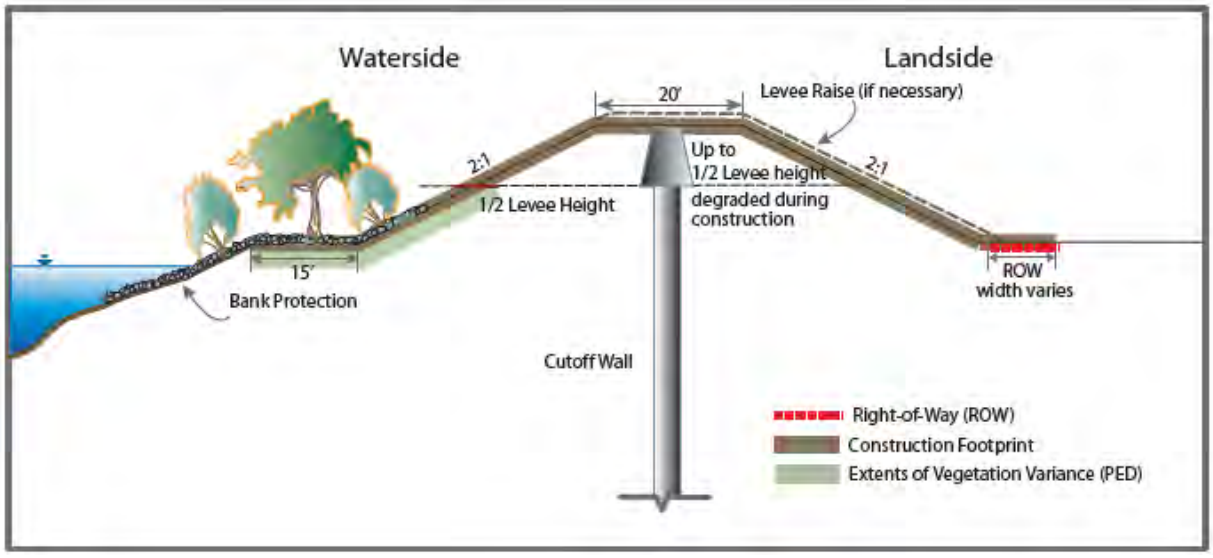

Figure 11. Fix-In-Place with Cutoff Wall and Levee Raise.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown (Figure 9). The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 85 feet. For cutoff walls of greater depth the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. This method of slurry wall installation will also reduce the risk of slurry mixture following seepage paths and leaking into the river or into landside properties.

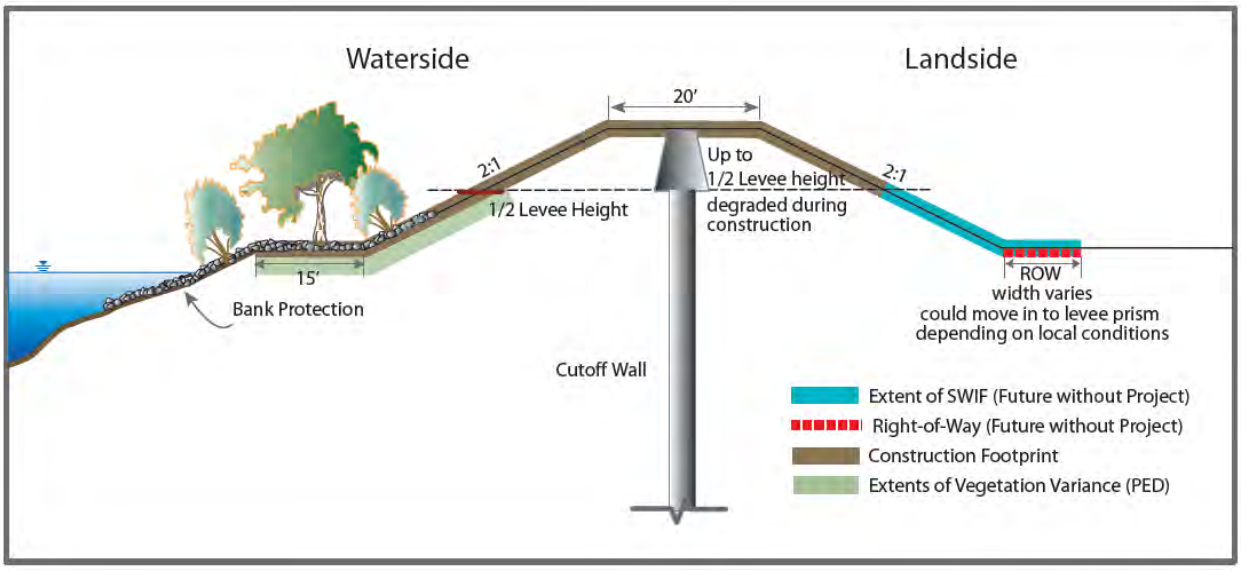

Figure 12. Fix-In-Place with Cutoff Wall and No Levee Raise.

Open Trench Cutoff Wall

Under the open trench method, a trench approximately 3 feet wide would be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it is filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of approximately 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout would be injected through the augers and mixed with the native soils. An overlapping series of mixed columns would be drilled to create a continuous seepage cutoff barrier. A degrade of up to one half the levee height would be required for construction of the DSM wall. For both methods, once the slurry has hardened it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

Bank Protection

Bank protection on the Sacramento River would be addressed via either the launchable rock trench method described for the American River in Section 2.2.1 above, or by standard bank protection with planting berm (Figure 9). The standard bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, where necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. Large trees on the lower 1/2 slope will be protected in place to retain SRA habitat. The sites would be prepared by removing vegetation along the levee slopes at either end of the site for construction of a temporary access ramp, if needed. The ramp would then be constructed using imported borrow material that would be trucked on site.

The placement of rock onto the levee slope would occur from atop the levee and/or from the water side by means of barges. Rock required within the channel, both below and slightly above the water line at the time of placement, would be placed by an excavator located on a barge. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes. Rock required on the upper portions of the slopes would be placed by an excavator located on top of the levee. Rock placement from atop the levee would require one excavator and one loader for each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the water side of the levee.

The revetment would be placed via the methods discussed above on existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a small planting berm would be constructed in the rock to allow for revegetation of the site (Figure 13).

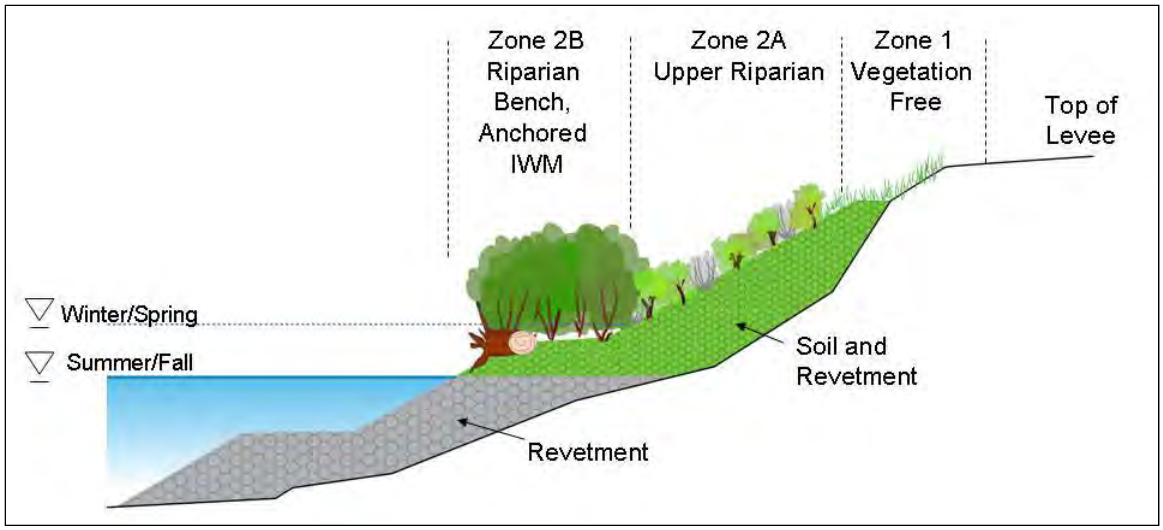

Figure 13. Planting Berm with Vegetation and Woody Material.

2.2.5 East Side Tributaries

The East Site Tributaries include measures proposed for the Natomas East Main Drain Canal (NEMDC), Arcade Creek, Dry/Robla Creek, and Magpie Creek. Arcade Creek and portions of NEMDC are included in the North Sacramento Stream Project, SAFCA's early implementation action on the ARCF GRR. The proposed measures for the East Side Tributaries under the ARCF GRR are shown on Figure 7 above.

Natomas East Main Drain Canal (NEMDC)

The east levee of the NEMDC requires 6,000 LF of improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A conventional open trench centerline cutoff wall would be constructed at these locations to address the seepage and stability problems (Figure 14). The open trench cutoff walls would be constructed as described for the Sacramento River levee in Section 2.2.2 above.

In addition, SAFCA is proposing to address seepage and stability in advance of the Federal project on a 1,700 foot reach of the NEMDC from Station 3028+00 to Station 3051+00, just south of the Arcade Creek south levee. For this reach, SAFCA proposes to construct a cement bentonite (CB) slurry cutoff wall at the waterside toe of the levee. This measure is described in greater detail in the Arcade Creek discussion below.

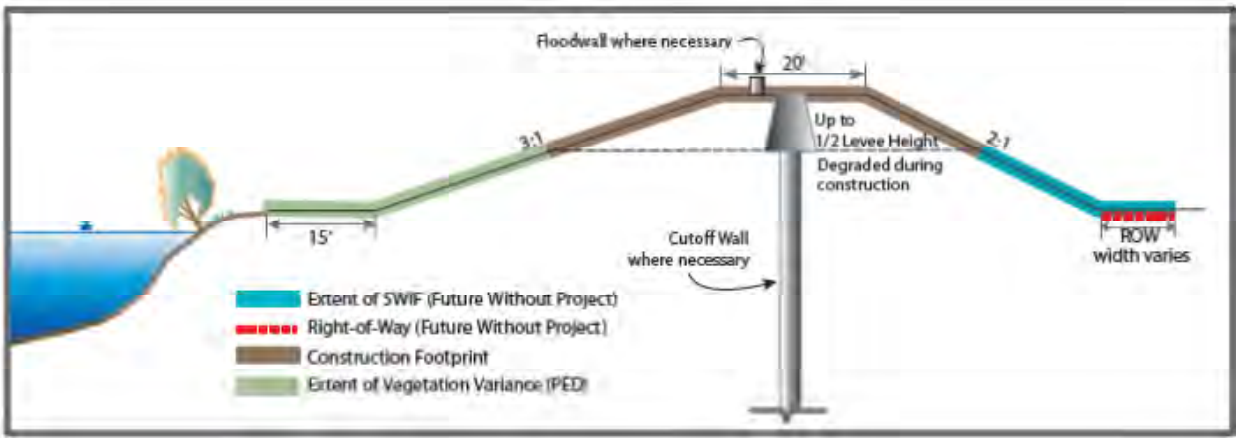

Figure 14. Conventional Open Trench Cutoff Wall or Floodwall Scenario.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A centerline cutoff wall would be constructed to address seepage along 22,000 feet of the levee (Figure 12). There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path, and could affect the stability of the levee. The ditch would be replaced with a conduit or box culvert and then backfilled. This would lengthen the seepage path and improve the stability of the levee (Figure 12). The majority of the Arcade Creek levees have existing floodwalls which vary in height from 1 to 4 feet, however there remains a height issue in this reach. A 1 to 4-foot floodwall raise would allow the levees to pass flood events greater than the current design level. The new floodwall or added height would result in a total floodwall height of approximately 4 to 6 feet. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 14). The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base.

SAFCA's NSS project is primarily focused on addressing seepage and slope stability concerns on Arcade Creek. Figure 15 below shows Arcade Creek in detail, broken down into Arcade Creek North (ACN) and Arcade Creek South (ACS) reaches. The NSS project includes centerline cutoff walls for most of the Arcade Creek levees (ACS A, ACS B, and ACN B). For the ACS C and ACN C reaches, stretching generally from Rio Linda Boulevard to Marysville Boulevard, SAFCA proposes to construct a CB slurry cutoff wall at the waterside toe of the levee, rather than a centerline cutoff wall. In addition, on the ACN C reach, SAFCA proposes to reconstruct the waterside slope from Station 5075+00 to Station 5100+00, and from Station 5100+00 to Marysville Boulevard, SAFCA proposes to construct a sheet pile cutoff wall at the centerline of the levee, rather than the waterside toe cutoff wall. For the ACN A reach, SAFCA proposes to install pressure relief wells along the landside toe of the levee. The waterside toe slurry cutoff walls and sheet pile walls are described in greater detail below.

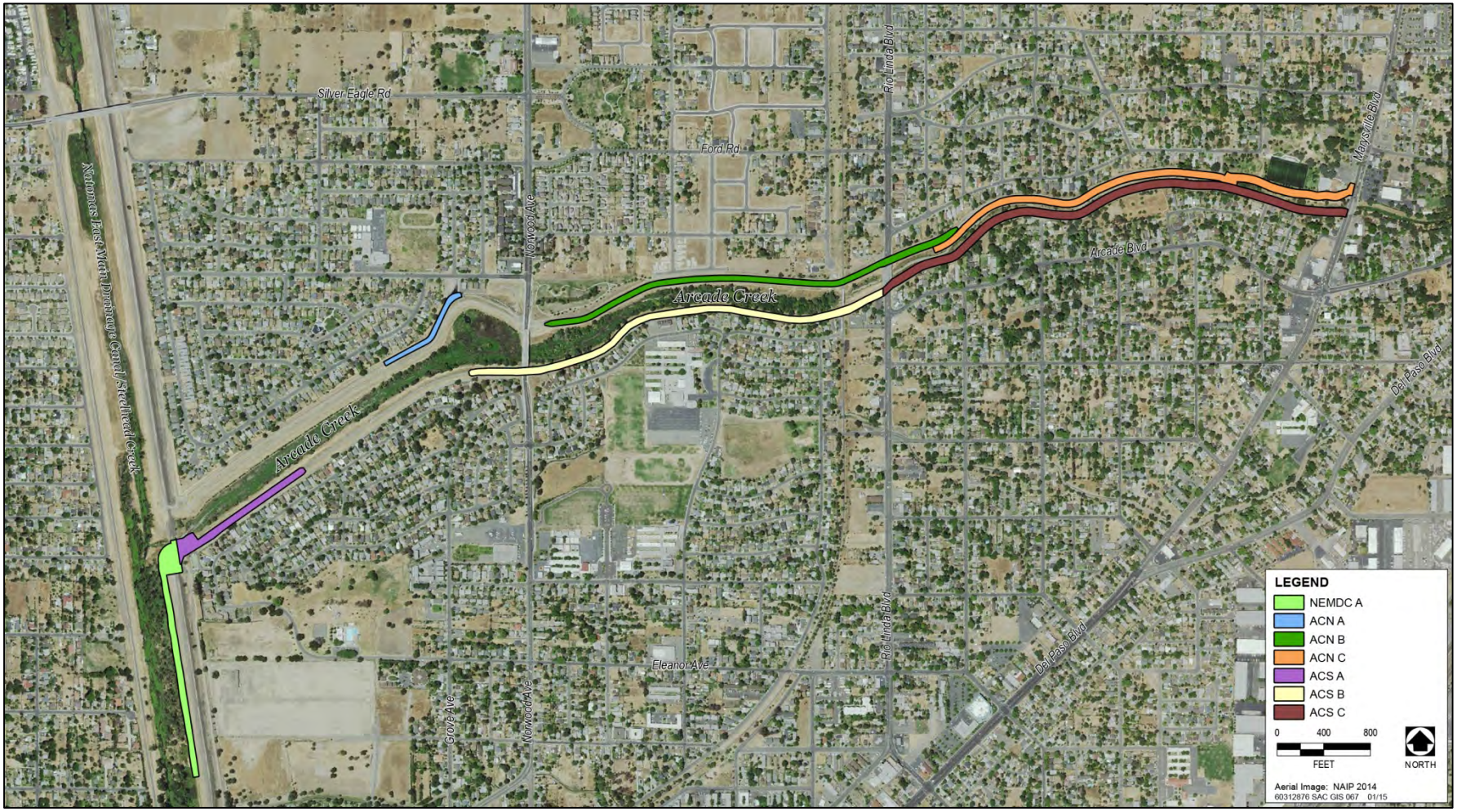

Figure 15. North Sacramento Streams Levee Improvement Project Area Reaches.

Toe Slurry Cutoff Wall Construction

Construction of the toe CB slurry cutoff walls to depths ranging from 15 to 30 feet along the existing waterside levee toe would be accomplished primarily with small- to medium-size excavators depending on required wall depth. This equipment and the associated sequence of excavation and placement of the centerline CB material into the trench, would require constructing a work bench along the toe. The bench elevation would be selected based on existing topography, required working room for cutoff wall installation, optimizing earthwork, and minimizing the need for bench elevation changes along the levee that could complicate slurry wall construction.

Excavations for the bench would extend deep enough below existing grade to remove organic material and soft, unsuitable foundation soils. Some dewatering and groundwater control is anticipated in connection with this excavation. Bench excavation would also extend into the existing waterside slope of the levee as needed to ensure that new selected bench fill material is integrated effectively with existing low permeability blanket material on the levee slope. This provides an integral seepage barrier with the cutoff wall over the full height of the levee. To the fullest extent possible, all excavated non-organic soil suitable for reuse would be processed and used for reconstruction to minimize off-hauling materials.

Some portions of ACN C reach, as described above, would require a more substantial excavation and reconstruction of the waterside slope to provide a low permeable seepage levee slope barrier, which may not currently exist. Here again, the bench fill material would be integrated with the slope reconstruction fill to provide an integral seepage barrier with the cutoff wall over the full height of the levee slope.

After the foundation has been excavated and accepted, properly moisture conditioned embankment materials would be placed in accordance with accepted levee construction standards and compacted to create the bench working surface for slurry wall construction. Each lift would be moisture-conditioned and compacted to the specified density using suitable tamping foot compactors.
After backfilling to the working surface for cutoff wall construction, the CB wall would be installed. For CB centerline wall construction, it is assumed that 50 percent of the material from the trench can be salvaged and processed with other excavated soil or borrow material for reuse in levee reconstruction. The remaining material from the trench excavation is assumed unsuitable for reuse and would be disposed of as described previously.

After installation of the cutoff wall, properly moisture-conditioned embankment materials would be placed to complete the bench construction to a minimum height of approximately 3 feet over the top of the cutoff wall and complete reconstruction of cuts on the waterside slope. Embankment material would be blended and processed material suitable for reuse. Each lift would be moisture-conditioned and compacted to the specified density using suitable tamping foot compactors. After the bench is completed, the top and waterside slope would be covered with rip rap to control erosion over the completed cutoff wall. Above the bench, all disturbed construction areas would be revegetated. Gravel surfacing on the levee crown would be supplemented or replaced within the levee repair limits wherever damaged by haul vehicles and other construction-related traffic.

Sheet Pile Cutoff Walls

Sheet pile cutoff walls are installed with a crane and hydraulic ram that hammers or pushes the sheet pile into the ground to the desired depth. In levee reach ACN C near Marysville Boulevard where the wall would be located along the approximate existing levee crown centerline, the asphalt concrete surfacing would be removed prior to sheet pile placement. No levee degradation is needed except to develop an access platform for the crane of sufficient width. A 3-foot-wide by 3-foot-deep trench would be excavated along the sheet pile alignment. The sheet piling would be driven in the trench. The trench would then be backfilled with suitable levee fill materials placed on both sides and over the top of the completed wall. After backfilling the trench the existing asphalt-concrete pavement would be reconstructed.

Dry and Robla Creeks

The Dry and Robla Creeks levees require improvements to address overtopping for when flood events exceed the design level. Height improvements would be made with a new floodwall constructed to a height of 4 to 6 feet along 2,500 LF of the south levee. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 16). Construction of the floodwall would be consistent with the description for NEMDC, above. The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base.

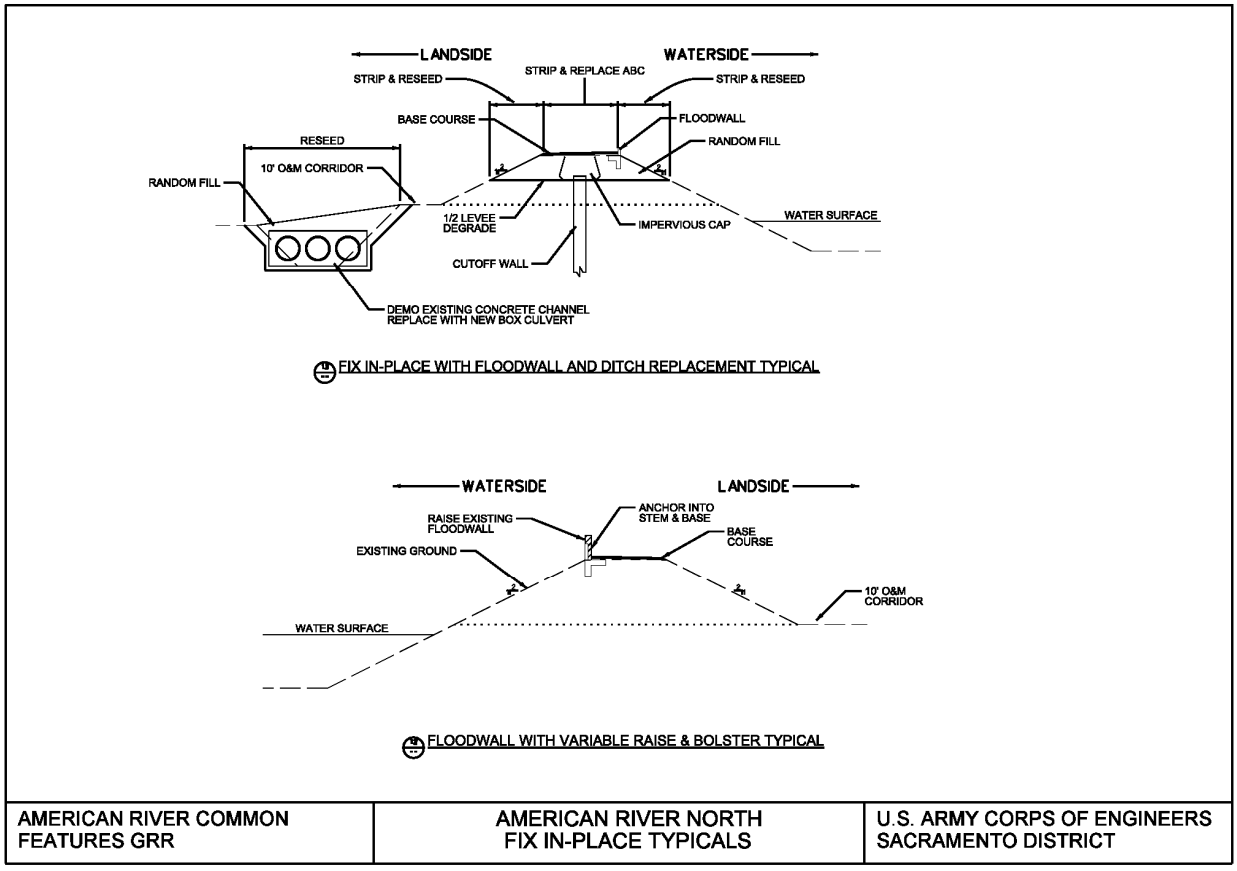

Figure 16. Floodwall with Variable Raise and Bolster Typical.

Magpie Creek Diversion Canal

A number of features are proposed for the Magpie Creek Diversion Canal. The existing project levee on the diversion canal would be raised by approximately 3 to 4 feet for a distance of approximately 2,100 feet. Construction of the raise would be similar to the levee raise described for the Sacramento River above. Additionally, a new, approximately 1,000-foot-long levee would be constructed adjacent to Raley Boulevard, south of the Magpie Creek bridge. The footprint of the existing and new levee is shown on Figure 17.

In addition to the above levee improvements, an approximately 79-acre flood detention basin would be created for the overflow of flood waters in the Magpie Creek area. The flood detention basin would mostly be created through the acquisition of property in the floodplain that is currently flooded during high water events. The flood detention basin would be located on both sides of Raley Boulevard near Magpie Creek. The frequency of flooding of this property would not change with implementation of the proposed measures, however, there would be a increase in surface elevation on the property during these events and the property may remain flooded for longer durations.

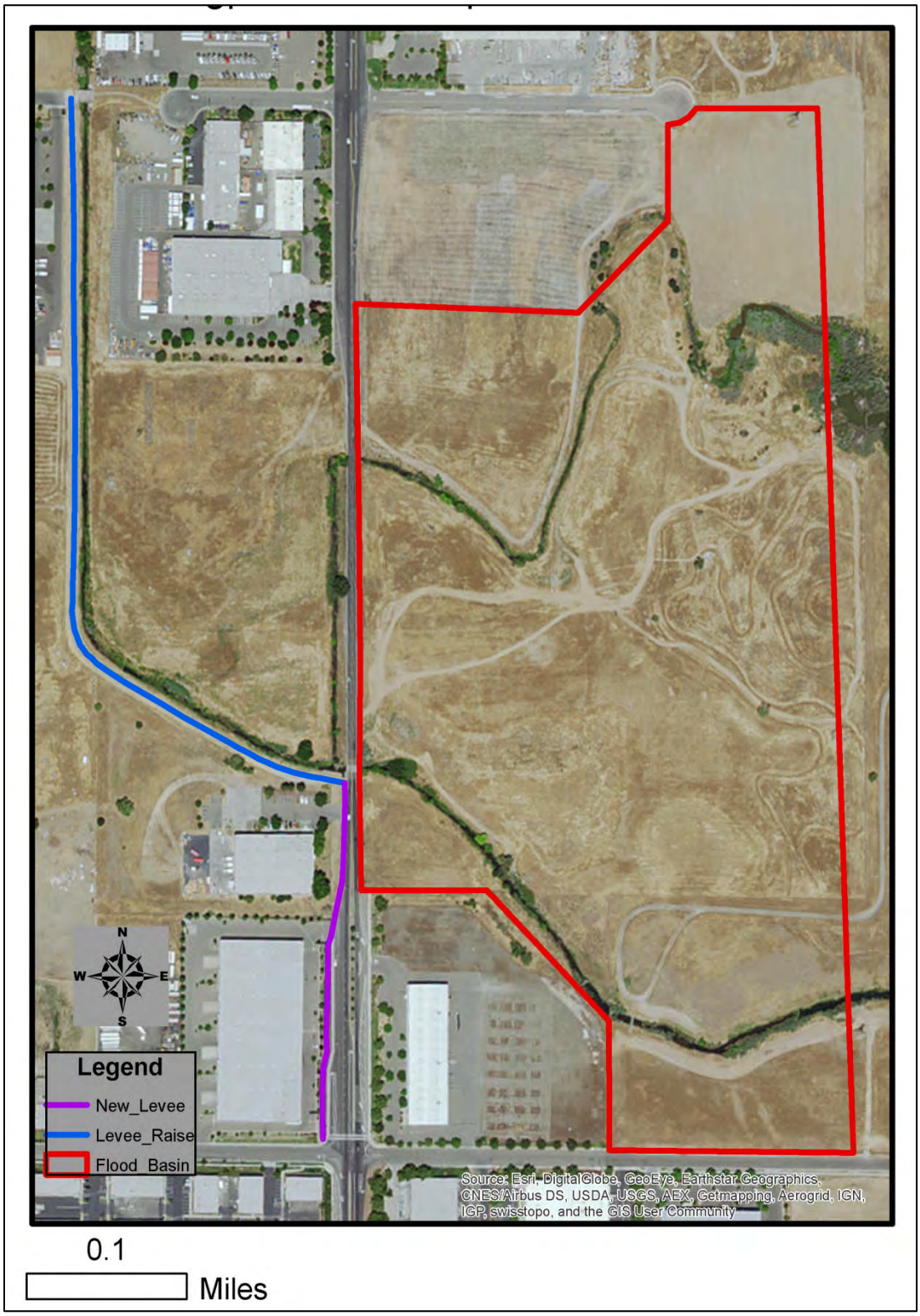

Figure 17. Magpie Creek Proposed Measures.

The features and design proposed for Magpie Creek were originally associated with a separate project, the Magpie Creek Flood Control Project, which was planned and designed by the Corps and SAFCA in 2004. In September 2004, USFWS issued a Biological Opinion to the Corps on the Magpie Creek Flood Control Project (Appendix E). Since the design has not changed at this time from the 2004 project, the 2004 Biological Opinion is considered to be valid and addresses the potential impacts associated with this portion of the ARCF GRR. These effects are summarized throughout this BA, as appropriate.

2.2.6 Sacramento Weir and Bypass

The Sacramento Weir was completed in 1916. It is the only weir that is manually operated – all others overflow by gravity on their own. It is located along the right bank of the Sacramento River approximately 4 miles upstream of the Tower Bridge, and about 2 miles upstream from the confluence with the American River. Its primary purpose is to protect the city of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The weir limits flood stages (water surface elevations) in the Sacramento River to project design levels through the Sacramento/West Sacramento area. Downstream of the Sacramento Weir, the design flood capacity of the American River is 5,000 cfs higher than that of the Sacramento River. Flows from the American River channel during a major flood event often exceed the capacity of the Sacramento River downstream of the confluence. When this occurs, floodwaters flow upstream from the mouth of the American River to the Sacramento Weir.

The project design capacity of the weir is 112,000 cfs. It is currently 1,920 feet long and consists of 48 gates to divert floodwaters to the west through the mile-long Sacramento Bypass to the Yolo Bypass. Each gate has 38 vertical wooden plank "needles" (4 inches thick by 1 foot wide by 6 feet long). It is cumbersome and expensive to operate, and questions have long been asked about whether this 1916 design is appropriate for today’s water management needs (DWR 2010).

Though the weir crest elevation is 24.75 feet, the weir gates are not opened until the river reaches 27.5 feet at the I Street gage with a forecast to continue rising. This gage is about 1,000 feet upstream from the I Street Bridge and about 3,500 feet upstream from the mouth of the American River. The number of gates to be opened is determined by the National Weather Service /Department of Water Resources (DWR) river forecasting team to meet either of two criteria: (1) to prevent the stage at the I Street gage from exceeding 29 feet, or (2) to hold the stage at the downstream end of the weir to 27.5 feet (DWR 2010). The weir gates are then closed as rapidly as practicable once the stage at the weir drops below 25 feet. This provides "flushing" flows to re-suspend sediment deposited in the Sacramento River between the Sacramento Weir and the American River during the low flow periods when the weir is open during the peak of the flood event (DWR 2010).

Under Alternative 2, the Sacramento Weir and Bypass would be expanded to roughly twice their current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass would be degraded and a new levee would be constructed approximately 1,500 feet to the north. The existing Sacramento Weir would be expanded to match the wider bypass. At this time, it is not known whether the new segment of weir would be constructed consistent with the 1916 design described above, or whether it would be designed to be a gravity-type weir. The new north levee of the bypass would be designed to be consistent with the existing Sacramento Bypass north levee, however, it would also include a 300-foot-wide seepage berm on the landside with a system of relief wells. A hazardous, toxic, and radiological waste (HTRW) site near the existing north levee would be remediated by the non-Federal sponsor prior to construction.

To avoid potential effects to the Yolo Bypass, the new segment of the Sacramento Weir would be operated only during high water situations, when flows from Folsom Dam exceed 115,000 cfs. Operation of the existing Sacramento Weir and Bypass would remain the same, as described above. While not specifically modeled, there are not expected to be any water quality impacts. The approximate change in water diversions, which are shown in Table 6 below, would vary based on the size of the flood event. The frequency of water diversion is expected to be the same, which is to use the current Sacramento Weir operation based on a stream gage at the I Street Bridge (Schlunegger 2014). Under these operation assumptions, Alternative 2 would result in a diversion of flows from the Sacramento River to the Yolo Bypass that would slightly raise water surface elevations in the Yolo Bypass when flows in the American River exceed 115,000 cfs.

With the Folsom Dam improvements in place, releases from Folsom Dam would be above 115,000 cfs for flood events greater than 1/100 ACE event. Therefore, for events up to and including the 1/100 ACE event, only the existing weir will be operated per the criteria previously established. For events greater than the 1/100 ACE event when the release from Folsom Dam will go above 115,000 cfs, the new weir will be opened. With the increased flood storage space and anticipatory releases at Folsom Dam, this translates into a reduction of flows into the Yolo Bypass with Alternative 2 in place compared to the existing conditions. See Table 6 for a comparison of the flows at various locations for the Existing Condition, the Future Without Project Condition (Folsom Dam improvements), and Future With Project Condition (Alternative 2) in place. For the 1/100 ACE event and greater, the benefits of the Folsom Dam improvements would be realized in the form of reduced flows compared to the existing condition.

Table 6. Comparison of 10, 100 and 200 year Frequency Flows under Various Conditions.

10 year event	**Existing Condition**	**Future Without Project Condition with JFP**	**Future With Project Condition (Alternative 2)**
American River	43,000cfs	72,000cfs	72,000cfs
Sacramento Bypass	50,000cfs	66,000cfs	66,000cfs
Yolo Bypass below Sac Bypass	270,000cfs	296,000cfs	296,000cfs
100 year event	**Existing**	**Future Without Project and Alt. 1**	**Alt. 2 (TSP)**
American River	145,000cfs	115,000cfs	115,000cfs
Sacramento Bypass	131,000cfs	115,000cfs	115,000cfs
Yolo Bypass below Sac Bypass	555,000cfs	535,000cfs	535,000cfs
200 year event	**Existing**	**Future Without Project and Alt. 1**	**Alt. 2 (TSP)**
American River	320,000cfs	160,000cfs	160,000cfs
Sacramento Bypass	183,000cfs	149,000cfs	164,000cfs
Yolo Bypass below Sac Bypass	656,000cfs	631,000cfs	643,000cfs

The widening of the Sacramento Weir and Bypass diverts flood flows from the Sacramento and American River into the Yolo Bypass. At a 10-year level event, the Yolo Bypass is already flooded with water from levee toe to levee toe. By the time flows in the American River exceed 115,000 cfs, water would be approximately 5 to 6 feet below the top of the Yolo Bypass levees. As a result, to avoid impacts to the Yolo Bypass, the widened portion of the weir will only be operated when flood releases from Folsom Dam are above the existing objective release of 115,000 cfs which would occur during flood events greater than 1/100 ACE event. Therefore, for events up to the 1/100 ACE event, there would be no change in flow conditions in the Sacramento and Yolo Bypasses.

For flood events greater than 1/100 ACE event when releases from Folsom Dam would go above 115,000 cfs (such as a 1/200 ACE event in which the Folsom release goes up to 160,000 cfs), there would be an increase in flows in the Sacramento Bypass of approximately 15,000 cfs. In the Yolo Bypass, this equates to an increase of approximately 0.10-foot of water surface elevation. During the 200-year event, the Yolo Bypass is already flooded from levee to levee with depths of up to 21 feet. The addition of these flows would equate to approximately one or two tenths of a foot, which would amount to less than 1 foot of additional width on both levee slopes. This amounts to a total addition of approximately 4.8 acres of flooded area along the existing levee slopes of the Yolo Bypass.

2.2.7 Additional North Sacramento Streams Project Components

Erosion Protection

The only erosion protection currently envisioned includes placement of rip rap on waterside benches where waterside toe slurry walls are constructed. Following construction, levee slopes and other areas disturbed by construction would be revegetated and brought back to pre-project conditions. Locations where erosion is identified along the waterside levee slope and riverbank have been evaluated to determine whether levee integrity or stability may be affected. Insufficient embankment protection may cause a levee to be undermined by erosive forces due to wave action and/or high flow velocities along the levee bank. In many cases, the placement of embankment protection material, such as engineered armoring (rip-rap), would dissipate wave and velocity forces and reduce the potential for erosion to occur. Other factors to be considered prior to installing embankment protection material include grading the levee waterside slope to address stability issues, and environmental impacts within the vicinity of the embankment repair site.

Utility Relocation

SAFCA prepared an inventory and assessment of existing encroachments and penetrations within the NSS Levee Improvements Project area. Known utilities that cross or are adjacent to the levee include gas pipelines; storm drainage and pump station discharge pipes; and numerous water supply mains, culverts, electrical conduits, and sanitary sewers. The construction contractor can work around many of these utilities. However, some utilities may need to be temporarily removed or relocated prior to construction. Temporary bypass pumping may be required for sanitary sewers. SAFCA and the construction contractor would coordinate closely with utility owners to manage the utilities in advance of construction. Disturbed utilities would be restored after construction consistent with CVFPB requirements. Coordination between SAFCA and the utility owner would be required for those utilities that do not currently have CVFPB encroachment permits.

Stormwater Pollution Prevention

Temporary erosion/runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. These temporary control measures may include implementing construction staging in a manner that minimizes the amount of area disturbed at any one time; secondary containment for storage of fuel and oil; and the management of stockpiles and disturbed areas by means of earth berms, diversion ditches, straw wattles, straw bales, silt fences, gravel filters, mulching, revegetation, and temporary covers as appropriate. Erosion and stormwater pollution control measures would be consistent with National Pollutant Discharge Elimination System (NPDES) permit requirements and would be included in a Stormwater Pollution Prevention Plan (SWPPP).

After completion of construction activities, the temporary facilities (construction trailers and batch plants) would be removed and the site would be restored to pre-project conditions. Site restoration activities for areas disturbed by construction activities, including borrow areas and staging areas, will include a combination of regrading, reseeding, constructing permanent diversion ditches, using straw wattles and bales, and applying straw mulch and other measures deemed appropriate.

Proposed Sequence of Project Construction

It is anticipated that the North Sacramento Streams levee improvements would be implemented in one construction season (2016). The construction season would take place from April 15 to November 1. An approximate construction sequence includes the following:

- **Mobilization:** Mobilization would include setting up construction offices and the slurry batch plant and transporting heavy earthmoving equipment to the site. These activities may take up to 1 month.
- **Vegetation and encroachment removal:** Trees and other encroachments that impact remedial measures would be removed consistent with established SAFCA policies regarding vegetation and encroachments. These activities may take 1–4 weeks depending upon the reach being remediated.
- **Levee degradation for cutoff wall installation:** Beginning of levee degradation would follow vegetation and encroachment removal and precede cutoff wall installation. Degradation would take a total of about 4 months but it would not likely be conducted in one simultaneous operation. Rather, levee reaches would be degraded for specific lengths of cutoff wall to minimize the total length of degraded levee at any one time. Construction would take approximately 3 months.
- **Cutoff wall installation:** This activity would begin with construction of the work pad once a sufficient length of levee was degraded and was available for construction. Assuming four headings, construction would take approximately 4 months.
- **Drainage blanket construction:** Drainage blanket would be constructed prior to placing overlying slope reconstruction fill. Portions of drainage blanket extending up levee cut slopes would be placed as the adjacent slope reconstruction material is placed. Construction would take approximately 1 month since such construction is a small part of the proposed project.
- **Toe cutoff wall erosion protection:** Toe cutoff wall rip rap erosion protection would be placed after the toe cutoff wall bench has been completed to final lines and grades. Construction would take approximately 2 months.

- **Utility relocation:** Any required utility relocation would be conducted concurrent with the levee degradation, toe cutoff wall bench construction, and reconstruction operations. Construction would take approximately 4 months.
- **Levee reconstruction:** Levee reconstruction would begin once there was sufficient length completed cutoff wall to efficiently begin reconstructing the levee embankment. Total time estimated for levee reconstruction is about 6 months.
- **Seepage Wells:** Seepage wells can be installed at any time during the construction season. Installation and development of relief wells and reconstruction of paved channel and basin inverts would likely take about 2 month.
- **Site restoration and demobilization:** Upon completion of the main construction activities, the levee patrol road would be resurfaced, disturbed areas would be revegetated, staging and borrow areas would be restored, and the contractor would demobilize the site(s). These activities are expected to take about 2 months.

Construction would be staged and sequenced with the appropriate stakeholders: the City, County, Reclamation District, utility and service providers, biological resource construction work windows, and other environmental and land use/real estate constraints, to the greatest extent practical to minimize impacts and effects on the community.

High Hazard Levee Encroachment and Vegetation Removal

Encroachment Management

The National Flood Insurance Program (NFIP) standards for levee accreditation and the State's ULDC both require removal or modification of encroachments that pose an unacceptably high risk to the performance and safety of a levee either by undermining its structural integrity or by interfering with necessary inspection, operation, and maintenance activities. To address this requirement, SAFCA has identified and evaluated all of the encroachments in the NSS Levee Improvements area. Each of these encroachments has been evaluated to determine whether it constitutes an unacceptably high risk to the performance of the levee either by undermining the stability of the levee or by interfering with necessary patrolling, operation, and maintenance activities. Based on this evaluation, the encroachments have been classified as either:

- High-risk – poses a threat to levee integrity, removable prior to the levee being accredited;
- High-risk – impedes operation, maintenance, and inspection, removable within 3 years after the levee is accredited; or
- Low-risk – not identified as high hazard.

In the NSS Levee Improvements area, high-risk encroachments to be removed are limited to residential landscaping located at approximately 10 locations along the landside of the south and north levees of Arcade Creek (mainly between Marysville Boulevard and Rio Linda Boulevard) and along the Robla Creek South Levee, east of Rio Linda Boulevard.

Vegetation Management

The levee accreditation element of the proposed project also includes a vegetation management component. Although the NFIP does not identify specific standards for managing vegetation on levees, ULDC provides criteria that reflect the underlying risk management objectives of the NFIP. Under these criteria, vegetation on levees must be modified or removed if it presents an unacceptable risk to the structural integrity or impedes operation and maintenance of the levee. In the NSS Levee Improvements area, approximately 8 high-risk trees along Arcade Creek have been identified for removal. All of the trees are either nonnative (7) or snags (3). Five are located on the waterside of the levees. These trees are in addition to any trees that would be removed as a result of implementation of levee improvements in the NSS Levee Improvements area.

2.3 Operation and Maintenance

Operation and maintenance (O&M) of the levees in the Sacramento area are the responsibility of the local maintaining agencies, including the American River Flood Control District, Maintenance Area 9, the California Department of Water Resources, and the City of Sacramento. The applicable O&M Manual for the Sacramento area levees is the Standard Operation and Maintenance Manual for the Sacramento River Flood Control Project. Typical levee O&M in the Sacramento area currently includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.
- Post-construction, groundwater levels would be monitored using the piezometers.

Following construction, the O&M manual for these reaches would be adjusted to reflect the vegetation variance and the SWIF plan. Under the adjusted O&M manual, large trees that are protected

in place under the variance would be allowed to remain on the waterside slopes, but smaller shrubs would be removed and grasses would be regularly mowed to allow for inspection and access.

Vegetation maintenance includes keeping maintenance roads clear of overhanging branches. Some of the vegetation along the levees includes elderberry shrubs. As part of long-term O&M, elderberry shrubs will be trimmed by the three levee maintenance districts. The following table describes the maximum amount of elderberry acreage that will be trimmed each year as a result of O&M. Trimming consists of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. Up to a third of a shrub will be trimmed in a single season. Trimming will occur between November 1 and March 15. Loss of habitat will be offset through the development of a conservation area as described in the conservation measures below. Each year the local maintaining authority will document the amount of valley elderberry longhorn beetle habitat that they have trimmed and report that number to the Corps to ensure compliance with this biological opinion. If the local maintaining agency has a need to exceed the amount of valley elderberry longhorn beetle habitat which needs to be trimmed or affected due to routine maintenance then they will request the Corps reinitiate consultation on this biological opinion for those actions.

2.4 Full Consultation Biological Assessment Approach

The description of baseline conditions and the evaluation of potential impacts have been organized by waterway, which includes the American River, Sacramento River, NEMDC, Arcade Creek, Dry/Robla Creek, Magpie Creek, and the Sacramento Weir/Bypass areas. For species that are described and covered in this consultation, habitat preferences and distributions are based on published data, agency documents, and review of the California Natural Diversity Database (CNDDB) (CDFW 2013a). Species distributions were assessed throughout the ARCF study area, and where appropriate, within specific regions.

Descriptions of baseline conditions are based on information published in peer-reviewed scientific literature, resource agency publications, as well as aerial photography viewed in Google Earth Pro within the project area. Baseline conditions are described with a focus on features that affect habitat conditions for threatened and endangered species, including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, delta smelt, green sturgeon, giant garter snake, valley elderberry longhorn beetle, vernal pool fairy shrimp, vernal pool tadpole shrimp, western yellow-billed cuckoo, and other special status bird species.

Table 7 summarizes the species addressed in this Biological Assessment and where the Corps assumes their habitat is present within the study area.

Table 7. Presence of Listed Species within the Study Area.

	Valley Elderberry Longhorn Beetle	Vernal Pool Fairy Shrimp	Vernal Pool Tadpole Shrimp	Giant Garter Snake	Winter-run Chinook Salmon	Spring-run Chinook Salmon	Central Valley Steelhead	Green Sturgeon	Delta Smelt	Western Yellow-billed Cuckoo
American River	Yes	No	No	No	Yes	Yes	Yes	Critical Habitat to Highway 160	No	Yes
Sacramento River	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Natomas East Main Drainage Canal	Yes	No	No	No	No	No	Yes	No	No	No
Arcade Creek	Yes	No	No	No	No	No	No	No	No	No
Dry/Robla Creek	Yes	No	No	No	No	No	Yes	No	No	No
Magpie Creek	Yes	Yes	Yes	No	No	No	No	No	No	No
Sacramento Bypass	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No

2.5 Proposed Conservation and Mitigation Measures

2.5.1 Compensation Timing

Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to protected species from designated compensation sites. In general, compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] § 2283).

2.5.2 Valley Elderberry Longhorn Beetle Conservation and Mitigation Measures

The following is a summary of measures that would be implemented during construction based on the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (Conservation Guidelines) (USFWS 1999a). These measures will be implemented to minimize any potential effects on valley elderberry longhorn beetles or their habitat, including restoration and maintenance activities, long-term, protection, and compensation if shrubs cannot be avoided. If shrubs cannot be avoided, compensation shall be implemented as shown in Tables 10 and 11 below. These measures could be adjusted in compliance with the most current guidance at the time of construction.

- The Corps assumes complete avoidance of the valley elderberry longhorn beetle when a 100-foot (or wider) buffer is established and maintained around elderberry shrubs.
- When work will occur within the 100-foot buffer, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.
- During construction activities, all areas to be avoided will be fenced and flagged.
- Contractors will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs will be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area will be restored.
- Buffer areas will continue to be protected after construction.

- No insecticides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Elderberry shrubs that cannot be avoided would be transplanted to an appropriate riparian area at least 100 feet from construction activities.
- If possible, elderberry shrubs would be transplanted during their dormant season (approximately November, after they have lost their leaves, through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation will apply.
- Elderberry compensation would be planted in the American River Parkway. The Corps has six existing sites which are offsetting previous Corps flood control projects along the lower American River and near Folsom Dam. The Corps will find areas within the lower American River parkway which will either expand existing compensation areas or provide for connectivity between conserved valley elderberry longhorn beetle habitat. Sites within the Parkway will be coordinated with County Parks and the Service during the design phase of the project. Sites will be designed and developed prior to any effects to valley elderberry longhorn beetle habitat. The Corps will create 69.91 acres of riparian habitat which supports valley elderberry longhorn beetle within the lower American River parkway.
- The Corps will work to develop compensation areas prior to or concurrent with any take of valley elderberry longhorn beetle habitat.
- Management of these lands will include all measures specified in USFWS's conservation guidelines (1999a) related to weed and litter control, fencing, and the placement of signs.
- Monitoring will occur for ten consecutive years or for seven non-consecutive years over a 15-year period. Annual monitoring reports will be submitted to USFWS.
- Off-site areas will be protected in perpetuity and have a funding source for maintenance (e.g., endowment).

2.5.3 Giant Garter Snake Conservation and Mitigation Measures

The following measures will be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity. These measures are based on USFWS guidelines for restoration and standard avoidance measures included as appendices in USFWS (1997).

- Unless approved otherwise by USFWS, construction will be initiated only during the giant garter snakes' active period (May 1–October 1, when they are able to move away from disturbance).
- Construction personnel will participate in USFWS-approved worker environmental awareness program.

- A giant garter snake survey would be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than two weeks, a biologist would survey the project area again no later than 24 hours prior to the restart of construction.
- Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from giant garter snake aquatic habitat.
- Giant garter snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel to the maximum extent feasible.
- Habitat temporarily affected for one season (the 5.5 acre borrow site along the NEMDC and the 75 acres along the toe drain of the Sacramento Bypass levee) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants. If for any reason construction extends into another active season the Corps will replace the habitat on-site and purchase credits at a ratio of 1:1 at a Service approved conservation bank.
- Habitat temporarily affected for more than three or more seasons will be restored and twice as much habitat will be created.
- Habitat permanently affected in the Sacramento Bypass in the form of drainage ditches and irrigation canals will be compensated for through the purchase of 135 acres of credits at a USFWS-approved conservation bank.
- One year of monitoring will be conducted for the 80.5 acres that are temporarily affected.
- The Corps will purchase credits at a conservation bank prior to any permanent disturbance of giant garter snake habitat.

For SAFCA's NSS project, the following measures are additionally proposed to reduce impacts to GGS from use of Borrow Site 2:

- A biological monitor shall be on-site during all ground-disturbing activities at Borrow Site 2.
- At least 10 days prior to the commencement of ground disturbing activities and after May 1, exclusionary fencing will be erected around the perimeter of Borrow Site 2K. Prior to fencing installation, the fence line shall be mowed (with a minimum height of 6 inches) in order to conduct a surface survey of potential burrows. Fencing shall be installed with a minimum of 6 inches buried in the ground and a minimum of 24 inches above ground. Fence staking shall

be installed on the inside of the exclusion area. One-way escape funnels shall be installed every 50 to 100 feet and sealed along the fence line, to provide an escape for any giant garter snake that may be within the exclusion area. The fencing shall enclose the entirety of the site, or additional exclusionary fencing can be extended 200 to 400 feet beyond the proposed entrance area. The fencing will be inspected before the start of each work day and maintained by the project proponents until completion of the project. The fencing will be removed only when project activities within Borrow Site 2 are completed.

2.5.4 Vernal Pool Crustacean Conservation and Mitigation Measures

The following measures from the 2004 Biological Opinion from the Magpie Creek Flood Control Project would be implemented to avoid and minimize impacts to potential vernal pools in the vicinity of the Magpie Creek construction area:

- Preservation component: For every acre of habitat directly or indirectly affected, at least two vernal pool credits will be dedicated within a Service-approved ecosystem preservation bank or, based on Service evaluation of site-specific conservation values, three acres of vernal pool habitat may be preserved on the project site or another nonbank site as approved by the Service.
- Creation component: For every acre of habitat directly affected, at least one vernal pool creation credit will be dedicated within a Service-approved habitat creation bank or, based on Service evaluation of site-specific conservation values, two acres of vernal pool habitat will be created and monitored on the project site or another non-bank site as approved by the Service.
- Listed vernal pool crustacean habitat and associated uplands utilized as on-site compensation will be protected from adverse effects and managed in perpetuity or until the Corps, the applicant, and the Service agree on a process to exchange such areas for credits within a Service-approved conservation banking system. Off-site conservation at a Service-approved non-bank location will be protected and managed in perpetuity through a Service-approved conservation easement, Service-approved management plan, and a sufficient endowment fund to manage the site in perpetuity in accordance with the management plan.
- If habitat is avoided (preserved) on site, then a Service-approved biologist (monitor) will inspect any construction-related activities at the proposed project site to ensure that no unnecessary take of listed species or destruction of their habitat occurs. The biologist will have the authority to stop all activities that may result in such take or destruction until appropriate corrective measures have been completed. The biologist also will be required to immediately report any unauthorized impacts to the Service and the California Department of Fish and Game.

- Adequate fencing will be placed and maintained around any avoided (preserved) vernal pool habitat to prevent impacts from vehicles.
- All on-site construction personnel will receive instruction regarding the presence of listed species and the importance of avoiding impacts to these species and their habitat.
- The applicant will ensure that activities that are inconsistent with the maintenance of the suitability of remaining habitat and associated on-site watershed are prohibited. This includes, but is not limited to: (i) alteration of existing topography or any other alteration or uses for any purposes, including the exploration for or development of mineral extraction; (ii) placement of any new structures on these parcels; (iii) dumping, burning, and/or burying of rubbish, garbage, or any other wastes or fill materials; (iv) building of any new roads or trails; (v) killing, removal, alteration, or replacement of any existing native vegetation; (vi) placement of storm water drains; (vii) fire protection activities not required to protect existing structures at the project site; and (viii) use of pesticides or other toxic chemicals.

The proposed project will result in 0.25 acre of indirect effects to vernal pools/swales of potentially suitable vernal pool shrimp and vernal pool tadpole shrimp habitat. The applicant has identified and agreed to purchase 0.5 vernal pool preservation credits at a Service-approved conservation bank or Service-approved fund. Credits will be purchased prior to the effect on any vernal pool habitat. The agreed upon conservation responsibilities of the applicant are as follows:

- Prior to any earth-moving activities at the proposed project site, the applicant shall purchase at least 0.5 vernal pool preservation credits within a Service-approved ecosystem preservation bank or fund account.

2.5.5 Western Yellow-Billed Cuckoo Conservation Measures

The following measures would be implemented to avoid and minimize impacts to potential yellow-billed cuckoo habitat in the study area:

- Prior to construction, surveys will be conducted to determine the presence of yellow-billed cuckoos within the project area in accordance with any required Service survey protocols and permits at the time of construction.
- If surveys find cuckoos in the area, vegetation removal will be done outside of the cuckoo nesting season.
- Riparian habitat that is removed due to project construction along the American River will be replanted within the American River Parkway. The Corps intends to expand existing conserved riparian lands within the parkway that could support the yellow-billed cuckoo. The design of replacement riparian areas will be coordinated with the Service to ensure that the habitat benefits both valley elderberry longhorn beetle and yellow-billed cuckoos.

2.5.6 Fisheries Conservation and Mitigation Measures

Green Sturgeon

The Corps proposes to develop a green sturgeon habitat, mitigation, and monitoring plan (HMMP) to address the long-term negative impacts to green sturgeon designated critical habitat with the specific elements that are described below:

- The green sturgeon HMMP shall be developed in coordination with the Interagency Ecological Program (IEP) green sturgeon project work team and consulted on with NMFS prior to the construction of any work within the designated critical habitat of sDPS green sturgeon related to the ARCF GRR.
- The Corps shall either refine the SAM or develop an alternative green sturgeon survival and growth response model based on using and updating the existing Hydrologic Engineering Center Ecosystem Function Model (HEC-EFM) that reflects green sturgeon's preference for benthic habitat.
- The green sturgeon HMMP shall also be developed with measurable objectives for completely offsetting all adverse impacts to all life stages of sDPS green sturgeon (as modeled using refined approaches described above and considering design refinements that occur in the PED phase of project implementation.
- The HMMP shall also, restore or compensate for the number of acres of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This mitigation shall be coordinated with the Interagency Working Group (IWG) or a Bank Protection Working Group (BPWG) and must be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat.
- Mitigation actions shall be initiated prior to the construction activities affecting sDPS green sturgeon and their critical habitat.
- The sDPS green sturgeon HMMP will include measurable performance standards at agreed upon intervals and will be monitored for a period of at least ten years following construction.

The following additional conservation measures would be implemented to reduce the adverse effects to listed Chinook, steelhead, delta smelt, and green sturgeon:

- In-water construction activities (e.g., placement of rock revetment) will be limited to the work window of August 1 through November 30. If the Corps wants to work outside of this window they will consult with USFWS and NMFS.
- The Corps will purchase 42 acres of delta smelt credits from a USFWS-approved conservation bank to off-set the loss of 14 acres of shallow water habitat.
- The Corps will purchase an additional 32 acres of delta smelt credits from a USFWS-approved conservation bank to off-set the loss of spawning habitat due to the placement of riprap on the river bed.
- Erosion control measures (BMPs), including Storm Water Pollution Prevention Program and Water Pollution Control Program, that minimize soil or sediment from entering the river. BMPs shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to Federally listed fish and their designated critical habitat.
- Screen any water pump intakes, as specified by NMFS and USFWS screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.
- No grading or altering of the lands within the existing Sacramento Bypass will occur as part of the project.
- The Corps shall participate in an existing IWG or work with other agencies to participate in a new BPWG to coordinate stakeholder input into future flood risk reduction actions associated with the ARCF GRR.
- The Corps shall coordinate with NMFS during PED as future flood risk reduction actions are designed to ensure conservation measures are incorporated to the extent practicable and feasible and projects are designed to maximize ecological benefits.
- The Corps shall include as part of the Project, a Riparian Corridor Improvement Plan with the overall goal of maximizing the ecological function and value of the existing levee system within the Sacramento Metropolitan Area.
- The Corps shall develop a HMMP with an overall goal of ensuring the conservation measures achieve a high level of ecological function and value. The HMMP shall include:
    - Specific goals and objectives and a clear strategy for maintaining all of the project conservation elements for the life of the project.
    - Measures to be monitored by the Corps for 10 years following construction and shall update their O&M manual to ensure the HMMP is adopted by the local

sponsor to ensure the goals and objectives of the conservation measures are met for the life of the project.

- Include specific goals and objectives and a clear strategy for achieving full compensation for all project-related impacts to listed fish species.
- The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP.
- The Corps shall host an annual meeting and issue annual reports for five years following completion of project construction.

- The Corps shall ensure that, for salmon and steelhead, the maximum SAM WRI deficits for each seasonal water surface elevation as determined appropriate with input from the IWG or the BPWG are fully offset through the purchase of credits at a NMFS approved conservation bank (as described in this BA).
- The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.
- The Corps shall ensure that the planting of native vegetation will occur as described in the HMMP. All plantings must be provided with the appropriate amount of water to ensure successful establishment.
- The Corps shall provide a copy of the BO, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in the documents and to educate and inform all other contractors involved in the project as to the requirements of the BO.
- A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. Written documentation of the training will be submitted to NMFS within 30 days of the completion of training.
- The Corps shall consider installing IWM along future flood risk reduction projects associated with the ARCF GRR at 40 to 80 percent shoreline coverage at all seasonal water surface elevations in coordination with the IWG or the BPWG. The purpose is to maximize the refugia and rearing habitats for juvenile fish.
- The Corps shall protect in place all riparian vegetation on the lower waterside slope of any levee unless removal is specifically approved by NMFS.
- The Corps shall develop a Vegetation Variance for all elements of the ARCF GRR that are adjacent to habitat that is occupied by federally listed salmon, steelhead and green sturgeon, including the main channel of the Sacramento River (as proposed) and the Sacramento Bypass.
- Additional mitigative concerns, not considered in a SAM analysis, will be included in the MMP (See Appendix I) along the Sacramento Bypass reach, including potential adult and

juvenile passage issues, loss of shoreline riparian vs. gain in floodplain, and contradicting ESA species habitat requirements. These issues will be considered and appropriate actions will be taken where possible in coordination with other agencies.

For SRA habitat impacted by construction, the following measures would be implemented to compensate for the habitat loss:

- Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to protected species from designated compensation sites. In general, compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] §§ 2201–2330).
- For identified designated critical habitat, where feasible all efforts will be made to compensate for impacts where they have occurred or in close proximity. Impacts to designated critical habitat, SRA and instream components combined and the compensation value of replacement habitat will be based on the interagency approved Standard Assessment Model (SAM) used throughout the Sacramento River basin and Delta flood control system.
- Compensation sites would be monitored and vegetation would be replaced as necessary based on performance standards in the Mitigation Monitoring Plan (MMP) as detailed in Appendix I of the EIS/EIR.

Depending on the species of interest (e.g., delta smelt), the severity of the short- term habitat losses due to bank erosion repair actions may not be compensated by long-term gains, whereas longer lived species (e.g., steelhead, Chinook) have longer periods for compensation to be provided. The following compensation time periods (based loosely on life expectancy) should be considered as guidelines for compensation:

- Green sturgeon, 15 years;
- Chinook salmon, 5 years;
- Central Valley steelhead, 4 years; and
- Delta smelt, 1 year.

2.5.7 Additional Minimization and Conservation Measures

- Obtain an ETL approved vegetation variance exempting sites from vegetation removal prior to final design and construction phase for the Sacramento River.
- Minimize the removal of existing vegetation in the proposed project area. Any disturbance or removal of vegetation will be replaced with native riparian vegetation, outside of the vegetation-free zone, as established in the ETL. Compensation for impacts to native riparian habitat will occur on a 2:1 basis on-site or in close proximity to the impact area. Riparian vegetation impacted under the SAFCA 408/404 actions will be replaced on a 3:1 canopy acreage basis.
- Erosion control measures (BMPs) including Storm Water Pollution Prevention Program and Water Pollution Control Program that minimize soil or sediment from entering the river. BMPs shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to Federally listed fish and their designated critical habitat.
- Implement BMPs to prevent slurry seeping out to river and require piping system on land side only.
- Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110% containment system.
- Construction will be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present, then coordination/reinitiation with the resource agencies will need to occur.
- Site access will be limited to the smallest area possible in order to minimize disturbance. Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
- To minimize ground and vegetation disturbance during project construction, project limits shall be clearly marked, including the boundaries of designated equipment staging areas; ingress and egress corridors; stockpile areas for spoils disposal, soil, and materials; and equipment exclusion zones.
- Project-related vehicles shall observe a 20-mile-per-hour speed limit within construction areas, except on County roads and on State and Federal highways.Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any

such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.

- Designating a Service-approved biologist as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.

Furthermore, the Corps will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible. A number of measures will be applied to the entire project or specific actions, and other measures may be appropriate at specific locations within the study area. Avoidance activities to be implemented during final design and construction may include, but are not limited to, the following:

- Identifying all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, aquatic, and/or plant species in the potentially affected project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporating sensitive habitat information into project bid specifications.
- Incorporating requirements for contractors to avoid identified sensitive habitats into project bid specifications.
- Minimizing vegetation removal to the extent feasible.
- Minimizing, to the extent possible, grubbing and contouring activities.
- Where feasible compensating for impacts close to where impacts have occurred.

2.5.8 Summary of Environmental Commitments

Items below present a general summary of environmental commitments that the Corps will adhere to as part of the ARCF GRR.

If habitat compensation efforts for listed species or designated critical habitat do not perform, or adequately compensate for habitat losses per established guidelines, then the Corps will purchase compensation at a mitigation bank approved by the USFWS and/or NMFS or work with the Services to determine where appropriate mitigation can be created.

- The Corps will obtain an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The Corps will be complying with the ETL on the American River via a SWIF. Full ETL compliance would occur on the East Side Tributaries sites. This

approval process is in alignment with the Corps' Levee Safety Program's goal of maintaining public safety as the primary objective and assuring application of consistent and well-documented approaches.

- The Corps will use a rock soil mixture to facilitate re-vegetation of the proposed project area. A (70:30) rock to soil ratio would be implemented. The soil-rock mixture would be placed on top of the of the rock revetment to allow native riparian vegetation to be planted to insure that SRA habitat lost is partially replaced or enhanced. Alternatively, a rock lined soil trench approach could be taken.
- In addition to an approved vegetation variance, the Corps will minimize the removal of existing vegetation in the proposed project area. Disturbance or removal of trees or larger woody vegetation will be replaced with native riparian species, outside of the vegetation-free zone, as established in the ETL.
- Vegetation removal, particularly tree removal, shall be conducted between September 16 and January 31, to the extent feasible, to minimize potential loss of active bird nests and bat maternity roosts.
- Construction will be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area, approximately May or June through October, depending on the species present on a site-specific basis. If construction needs to extend into the timeframe that species are present coordination with the resource agencies will occur.

The Corps is committed to implementing project compensation and mitigation as detailed above, however site selection and real estate coordination has not occurred at this time and would be determined during the design phase of the project. A draft mitigation and monitoring plan will accompany the final EIS/EIR, and would be updated throughout the design phase as detailed design efforts allow for finalizing the mitigation plans. The mitigation and monitoring plan would be coordinated with the Services during the design phase. The Corps would go through the following process in order to determine sites for implementing compensation for impacts to riparian habitat, including VELB and yellow-billed cuckoo compensation sites:

- The Corps would assess opportunities for on-site compensation to the maximum extent practicable. This assessment would include considering site-specific conditions, including whether the site is protected from future erosion by bank protection, or remains at risk of berm and vegetation loss due to the launchable rock trench.
- If on-site compensation is not possible, the Corps would evaluate opportunities to expand existing Corps mitigation sites within the American River Parkway, such as the River Bend Park mitigation site.
- If the Corps requires additional lands for compensation, the Corps would evaluate other opportunities within the American River Parkway in coordination with County Parks, USFWS, NMFS, and the ARFCD.

- If the above three opportunities are exhausted and further compensation is still required, the Corps would seek credits at a USFWS-approved mitigation bank.

SAFCA will mitigate for impacts to riparian habitat caused by levee improvements along Arcade Creek, and for removal of high-hazard trees that may affect the performance and reliability of existing levees on the Arcade Creek. SAFCA has identified some locations where native riparian vegetation could be established. Planting locations were selected to increase the patch size, improve habitat connectivity, and expand age class and species diversity of woodland habitat. These improvements would enhance nesting opportunities for native bird species.

Arcade Creek Habitat Improvements

Impacts caused by levee improvements and high-hazard tree removal along Arcade Creek would be mitigated on-site to the extent feasible by improving and expanding native wetland and riparian habitat adjacent to the low-flow channel within the reach between Rio Linda Boulevard and Marysville Boulevard, which is currently dominated by nonnative annual grasses and broadleaf weeds. Following construction, native wetland vegetation (e.g., Santa Barbara sedge, Baltic rush) would be planted along the banks of Arcade Creek, and one row of large riparian tree species (e.g., valley oak) would be planted along each bank of the low-flow channel. The tree spacing would be determined by the capacity of the floodplain to accommodate vegetation without impacting the desired flood performance. The dense, high overhead canopy of the trees as they mature would provide important shade to the low-flow channel and bank, cover for small mammals and a connected migration corridor for flying and gliding animals (both vertebrates and invertebrates). The SRA habitat along the active channel would benefit water quality by keeping temperatures lower (cooler water retains higher levels of dissolved oxygen needed to sustain native fish and aquatic invertebrates), and provide leaf drop and other organic material to support aquatic food webs. In addition, shade from streamside trees would help suppress some growth of dense red sesbania and willows in the understory to maintain flood conveyance, and prevent new colonization of invasive species.

Robla Creek Habitat Improvements

Replacement riparian woodlands are proposed either on Robla Creek Mitigation Site A, approximately 6 acres north of Rio Linda Boulevard, or on Robla Creek Mitigation Site B (approximately 7.1 acres south of Rio Linda Boulevard). Both sites are adjacent to and west of Robla Creek (Figure 18). Site A is a previous borrow site and is at a lower elevation making this area better suited for wetland mitigation. Site B is connected to the Robla Creek floodplain and is the site of a future multi-use recreational trail. SAFCA would provide right-of-way for future construction of the trail.

Figure 18. North Sacramento Streams Potential Robla Creek Mitigation Sites.

3.0 Federally Protected Species and Critical Habitat

Federally protected species and critical habitat that may be affected by the proposed action within the ARCF study area were determined through consultation with USFWS and NMFS. The Central Valley fall-/late fall–run Chinook salmon, which is an Evolutionarily Significant Unit (ESU) of special concern but is not Federally listed, is included because the project's effects on EFH must also be assessed.

3.1 Plants

Federally listed plant species are associated with habitat such as, salt marsh, dunes, or cismontane woodland/valley and foothill grasslands. Salt marsh habitat and cismontane woodland/valley and foothill grasslands are also very unlikely to occur along or adjacent to the levees. Due to the general lack of supporting habitat, potential impacts to Federally listed plants are not considered in this BA.

3.2 Invertebrates

3.2.1 Valley Elderberry Longhorn Beetle

Status and Distribution

The valley elderberry longhorn beetle is listed as a threatened species under the ESA (USFWS 1980). USFWS previously issued a proposed rule and a 12-month review finding on October 2, 2012 (77 FR 60238), to remove the valley elderberry longhorn beetle from the Federal endangered species list and to remove the designation of critical habitat for this species. In a proposed rule issued on September 17, 2014 (79 FR 55874), the USFWS withdrew the proposed rule to delist the species based on the best scientific and commercial data available and evaluation that indicated that threats to the species and its habitat have not been reduced such that removal of the species from the Federal endangered species list is appropriate and warranted.

The valley elderberry longhorn beetle's range extends from southern Shasta County to Fresno County (Talley et al. 2006). Along the eastern edge of the species' range, adult beetles have been found in the foothills of the Sierra Nevada at elevations up to 2,220 feet, and beetle exit holes have been located on elderberry plants at elevations up to 2,940 feet. Along the western edge of the species' range, adult beetles have been found on the eastern slopes of the Coast Ranges at elevations of up to

500 feet, and beetle exit holes have been detected on elderberry plants at elevations up to 730 feet (Barr 1991).

Critical habitat for the valley elderberry longhorn beetle occurs in two locations near the city of Sacramento (USFWS 1980). One area is enclosed by the Western Pacific railroad tracks and Highway 160, approximately one-half mile north of the American River near its confluence with the Sacramento River. The second site is located along the south bank of the American River at River Bend Park, just upstream of RM 13. Both of these areas are within the study area, however they would not be impacted by the proposed project. No bank protection measures are proposed in the area near Highway 160, and River Bend Park is upstream of the termination of the American River levees.

Life History and Habitat Requirements

Because historic loss of riparian habitat in the study area has already occurred, the rate of riparian habitat loss has slowed significantly over the last 30 years. During this period, incidental take of habitat has been authorized primarily for urbanization, transportation, water management, and flood control, on the order of 10,000 to 20,000 acres. Several habitat conservation plans are being developed to allow for continued urbanization of the Sacramento Valley (Talley et al. 2006).

Approximately 50,000 acres of existing riparian habitat in the Central Valley, primarily in the Sacramento Valley, have been protected by Federal, State, and local agencies as well as private organizations. Within the study area, large parcels of suitable habitat for the valley elderberry longhorn beetle have been protected, along the American River Parkway. Restoration of more than 5,000 acres of habitat has been initiated throughout the beetle's range (Talley et al. 2006). Mitigation for previous Corps projects has planted within the American River Parkway through agreements with Sacramento County Parks. Additional lands are currently available for mitigation that may be required for this project.

Valley elderberry longhorn beetle is only found in close association with its host plant, elderberry shrubs (*Sambucus* spp.). Elderberry shrubs are found in or near riparian and oak woodland habitats. The valley elderberry longhorn beetle's life history is assumed to follow a sequence of events similar to those of related taxa. Female beetles deposit eggs in crevices in the bark of living elderberry shrubs. Presumably, the eggs hatch shortly after they are laid, and the larvae bore into the pith of the trunk or stem. When larvae are ready to pupate, they move through the pith of the plant, open an emergence hole through the bark, and return to the pith for pupation. Adults exit through the emergence holes and can sometimes be found on elderberry foliage, flowers, or stems or on adjacent vegetation. The entire life cycle of the valley elderberry longhorn beetle is thought to encompass 1 or 2 years, from the time eggs are laid and hatch until adults emerge and die (USFWS 1984).

The presence of exit holes in elderberry stems indicates previous valley elderberry longhorn beetle habitat use. Exit holes are cylindrical and approximately 0.25 inch in diameter. Exit holes can be found on stems that are 1 or more inches in diameter. The holes may be located on the stems from a few inches to about 9 to 10 feet above the ground (Barr 1991).

Factors Affecting Abundance

The valley elderberry longhorn beetle distribution decline is most likely related to the extensive loss of riparian forests in the Central Valley, which has reduced the amount of available habitat for the species, and has most likely decreased and fragmented the species' range (USFWS 1984).

Insecticide drift from cultivated fields and orchards adjacent to elderberry plants may affect valley elderberry longhorn beetle populations, if drift occurs at a time when adults are present on the shrubs (Barr 1991). Herbicide drift from agricultural fields and orchards can likewise affect the health of elderberry plants, thereby reducing their quantity and quality as valley elderberry longhorn beetle habitat.

The invasive Argentine ant (*Linepithema humile*) has been spreading in riparian habitats and may affect survival of the valley elderberry longhorn beetle. Argentine ants may predate valley elderberry longhorn beetle eggs although this interaction needs further exploration (Huxel 2000). The spread of invasive exotic plants (e.g., giant reed [*Arundo donax*] may also negatively affect the valley elderberry longhorn beetle by affecting supporting riparian habitats. The presence of giant reed promotes a more frequent fire cycle and homogenous plant community (Talley et al. 2006).

3.2.2 Vernal Pool Fairy Shrimp

Status and Distribution

The vernal pool fairy shrimp is listed as a threatened species under the ESA (59 FR 48136). Fairy shrimp are endemic to vernal pools in the Central Valley, coast ranges, and a limited number of sites in the Transverse Range and Santa Rosa Plateau of California. . The most accurate indication of the distribution and abundance of vernal pool fairy shrimp is the number of inhabited vernal pool complexes. There are 32 known populations of the vernal pool fairy shrimp, extending from the Stillwater Plain in Shasta County through the Central Valley to Pixley in Tulare County. In addition, the shrimp occur along the central Coast Range from northern Solano County to Pinnacles National Monument in San Benito County.

Critical habitat for the vernal pool fairy shrimp is designated in the vicinity of the study area on lands surrounding Mather Field. There is no critical habitat for vernal pool fairy shrimp in the study area.

Life History and Habitat Requirements

Vernal pool fairy shrimp live in vernal pools, an ephemeral freshwater habitat. None are known to occur in riverine waters, marine waters, or other permanent bodies of water. They are ecologically dependent on seasonal fluctuations in their habitat, such as absence or presence of water during specific times of the year, duration of inundation, and other environmental factors that include specific salinity, conductivity, dissolved solids, and pH levels. Water chemistry is one of the most important factors in determining the distribution of fairy shrimp (Belk 1977).

Fairy shrimp and tadpole shrimp play an important role in the community ecology of many ephemeral water bodies (Loring et al. 1988). They are fed upon by waterfowl and other vertebrates, such as western spadefoot toad (*Scaphiopus hammondi*) tadpoles (Ahl 1991).

Fairy shrimp have delicate elongate bodies, large stalked compound eyes, no carapace, and 11 pairs of swimming legs. They swim or glide gracefully upside down by means of complex beating movements of the legs that pass in a wavelike, anterior-to-posterior direction. Nearly all fairy shrimp feed on algae, bacteria, protozoa, rotifers, and bits of detritus. Female shrimp drop their eggs to the pool bottom or eggs remain in the brood sac until the female dies and sinks. The "resting" or "summer" eggs are capable of withstanding heat, cold, and prolonged desiccation. When the pools refill in the same or subsequent seasons some, but not all, of the eggs may hatch. The egg bank in the soil may be comprised of the eggs from several years of breeding (Donald 1983). The eggs hatch when the vernal pools fill with rainwater. The early stages of the fairy shrimp develop rapidly into adults. These non-dormant populations often disappear early in the season long before the vernal pools dry up.

Vernal pools form in regions with Mediterranean climates where shallow depressions fill with water during fall and winter rains and then evaporate in the spring (Collie and Lathrop 1976). Downward percolation is prevented by the presence of an impervious subsurface layer, such as a claypan, hardpan, or volcanic stratum (Holland 1976, 1988). Due to local topography and geology, the pools are usually clustered into pool complexes (Holland and Jain 1988). Pools within a complex typically are separated by distances on the order of meters and may form dense, interconnected mosaics of small pools or a more sparse scattering of larger pools. Temporary inundation makes vernal pools too wet during the wetted period for adjacent upland plant species adapted to drier soil conditions, while rapid drying during late spring makes pool basins unsuitable for typical marsh or aquatic species that require a more permanent source of water. However, many indigenous plant and aquatic invertebrate species have evolved to occupy the extreme environmental conditions found in vernal pool habitats.

Factors Affecting Abundance

Vernal pools are in danger due to a variety of human-caused activities, including urban development, water supply and flood control activities, and conversion of land to agricultural use. Changes in hydrologic pattern, overgrazing, and off-road vehicle use also imperil this aquatic habitat . Habitat loss occurs from direct destruction and modification of pools by filling, grading, discing, leveling, and other activities. Vernal pools can also be indirectly impacted when modifications of the surrounding uplands alter the vernal pool watershed (USFWS 1992b). Diversion of watershed runoff feeding the pools can result in premature pool dry-down before the life cycle of the fairy shrimp is complete. The fairy shrimp is also intolerant of flowing water that washes away the egg bank. Supplemental water from outside the natural watershed into vernal pools can change the habitat into a marsh-dominated or a permanent aquatic community that is unsuitable for the
vernal pool shrimp.

Other secondary impacts associated with urbanization include disposal of waste materials into habitat for the four species included in this final rule (Bauder 1986, 1987). Disposal of concrete, tires, refrigerators, sofas, and other trash adversely affects these animals by eliminating habitat, disrupting pool hydrology or, in some cases, through release of toxic substances. Dust and other forms of air or water pollution from commercial development or agriculture projects also may be deleterious to these animals. Introduction of the bullfrog (*Rana catesbeiana*) to areas inhabited by the vernal pool tadpole shrimp appears to increase the threat of predation facing this crustacean.

3.2.3 Vernal Pool Tadpole Shrimp

Status and Distribution

The vernal pool tadpole shrimp is listed as an endangered species under the ESA (59 FR 48136). They are endemic to vernal pools in the Central Valley, coast ranges, and a limited number of sites in the Transverse Range and Santa Rosa Plateau of California. The most accurate indication of the distribution and abundance of the vernal pool tadpole shrimp is the number of inhabited vernal pool complexes. There are 18 known populations of vernal pool tadpole shrimp in the Central Valley, ranging from east of Redding in Shasta County south to the San Luis National Wildlife Refuge in Merced County.

Critical habitat for the vernal pool tadpole shrimp is designated in the vicinity of the study area on lands surrounding Mather Field. There is no critical habitat for vernal pool fairy shrimp in the study area.

Life History and Habitat Requirements

The life history of the vernal pool tadpole shrimp is linked to the phenology of the vernal pool habitat. None are known to occur in riverine waters, marine waters, or other permanent bodies of water. After winter rainwater fills the pools, the populations are reestablished from diapaused eggs that lie dormant in the dry pool sediments (Ahl 1991). Tadpole shrimp are primarily benthic animals that swim with their legs down. They climb or scramble over objects, as well as plow along in bottom sediments. Their diet consists of organic detritus and living organisms, such as fairy shrimp and other invertebrates (Pennak 1989).

A female surviving to large size may lay up to six clutches of eggs, totaling about 861 eggs in her lifetime (Ahl 1991). The eggs are sticky and readily adhere to plant matter and sediment particles (Simovich and Fugate 1992). A portion of the eggs hatch immediately and the rest enter diapause and remain in the soil to hatch during later rainy seasons (Ahl 1991). Ahl (1991) found that eggs in one pool hatched within three weeks of inundation and maturated to sexually reproductive adults in another three to four weeks. Simovich and Fugate (1992) reported sexually mature adults occurred in another pool three to four weeks after the pools had been filled. The vernal pool tadpole shrimp matures slowly and is a long-lived species (Ahl 1991). Adults are often present and reproductive until the pools dry up in the spring (Ahl 1991; Simovich et al. 1992).

Factors Affecting Abundance

Vernal pools are in danger due to a variety of human-caused activities, including urban development, water supply and flood control activities, and conversion of land to agricultural use. Changes in hydrologic pattern, overgrazing, and off-road vehicle use also imperil this aquatic habitat . Habitat loss occurs from direct destruction and modification of pools by filling, grading, discing, leveling, and other activities. Vernal pools can also be indirectly impacted when modifications of the surrounding uplands alter the vernal pool watershed (USFWS 1992b). Diversion of watershed runoff feeding the pools can result in premature pool dry-down before the life cycle of the tadpole shrimp is complete. The tadpole shrimp is also intolerant of flowing water that washes away the egg bank. Supplemental water from outside the natural watershed into vernal pools can change the habitat into a marsh-dominated or a permanent aquatic community that is unsuitable for the vernal pool tadpole shrimp.

Other secondary impacts associated with urbanization include disposal of waste materials into habitat for the four species included in this final rule (Bauder 1986, 1987). Disposal of concrete, tires, refrigerators, sofas, and other trash adversely affects these animals by eliminating habitat, disrupting pool hydrology or, in some cases, through release of toxic substances. Dust and other forms of air or water pollution from commercial development or agriculture projects also may be deleterious to these animals. Introduction of the bullfrog (*Rana catesbeiana*) to areas inhabited by the vernal pool tadpole shrimp appears to increase the threat of predation facing this crustacean.

3.3 Fish

Six fish species' ESUs or Distinct Population Segments (DPSs) and critical habitats are addressed below. These include Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, Central Valley fall-/late fall–run Chinook salmon ESU, Central Valley steelhead DPS, delta smelt, and green sturgeon southern DPS.

3.3.1 Sacramento River Winter-Run Chinook Salmon Evolutionarily Significant Unit

Status and Distribution

The Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) was listed as threatened under the Federal ESA on August 4, 1989 (NMFS 1989). NMFS subsequently upgraded the Federal listing to endangered on January 4, 1994 (NMFS 1994). NMFS designated critical habitat for Sacramento River winter-run Chinook salmon on June 16, 1993 (NMFS 1993a). The ESU includes all naturally spawned populations of winter-run Chinook in the Sacramento River and its tributaries, as well as populations from two artificial propagation programs, one at the Livingston Stone National Fish Hatchery and the other at Bodega Marine Laboratory (NMFS 2005a).

Prior to construction of Shasta Dam, winter-run Chinook salmon spawned in the upper reaches of the Sacramento River, the McCloud River, and the lower Pit River. Spawning is now restricted to approximately 44 miles of the mainstem Sacramento River, immediately downstream of Keswick Dam (Yoshiyama et al. 1998). The abundance of winter-run Chinook salmon in the Sacramento River before Shasta Dam was constructed, is unknown. Some biologists believe the run was relatively small, possibly consisting of a few thousand fish (Slater 1963). Others, relying on anecdotal accounts, believe the run could have numbered more than 200,000 fish (NMFS 1993b). During the mid-1960s, more than 20 years after the construction of Shasta Dam, the population exceeded 80,000 fish (USBR 1986). The population declined substantially during the 1970s and 1980s.

In 1988, winter-run Chinook salmon escapement was estimated at 696 adults. Escapement continued to decline, diminishing to an estimated 430 fish in 1989 and 211 fish in 1990 (CDFW 2013b). The rapid decline in escapement during the late 1980s and early 1990s prompted listing of the winter-run Chinook salmon as endangered under the California ESA and the Federal ESA. Escapement in 1991 was estimated to be 1,240 fish, indicating good survival of the 1988 class. NMFS data indicates that the population has increased during the late 1990s through 2001. In 1995, returning spawners numbered 1,337 fish and in 2012, returning adults were estimated to be 6,123 (CDFW 2013b). Despite increased efforts to maintain and enhance the population of winter-run Chinook salmon by various entities, in their final listing determination of June 28, 2005, NMFS again found "that the Sacramento River winter-run Chinook salmon ESU in total is in danger of extinction throughout all or a significant

portion of its range" and concludes that the ESU continues to warrant listing as an endangered species under the Federal ESA (NMFS 2005a).

Life History

Winter-run Chinook salmon spend 1 to 3 years in the ocean. Adult winter-run Chinook salmon leave the ocean and migrate through the Delta into the Sacramento River from December through July with peak migration in March. Adults spawn from mid-April through August (Moyle 2002). Egg incubation continues through October. The primary spawning habitat in the Sacramento River is above the Red Bluff Diversion Dam (RBDD) at RM 243, although spawning has been observed downstream as far as RM 218 (NMFS 2001). Spawning success below RBDD may be limited primarily by warm water temperatures (Hallock and Fisher 1985; Yoshiyama et al. 1998).

Downstream movement of juvenile winter-run Chinook salmon begins in August, soon after fry emerge. The peak abundance of juveniles moving downstream at Red Bluff occurs in September and October (Vogel and Marine 1991). Juvenile Chinook salmon move downstream from spawning areas in response to many factors, which may include inherited behavior, habitat availability, flow, competition for space and food, and water temperature. The numbers of juveniles that move and the timing of movement are highly variable. Storm events and their resulting high flows and turbidity appear to trigger downstream movement of substantial numbers of juvenile Chinook salmon.

Winter-run Chinook salmon smolts (i.e., juveniles that are physiologically ready to enter seawater) may migrate through the Delta and San Francisco Bay to the ocean from November through May (Yoshiyama et al. 1998). The Sacramento River channel is the main migration route through the Delta. However, the Yolo Bypass also provides significant outmigration passage during higher flow events.

During winter in the Sacramento–San Joaquin system, juveniles rear on seasonally inundated floodplains. Sommer et al. (2001) found higher growth and survival rates of juvenile Chinook salmon reared on the Yolo Bypass floodplain, than those that reared in the mainstem Sacramento River.

Factors Affecting Abundance

One of the main factors in the decline of Chinook salmon is habitat loss and degradation. On the Sacramento River, Shasta Dam blocked access to historical spawning and rearing habitat. Other factors affecting abundance include the effects of reservoir operations on water temperature, harvesting and fishing pressure, entrainment in diversions, contaminants, predation by non-native species, and interaction with hatchery stock (Corps 2000b).

In the Sacramento River, operation of the Central Valley Project (CVP) and State Water Project (SWP) influences river flow. Low flows can reduce habitat area and adversely affect water quality. The resulting warm water temperatures and low dissolved oxygen levels can stress incubating eggs and rearing juvenile winter-run Chinook salmon. Low flow may affect migration of juveniles and adults through increased water temperature or reduced velocity that slows downstream movement of juveniles. Low flow, in combination with diversions, may result in higher entrainment losses at the State and Federal pumping plants in the south Delta (Corps 2000b).

In the Delta, flow drawn through the Delta Cross Channel (DCC) and Georgiana Slough transports some percentage of downstream migrating salmon into the central Delta. The number of juveniles entering the DCC and Georgiana Slough is assumed to be proportional to the flow volume diverted from the Sacramento River (CDFG 1987). Survival of juvenile Chinook salmon that are drawn into the central Delta is lower than survival of juvenile Chinook salmon that remain in the Sacramento River channel.

Critical Habitat/Essential Fish Habitat

Within the ARCF GRR study area, the Sacramento River and Sacramento Bypass is considered to be critical habitat for winter-run Chinook salmon. Critical habitat includes the water column, river bottom, and adjacent riparian zone which fry and juveniles use for rearing (NMFS 2006b). The conservation value of critical habitat in the study area is high because it supports both recruitment and survival of juveniles and adults (NMFS 2006a).

EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All reaches within the ARCF study area are considered to be essential fish habitat for winter-run Chinook salmon.

3.3.2 Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Unit

Status and Distribution

The Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) was Federally listed as threatened on September 16, 1999 (NMFS 1999). Their threatened status was reaffirmed in NMFS's final listing determination issued on June 28, 2005 (NMFS 2005a). Critical habitat for Central Valley spring-run Chinook salmon was designated by NMFS on September 2, 2005 (NMFS 2005b). The ESU includes all naturally spawned spring-run Chinook salmon in the Sacramento River and its tributaries. Naturally spawned fish of hatchery origin in the Feather and Yuba Rivers as well as hatchery spawned fish in the Feather River are also included as a part of this ESU (NMFS 2005a).

Spring-run Chinook salmon may have once been the most abundant of Central Valley Chinook salmon (Mills and Fisher 1994), historically occupying the upstream reaches of all major river systems in the Central Valley where there were no natural barriers. Central Valley spring-run Chinook salmon are now restricted to the upper Sacramento River downstream of Keswick Dam; the Feather River downstream of Oroville Dam; the Yuba River downstream of Englebright Dam; several perennial tributaries of the Sacramento River (e.g., Deer, Mill, and Butte creeks); and the Delta.

The abundance of Central Valley spring-run Chinook salmon escapement, as measured by the number of adults returning to spawn from 1960 to 2013, averaged 10,236 adults for in-river natural spawners and 2,364 average adults returning to hatcheries (CDFW 2013b). Spring-run Chinook salmon spawn in the early fall and have interbred with fall-run Chinook salmon in the Sacramento and Feather Rivers. Genetically uncontaminated populations may exist in Deer Creek, Mill Creek, Butte Creek, and other eastside tributaries of the Sacramento River.

Life History

Adult spring-run Chinook salmon enter the mainstem Sacramento River from March through September, with the peak upstream migration occurring from May through June (Yoshiyama et al. 1998). Adults generally enter tributaries from the Sacramento River between mid-April and mid-June (Lindley et al. 2006 as cited in NMFS 2006b). Spring-run Chinook salmon are sexually immature during upstream migration, and adults hold in deep, cold pools near spawning habitat until spawning commences in late summer and fall. Spring-run Chinook salmon spawn in the upper reaches of the mainstem Sacramento River and tributary streams (USFWS 1995), with the largest tributary runs occurring in Butte, Deer, and Mill Creek's (Yoshiyama et al. 1998). Spawning typically begins in late August and may continue through October. Juveniles emerge in November and December in most locations but may emerge later when water temperature is cooler. Newly emerged fry remain in shallow, low-velocity edgewater (CDFG 1998).

Juvenile spring-run Chinook salmon typically spend up to one year rearing in fresh water before migrating to sea as yearlings, but some may migrate downstream as young-of-year juveniles. Rearing takes place in their natal streams, the mainstem of the Sacramento River, inundated floodplains (including the Sutter and Yolo bypasses), and the Delta. Based on observations in Butte Creek and the Sacramento River, young-of-year juveniles typically migrate from November through May. Yearling spring-run Chinook salmon migrate from October to March, with peak migration in November (Cramer and Demko 1997; Hill and Webber 1999). Downstream migration of yearlings typically coincides with the onset of the winter storm season, and migration may continue through March (CDFG 1998).

Factors Affecting Abundance

Main factors in the decline of spring-run Chinook salmon populations are habitat loss and degradation. Dams have blocked access to historical spawning and rearing habitat. Other factors affecting abundance of spring-run Chinook salmon include harvest, entrainment in diversions,

contaminants, predation by non-native species, and interbreeding with fall-run Chinook salmon and hatchery stocks (Corps 2000b).

In the Sacramento River and its major tributaries, operation of the CVP and SWP controls river flow. Low flows limit habitat area and adversely affect water quality, such as warm water temperature and low dissolved oxygen that stress incubating eggs and rearing juveniles. Low flow may affect migration of juveniles and adults through inadequate water depth to support passage, or through reduced velocity that slows the downstream movement of juveniles. Low flow, in combination with diversions, may result in higher entrainment losses (Corps 2000b).

In the Delta, flow drawn through the DCC and Georgiana Slough transports some portion of downstream migrants into the central Delta. The number of juveniles entering the DCC and Georgiana Slough is assumed to be proportional to the flow volume diverted from the Sacramento River (CDFG 1987). Survival of juvenile Chinook salmon that are drawn into the central Delta is lower than survival of juvenile Chinook salmon that remain in the Sacramento River channel.

Critical Habitat/Essential Fish Habitat

Critical habitat for spring-run Chinook salmon includes all river channels and sloughs within the ARCF GRR study area on the Sacramento River and on the American River from the confluence to the Watt Avenue bridge. (NMFS 2006b). Critical habitat includes the stream channels and the lateral extent as defined by the ordinary high-water line or bank-full elevation. Primary constituent elements (PCEs) of critical habitat in the study area include: (1) freshwater rearing sites that have adequate water quality and quantity, floodplain connectivity, and natural cover that supports juvenile growth and mobility, and (2) freshwater migration corridors that support adequate water quantity and quality as well as natural cover to provide food and migration pathways for juveniles as well as adults. (NMFS 2005e, 2006b). The conservation value of critical habitat in the study area is high because it supports both recruitment and survival of juveniles and adults (NMFS 2006a).

EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All reaches within the ARCF study area are considered to be EFH for spring-run Chinook salmon.

3.3.3 Central Valley Fall-/Late Fall–Run Chinook Salmon Evolutionarily Significant Unit

Status and Distribution

The Central Valley fall-/late fall–run Chinook salmon ESU (*Oncorhynchus tshawytscha*) is not listed under the Federal ESA. On March 9, 1998, NMFS issued a proposed rule to list fall-run Chinook salmon as threatened (NMFS 1998a). However, on September 16, 1999, NMFS determined that the species did not warrant listing (NMFS 1999). On April 15, 2004, NMFS classified Central Valley fall-/late

fall–run Chinook salmon as a species of concern (NMFS 2004). However, EFH is designated for this species.

The Central Valley fall-/late fall–run Chinook salmon ESU includes all naturally spawned populations of fall-run Chinook salmon in the Sacramento and San Joaquin river basins and their tributaries. Central Valley fall-/late fall–run Chinook salmon are currently the most abundant and widespread salmon runs in California (Mills et al. 1997), representing about 80% of the total Chinook salmon produced in the Sacramento River drainage (Kjelson et al. 1982). The most abundant spawning populations of fall-/late fall–run Chinook salmon occur in the Sacramento, Feather, Yuba, and American rivers (Mills and Fisher 1994). Fall-run Chinook salmon in the Sacramento, Feather, and American rivers have a relatively large hatchery component, from 1952 to 2013 the average was 57,508 fish. The average escapement in-river on the Sacramento and San Joaquin system from 1960 to 2013 was 264,475 (CDFW 2013b).

Life History

Adult fall-run Chinook salmon migrate into the Sacramento River and its tributaries from June through December in mature condition and spawn from late September through December, soon after arriving at their spawning grounds (Yoshiyama et al. 1998). The spawning peak occurs in October and November. Emergence occurs from December through March, and juveniles migrate downstream to the ocean soon after emerging, rearing in fresh water for only a few months. Smolt outmigration typically occurs from March through July (Yoshiyama et al. 1998).

Late fall–run Chinook salmon migrate upstream before they are sexually mature, and hold near spawning grounds for 1 to 3 months before spawning. Upstream migration takes place from October through April and spawning occurs from late January through April, with peak spawning in February and March (Yoshiyama et al. 1998). Fry emerge from April through June. Juvenile late fall–run Chinook salmon rear in their natal streams during the summer, and in some streams they remain throughout the year. Smolt outmigration can occur from November through May (Yoshiyama et al. 1998).

Factors Affecting Abundance

Factors affecting abundance of fall-/late fall–run Chinook salmon are similar to factors affecting abundance of winter- and spring-run Chinook salmon, i.e., habitat loss and degradation. Fall-run Chinook salmon, however, typically use spawning habitat farther downstream than the spawning habitat used by spring- and winter-run Chinook salmon. The effect of dams on spawning habitat area for fall-run Chinook salmon is not as severe as for other runs, although access to substantial spawning habitat area has been blocked by dams.

Critical Habitat/Essential Fish Habitat

Critical habitat is not designated for fall-/late fall–run Chinook salmon, however EFH is designated for this species. EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All reaches within the ARCF GRR study area are considered to be EFH for fall-/late fall-run Chinook salmon.

3.3.4 Central Valley Steelhead Distinct Population Segment

Status and Distribution

The Central Valley steelhead (*Oncorhynchus mykiss*) DPS was Federally listed as threatened on March 19, 1998 (NMFS 1998b). The threatened status of Central Valley steelhead was reaffirmed in NMFS's final listing determination on January 5, 2006 (NMFS 2006a); at the same time NMFS also adopted the term DPS, in place of ESU, to describe Central Valley steelhead and other population segments of this species. NMFS originally designated critical habitat for Central Valley steelhead on February 16, 2000 (NMFS 2000). However, following a lawsuit (*National Association of Home Builders et al. v. Donald L. Evans, Secretary of Commerce, et al.*), NMFS decided to rescind the listing and re-evaluate how to classify critical habitat for several DPSs of steelhead.

Critical habitat for Central Valley steelhead was re-designated by NMFS on September 2, 2005 (NMFS 2005b). The DPS includes all naturally spawned populations of steelhead in the Sacramento and San Joaquin rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries. Artificially propagated fish from the Coleman and Feather River hatcheries are included in the DPS (NMFS 2006a).

Steelhead ranged throughout the tributaries of the Sacramento and San Joaquin rivers prior to dam construction, water development, and watershed perturbation dating from the 19th and 20th centuries. Wild stocks are now mostly confined to the upper Sacramento River downstream of Keswick Dam; upper Sacramento River tributaries such as Deer, Mill, and Antelope creeks; and the Yuba River downstream of Englebright Dam. Populations may also exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather rivers (McEwan and Jackson 1996). The abundance of naturally reproducing Central Valley steelhead, as measured by the number of adults returning to spawn, is largely unknown. Natural escapement in 1995 was estimated to be about 1,000 adults each for Mill and Deer creeks and the Yuba River (S. P. Cramer and Associates 1995). Hatchery returns have averaged around 10,000 adults (Mills and Fisher 1994). The most recent annual estimate of adults spawning upstream of RBDD is less than 2,000 fish (NMFS 2006a).

Life History

Central Valley steelhead have one of the most complex life histories of any salmonid species, exhibiting both anadromous and freshwater resident life histories. Freshwater residents typically are referred to as rainbow trout, and those exhibiting an anadromous life history are called steelhead (NMFS 1999). Steelhead exhibit highly variable life history patterns throughout their range but are broadly categorized into winter and summer reproductive ecotypes. Winter steelhead are the most widespread reproductive ecotype and the only type currently present in Central Valley streams (McEwan and Jackson 1996). Winter steelhead become sexually mature in the ocean, enter spawning streams in summer, fall or winter, and spawn a few months later in winter or late spring (Meehan and Bjornn 1991; Behnke 1992).

In the Sacramento River, adult winter steelhead migrate upstream during most months of the year, beginning in July, peaking in September, and continuing through February or March (Hallock 1987). Spawning occurs primarily from January through March, but may begin as early as late December and may extend through April (Hallock 1987). Individual steelhead may spawn more than once, returning to the ocean between each spawning migration.

Juvenile steelhead rear a minimum of one and typically two or more years in fresh water before migrating to the ocean as smolts. Juvenile migration to the ocean generally occurs from December through August. The peak months of juvenile migration are January to May (McEwan 2001). The importance of main channel and floodplain habitats to steelhead in the lower Sacramento River and upper Delta is not well understood. Steelhead smolts have been found in the Yolo Bypass during the period of winter and spring inundation (Sommer 2002), but the importance of this and other floodplain areas in the lower Sacramento River and upper Delta is not yet clear.

Factors Affecting Abundance

The decline in steelhead populations is attributable to changes in habitat quality and quantity. The availability of steelhead habitat in the Central Valley has been reduced by as much as 95% or more due to barriers created by dams (NMFS 1996a). Populations have been most severely affected by dams blocking access to the headwaters of all major tributaries; consequently, most runs are maintained through artificial production. The decline of naturally produced Central Valley steelhead has been more precipitous than that of hatchery stocks. Populations in the range's southern portion have experienced the most severe declines (NMFS 1996b). Other factors contributing to the decline of steelhead in the Central Valley are mining, agriculture, urbanization, logging, harvest, hatchery influences, flow management (including reservoir operations), hydropower generation, and water diversion and extraction (NMFS 1996a).

Critical Habitat/Essential Fish Habitat

Habitat for endangered or threatened anadromous fish is designated as critical habitat under the ESA and as EFH under the MSA. EFH has been designated for Chinook salmon, but not for steelhead. Critical habitat for Central Valley steelhead includes the stream channels and the lateral extent as defined by the ordinary high-waterline or bank-full elevation in the designated stream reaches of the Sacramento and American River, NEMDC and Dry/Robla creek portions of the ARCF GRR. Primary constituent elements of critical habitat are as described for spring-run Chinook salmon (NMFS 2006b).

3.3.5 Delta Smelt

Status and Distribution

Delta smelt (*Hypomesus transpacificus*) was Federally listed as threatened on March 5, 1993 (USFWS 1993) and critical habitat was designated on December 19, 1994 (USFWS 1994). Population trends and abundance of delta smelt are poorly understood due to their short life span (1 year). Based on data from 21 years of monthly sampling in Suisun Marsh, delta smelt appear to be experiencing long-term declines (Matern et al. 2002). Summer tow-net and fall/mid-water trawl data show fluctuating annual abundance from 1991 through 1996, with an increasing trend in the late 1990s, followed by an overall decline in abundance since 1999 (Bryant and Souza 2004).

Life History

Delta smelt are endemic to the Sacramento–San Joaquin estuary and are found seasonally in Suisun Bay and Suisun Marsh. They typically are found in shallow water (less than 10 feet) where salinity ranges from 2 to 7 parts per thousand (ppt), although they have been observed at salinities between 0 and 18.4 ppt. Delta smelt have relatively low fecundity and most live for 1 year. They feed on planktonic copepods, cladocerans, amphipods, and insect larva (Moyle 2002).

Delta smelt are semi-anadromous. During their spawning migration, adults move into the freshwater channels and sloughs of the Delta between December and January. Spawning occurs between January and July, with peak spawning from April through mid-May (Moyle 2002). Spawning locations in the Delta have not been identified and are inferred from larval catches (Bennett 2005). Larval fish have been observed in Montezuma Slough; Suisun Slough in Suisun Marsh; the Napa River estuary; the Sacramento River above Rio Vista; and Cache, Lindsey, Georgiana, Prospect, Beaver, Hog, Sycamore, and Barker sloughs (Wang 1986, Moyle 2002, Stillwater Sciences 2006, and USFWS 1996). Spawning was also observed in the Sacramento River up to Garcia Bend (RM 51) during drought conditions, as a result of increased saltwater intrusion that moved delta smelt spawning and rearing farther inland (Wang and Brown 1993).

Laboratory experiments have found eggs to be adhesive, demersal, and usually attached to substrate composed of gravel, sand, or other submerged material (Moyle 2002, Wang 1991). Hatching takes approximately 9 to 13 days, and larvae begin feeding 4 to 5 days later. Newly hatched larvae contain a large oil globule that makes them semi-buoyant and allows them to stay near the bottom. As their fins and swim bladder develop, they move higher into the water column and are transported downstream to the open waters of the estuary (Moyle 2002).

Factors Affecting Abundance

Diversions and Delta inflow and outflow may affect survival of delta smelt. In water exported at the South Delta CVP and SWP export facilities, estimates of delta smelt entrainment suggest a population decline in the early 1980s, mirroring the decline indicated by mid-water trawl, summer tow-net, Kodiak trawl, and beach seine data (Bennett 2005). Diversions and upstream storage, including operation of the CVP and SWP, control Delta inflow and outflow during most months. Reduced Delta flow may inhibit or slow movement of larvae and juveniles to estuarine rearing habitat and into deeper and narrower channels of the Delta, resulting in lower prey availability and increased mortality from predators (Moyle 2002). Low Delta flow also may increase entrainment in diversions, including entrainment at the CVP and SWP export pumps (Moyle 2002). Additional factors affecting delta smelt abundance include extremely high river outflow that increases entrainment at export facilities, changes in prey abundance and composition, predation by nonnative species, toxic substances, disease, and loss of genetic integrity through interbreeding with the introduced Wagasaki smelt (Moyle 2002; CDFG 2000; Bennett 2005).

Critical Habitat/Essential Fish Habitat

Critical habitat for delta smelt consists of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the contiguous waters in the Delta (USFWS 1994). Critical habitat for delta smelt is designated in the following California counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo (USFWS 2003). Critical habitat in the ARCF GRR study area includes the Sacramento River up to the I Street Bridge and the Yolo Bypass just above Interstate 80 at the railroad tracks. Primary constituent elements of critical habitat determined to be essential to the conservation of the species include: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (USFWS 2006a).

3.3.6 Green Sturgeon Southern Distinct Population Segment

Status and Distribution

On January 23, 2003, NMFS determined that green sturgeon (*Acipenser medirostris*) are comprised of two populations, a northern and a southern DPS (NMFS 2003). The northern DPS includes populations extending from the Eel River northward, and the southern DPS includes populations south of the Eel River to the Sacramento River. The Sacramento River supports the southernmost spawning population of green sturgeon (Moyle 2002). On April 6, 2005, NMFS determined that the northern DPS does not warrant listing under the ESA, but it remains on the Species of Concern List (NMFS 2005c). On April 7, 2006, NMFS determined that the southern DPS of green sturgeon was threatened under the Federal ESA (NMFS 2006c). On October 9, 2009, NMFS (74 CFR 52300) designated critical habitat for the green sturgeon southern DPS throughout most of its occupied range.

Green sturgeon were classified as a Class 1 Species of Special Concern by CDFG in 1995 (Moyle et al. 1995). Class 1 Species of Special Concern are those that conform to the state definitions of threatened or endangered and could qualify for addition to the official list. On March 20, 2006, emergency green sturgeon regulations were put into effect by CDFG requiring a year-round zero bag limit of green sturgeon in all areas of the state (CDFG 2006).

Life History

The green sturgeon is anadromous, but it is the most marine-oriented of the sturgeon species and has been found in near shore marine waters from Mexico to the Bering Sea (NMFS 2005c). The southern DPS has a single spawning population in the Sacramento River (NMFS 2005d) and more recently spawning has been observed in the lower Feather River, a tributary of the Sacramento River (Seesholtz et al. 2012). Adults typically migrate upstream into rivers between late February and late July. Spawning occurs from March to July, with peak spawning from mid-April to mid-June. Green sturgeon are believed to spawn every 3 to 5 years, although recent evidence indicates that spawning may be as frequent as every 2 years (NMFS 2005c). Little is known about the specific spawning habitat preferences of green sturgeon. Adult green sturgeon are believed to broadcast their eggs in deep, fast water over large cobble substrate, where the eggs settle into the interstitial spaces (Moyle 2002). Spawning is generally associated with water temperatures from 46 to 57 degrees Fahrenheit (°F). In the Central Valley, spawning occurs in the Sacramento River upstream of Hamilton City, perhaps as far upstream as Keswick Dam (Adams et al. 2002) and the lower Feather River (Seesholtz et al. 2012).

Green sturgeon eggs hatch in approximately 8 days at 55°F (Moyle 2002). Larvae begin feeding 10 days after hatching. Metamorphosis to the juvenile stage is complete within 45 days of hatching. Juveniles spend 1 to 4 years in fresh and estuarine waters and migrate to salt water at lengths of 300 to 750 millimeters (mm) (NMFS 2005c).

Little is known about movements, habitat use, and feeding habits of green sturgeon. Green sturgeon have been salvaged at the state and Federal fish collection facilities in every month, indicating that they are present in the Delta year-round. Juveniles and adults are reported to feed on benthic invertebrates, including shrimp and amphipods, and small fish (NMFS 2005c).

Factors Affecting Abundance

The historical decline of the southern DPS of green sturgeon has been largely attributed to the reduction of spawning habitat area. Keswick and Shasta Dams on the Sacramento River and Oroville Dam on the Feather River are impassable barriers that prevent green sturgeon from accessing what were likely historical spawning grounds upstream of these dams. Other potential migration barriers or impediments include the Sacramento Deep Water Ship Channel locks, Fremont Weir, Sutter Bypass, the Delta Cross Channel, and Shanghai Bench and Sunset Pumps on the Feather River. Other factors that have been identified as potential threats to green sturgeon are reductions in freshwater outflow in the Delta during larval dispersal and rearing, high water temperatures during spawning and incubation, entrainment by water diversions, contaminants, predation and other impacts by introduced species, and poaching (NMFS 2005c).

Critical Habitat/Essential Fish Habitat

There is no EFH designated for green sturgeon. Designated critical habitat for the southern DPS of green sturgeon includes the Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, and the Yuba River downstream of Daguerre Dam; portions of Sutter and Yolo Bypasses; the legal Delta, excluding Five Mile Slough, Seven Mile Slough, Snodgrass Slough, Tom Paine Slough and Trapper Slough; and San Francisco, San Pablo, and Suisun bays. Freshwater habitat of green sturgeon of the southern DPS varies in function, depending on location within the Sacramento River watershed. Spawning areas currently are limited to accessible reaches of the Sacramento River upstream of Hamilton City and downstream of Keswick Dam (CDFG 2002) and portions of the Feather River (Seesholtz et al. 2012). Preferred spawning habitats are thought to contain large cobble in deep and cool pools with turbulent water (CDFG 2002; Moyle 2002; Adams et al. 2002). Sufficient flows are needed to sufficiently oxygenate and limit disease and fungal infection of recently laid eggs (Deng et al. 2002). Within the Sacramento River, spawning appears to be triggered by large increases in water flow during spawning (Brown and Michniuk 2007).

3.4 Amphibians

Two protected amphibian species were identified in the USFWS database records: the California red-legged frog (*Rana draytonii*) and the California tiger salamander (*Ambystoma californiense*) Amphibians are generally associated with smaller creeks, lentic habitats, and/or vernal pools. These aquatic habitats are generally not found along the ARCF reaches or in adjacent areas. Additionally, there are no known occurrences of these species in the action area. No suitable habitat for the salamander is present in the action area, and the action area is outside of the frog's extant range. Therefore, these listed amphibians are not considered further in this BA.

3.5 Reptiles

Two protected reptile species were identified in USFWS database records: the Alameda whipsnake (*Masticophis lateralis euryxanthus*) and giant garter snake (*Thamnophis gigas*). The range of the Alameda whipsnake is limited to Contra Costa and Alameda counties, which is not within the ARCF study area; therefore, Alameda whipsnake is dismissed and not discussed further in this BA.

3.5.1 Giant Garter Snake

Status and Distribution

The giant garter snake (*Thamnophis gigas*) is Federally listed as a threatened species under the ESA. Currently, this species is only known from 13 isolated population clusters within the Central Valley, from Chico to an area just southwest of Fresno (USFWS 1997). Giant garter snake populations that occur within the ARCF study area are within and adjacent to the Sacramento Bypass, which includes both small canals and rice fields. Additionally GGS is known to occur in the NEMDC north of the pump station at the Dry Creek north levee, however this is north of the ARCF GRR action area. SAFCA's Borrow Site 2 is located north of Dry Creek, so there is some potential for impacts to GGS in the NEMDC area.

Life History

The giant garter snake inhabits agricultural wetlands and associated waterways, including irrigation and drainage canals, rice fields, marshes, sloughs, ponds, low- gradient streams, and adjacent uplands. They have also been observed to use revetment as cover (Wylie et al. 2002). Giant garter snakes are believed to be most numerous in rice-growing regions (USFWS 1999b). Giant garter snakes are typically absent from the larger rivers; wetlands with sand, gravel, or rock substrates; and riparian areas lacking suitable basking sites or suitable prey populations (Hansen and Brode 1980; Brode 1988; USFWS 1999b). The giant garter snake hibernates from October to March in abandoned burrows of

small mammals located above prevailing flood elevations (Fisher et al. 1994), and breeds during March and April.

Factors Affecting Abundance

Giant garter snakes have been reduced in distribution and abundance due to habitat loss and degradation throughout the Central Valley. Several factors may degrade habitat for giant garter snakes, including upstream watershed modifications, water storage and diversion projects, and urban and agricultural development. Contamination from agricultural runoff may also have detrimental effects. On-going agricultural practices such as tilling, grading, harvesting and operation of other equipment may also result in mortality and increased rates of predation. Clearing and maintenance of irrigation canals and draining of rice fields may also result in mortality and degradation of habitat (USFWS 1999b).

3.6 Birds

3.6.1 Western Yellow-Billed Cuckoo

The western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is was Federally listed as threatened in October 2014. Nesting western yellow-billed cuckoos no longer occur on the Sacramento River south of Colusa as the river has been channelized and riprapped from that point into the Sacramento-San Joaquin River Delta. However, nesting western yellow-billed cuckoo do occur south of the Sacramento area, and north of the Sacramento area, so there is some potential for migrant individuals to use the riparian habitats along the American River Parkway as they move between nesting habitat areas. As a result, this species is discussed in greater detail below.

Prior to construction activities, surveys would be conducted within the study area to determine where potential nest sites occur. The surveys would be conducted annually in close proximity to construction locations and within one-half mile of any anticipated construction. If any special status bird species are found, coordination with the resource agencies would occur and appropriate avoidance and minimization measures would be established prior to the start of construction.

Status and Distribution

Over the last 100 years, western cuckoo population declined dramatically due to extensive loss of suitable breeding habitat, primarily riparian forests and associated bottomlands dominated by willow (Salix spp.), cottonwood (Populus spp.), or mesquite (Prosopis spp.) (Gaines and Laymon 1984, Laymon and Halterman 1987, Hughes 1999). Once considered a common breeder in California, by 1940 the yellow-billed cuckoo suffered severe population reduction (Grinnell and Miller 1944) and by 1987 was estimated to occupy only 30 percent of its historical range (Laymon and Halterman 1987). California statewide surveys conducted in 1977 (Gaines and Laymon 1984), 1986/1987 (Laymon and Halterman

1987), and 1999 (Halterman et. al 2001) found yellow-billed cuckoo populations were concentrated mostly along the Sacramento River from Red Bluff to Colusa, along the South Fork of the Kern River, and portions of the Lower Colorado River. Population estimates on the Sacramento and Kern Rivers from the 1999 surveys were similar to those of the 1986/1987 surveys, but lower when compared to the 1977 survey. The Lower Colorado River population appeared to suffer severe declines in the 12 years from the 1986/87 to the 1999 surveys.

In 2001, USFWS determined that western yellow-billed cuckoos represent a Distinct Population Segment (DPS), and as such became a candidate for protective listing under the Endangered Species Act (USFWS 2001). In 2002, the listing was determined to be warranted but precluded by higher priority listing actions (due to limited resources) (USFWS 2002). In 2013, USFWS formally proposed that the Western DPS be listed as Threatened under the Endangered Species Act. On October 3, 2014, the proposed rule became effective and finalized the USFWS determination for listing the western yellow-billed cuckoo, but not its critical habitat.

Life History

Yellow-billed cuckoos are among the latest-arriving Neotropical migrants. They arrive on their breeding grounds in Arizona and California by June (Hughes 1999). Diet during the breeding season consists primarily of large insects such as grasshoppers, katydids, caterpillars, praying mantids, and cicadas; also tree frogs and small lizards (Hamilton and Hamilton 1965, Laymon 1980, Laymon et al. 1997). Nesting usually occurs between late June and late July, but can begin as early as late May and continue until late September (Hughes 1999). Nests consist of a loose platform of twigs, which are built by both sexes and take one to two days to build (Hughes 1999), though occasionally the nest of another species is used (Jay 1911, Bent 1940, Payne 2005). Clutch size is 1 to 5 (Payne 2005), though up to 8 eggs have been found in one nest due to more than one female laying in the nest (Bent 1940). Eggs are generally laid daily until clutch completion (Jay 1911), and incubation begins once the first egg is laid, lasting 9 to 11 days (Hughes 1999). Young hatch asynchronously and are fed mostly large insects (Laymon and Halterman 1985, Laymon et al. 1997, Halterman et al. 2009) similar to the adult diet. Young fledge after 5 to 9 days (6 days average), but may be dependent on adults for at least three weeks (Laymon and Halterman 1985).

Fall migration is thought to begin in late August, with most birds gone by mid-September (Hughes 1999); however on the Lower Colorado River some individuals appear to begin migrating in early August (McNeil et al. 2011). Their non-breeding range is believed to be the western side of the Andes (Hughes 1999), though little information exists on migration routes and non-breeding range in South America where they can be confused with the endemic pearly-breasted cuckoo (C. euleri), their closest relative (Payne 2005).

Factors Affecting Abundance

Habitat losses associated with manmade flood control and water management features that alter watercourse hydrology have contributed to the decline of the species. The natural processes that sustained riparian habitat in western North America have greatly diminished. Loss and degradation of habitat has occurred as a result of livestock overgrazing and encroachment from agriculture. These losses are exacerbated by the conversion of native habitat to predominantly nonnative vegetation. Habitat losses result in additional effects such as increased predation and reduced dispersal potential. These effects are associated with small and widely separated habitat patches. These threats are particularly persistent where small habitat patches are within proximity to human-altered landscapes, especially agricultural fields, resulting in the potential for pesticides to poison individual western yellow-billed cuckoos and reduce their prey base.

4.0 Environmental Baseline

This section describes the physical conditions and general vegetation, wildlife, and fisheries resources present within the ARCF action area. These conditions are first presented generally throughout the ARCF action area and then site specific SRA is analyzed as well as affected species in the ARCF action area. The environmental baseline provides information necessary to determine if the proposed action would jeopardize the continued existence of species being considered, and if the project can support long-term survival of these species in the action area.

The ARCF action area includes the mainstem Sacramento River from Freeport (RM 46) in the Delta upstream to the American River confluence (RM 60). The region also includes the lower American River from the confluence with the Sacramento River upstream to RM 11, NEMDC, Arcade Creek, Dry/Robla Creeks and Magpie Creek.

Downstream from the American River confluence, the Sacramento River is moderately sinuous (average sinuosity of 1.3), with the channel confined on both sides by man-made levees enhanced by decades of man-made additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). Channel migration is similarly limited along the lower American River because of man-made levees and regulated flows from Folsom Dam.

The natural banks and adjacent floodplains of both rivers are composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the rivers, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass (RM 63). Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

NEMDC is an approximately 13.3-mile, human-made, partially leveed drainage channel that provides drainage from Sankey Road and connects streams of the American Basin (Dry, Robla, and Arcade Creeks) to the American River. South of the confluence with Arcade Creek, the east and west levees of NEMDC are dominated by wild oats grasslands, while the channel is characterized by Fremont cottonwood forest, with smaller amounts of valley oak woodland, smart-weed cocklebur patches, and perennial rye grass fields.

The approximately 16.2-mile-long channel of Arcade Creek extends east-to-west from Orangevale to the American River, via NEMDC. The north and south levees are dominated by wild oats grasslands. Valley oak woodland is the main riparian vegetation type along Arcade Creek, but Fremont cottonwood forest occurs in small patches along the easternmost reach of Arcade Creek near NEMDC. Hardstem bulrush marsh is found within Arcade Creek near Norwood Avenue while water primrose wetlands are predominant within the channel of Arcade Creek from approximately the confluence with NEMDC to Norwood Avenue. East of Norwood Avenue, the creek channel becomes narrower, and dominated by a shaded canopy of valley oak woodland.

The environmental baseline in the ARCF GRR action area also includes the sites completed under the WRDA 1996 and WRDA 1999 authorizations for the project. The WRDA 1996 construction included installing slurry walls in the American River levees to address seepage and slope stability concerns. The WRDA 1999 construction included shape and slope improvements to specific reaches of the American River levee system, and some segments of the Sacramento River levees. Consultation has occurred on these sites throughout the construction period on an as-needed basis to ensure compliance with the ESA. The original project construction was coordinated with USFWS as the American River Watershed (Common Features) Project, Sacramento County, California. The Biological Opinions for these sites are on file with USFWS under Reference # 1-1-99-F-0078.

4.1 Vegetation

The ARCF study area consists of primarily riparian forest, valley oak woodland, riparian scrub-shrub habitat, and typically non-native annual grassland. Scrub-shrub generally refers to areas where the woody riparian canopy is composed of young trees or shrubs less than 20 feet high. Species that are typically found in riparian forest, valley oak woodland, and scrub habitats include cottonwood, several willow species, sycamore valley oak, black walnut, Oregon ash, white alder, boxelder, blue elderberry, buttonbush, Himalaya blackberry, wild grape, and poison oak. Understory vegetation may consist of an herbaceous layer of sedges, rushes, grasses, and forbs.

Riparian forest typically has a dominant overstory of cottonwood, California sycamore, black walnut, black willow, or valley oak. Dominant species found in the sub canopy may also include alder, ash and box elder. Layers of climbing vegetation make up part of the subcanopy, with wild grape being a major component, but wild cucumber and clematis vines are also found in riparian communities.

Several species of invasive non-native trees, shrubs and vines may be present in some riparian locations, predominantly red sesbania, Himalayan blackberry, tamarix, false bamboo, tree-of-heaven, eucalyptus, and ivy.

The herbaceous ruderal groundcover, primarily nonnative annual grassland, is found on most levees along the Sacramento River. It occurs on the levees and also within gaps in the riparian habitats. Plant species include wild oats, soft chess, ripgut brome, red brome, wild barley, Bermuda grass, and foxtail fescue. Common forbs include broadleaf filaree, red stem filaree, turkey mullein, clovers, and many others. The majority of these plants are not native to the project area.

4.1.1 Historical Human Resource Use and Current Riparian Vegetation

Historical precipitation and runoff patterns resulted in the Sacramento River being bordered by up to 500,000 acres of riparian forest, with valley oak woodland covering the higher river terraces (Katibah 1984). However, human activities of the 1800s and 1900s have substantially altered the hydrologic and fluvial geomorphic processes that create and maintain riparian forests within the Sacramento basin, resulting in both marked and subtle effects on riparian communities. Riparian recruitment and establishment models (Mahoney and Rood 1998; Bradley and Smith 1986) and empirical field studies (Scott et al. 1997, 1999) emphasize that hydrologic and fluvial processes play a central role in controlling the elevational and lateral extent of riparian plant species. These processes are especially important for pioneer species that establish in elevations close to the active channel, such as cottonwood and willows (*Salix* spp.). Failure of cottonwood recruitment and establishment is attributed to flow alterations by upstream dams (Roberts et al. 2001) and to isolation of the historic floodplain from the river channel. In addition, many of these formerly wide riparian corridors are now narrow and interrupted by levees and weirs. Finally, draining of wetlands, conversion of floodplains to agricultural fields, and intentional and unplanned introduction of exotic plant species have altered the composition and associated habitat functions of many of the riparian communities that are able to survive under current conditions.

4.1.2 Site-Specific Analysis of Riparian Vegetation

Analysis of total linear feet (lf) of SRA was conducted using Google Earth Pro for the reaches only associated with bank protection on the American and Sacramento Rivers in the ARCF action area (Table 8). However, site specific conditions at proposed bank protection sites will evaluate SRA habitat values using the SAM method of analysis to determine impacts and onsite compensation value based on actual designs. The East Side Tributaries were not evaluated because no bank erosion protection is planned. It should be noted however that there is minimal, if any, SRA associated with the tributaries in the reaches where construction is proposed, except Arcade Creek. Approximately 8 acres of trees along the Sacramento River would be removed to construct the new 1,500 foot Sacramento Weir. Additionally, in the area proposed to be incorporated into the Sacramento Bypass, there is approximately 236 acres of newly planted nut orchard trees as of summer 2015. In order to construct the widened bypass, these trees would be removed.

Identification of individual reaches in the ARCF action area can be seen in Figure 2. American River North (ARN) reaches A through I includes the north side of the American River and the East Side Tributaries. American River South (ARS) reaches A through G includes the south side of the American River and the east side of the Sacramento River.

Table 8. Summary of Reach-Specific SRA Analysis.

American River		Sacramento River	
Reach	**Linear Feet (lf) of SRA**	**Reach**	**Linear Feet (lf) of SRA**
ARN A	19,000	D	9,200
ARS A	6,850	E	8,850
ARS B	875	F	21,100
ARS C	3,800	G	11,150
Total	30,525	Total	50,300

4.2 American River Hydraulic Baseline

The American River levee system was originally intended to convey a discharge of 115,000 cfs. When the Joint Federal Project (JFP) is completed at Folsom Dam, in combination with levee repairs currently being completed under the Common Features Project (and other authorities) and the dam 3.5 foot raise, the intent is for the river to be able to convey a discharge of 160,000 cfs, assuming that the levees do not fail from one or more of the potential failure modes (i.e., seepage, stability, insufficient height, or erosion).

In addition, modifications of Folsom Dam operations will shift the way floods are released into the lower river from Folsom Dam. Specifically, frequent flood events, that is, floods which occur say once in every ten to twenty-five years, will have a larger peak discharge compared to those under current dam operations.

4.2.1 Folsom Dam Operations

In 2017, the Folsom Joint Federal Project (JFP) auxiliary spillway at Folsom Dam will be completed and a new water control manual will be adopted. This includes a 400,000 acre-feet to 600,000 acre-feet (400/600) variable flood space operation that takes incidental storage space in upstream reservoirs into consideration when determining flood storage requirements at Folsom Dam during the flood season. The JFP will allow dam operators to release larger quantities of water at lower reservoir stages and more efficiently utilize flood space in the reservoir.

While the JFP and new water control manual are not in place, these projects will be in operation prior to any construction occurring on the ARCF project. As a result, including the operation of the JFP as a part of the baseline condition of this project is a reasonable assumption for the ARCF GRR. Therefore, the ARCF GRR assesses the impacts associated with the increase in water within the Yolo Bypass that results from the widening of the Sacramento Weir and Bypass. Additional changes in flows from the operation of the JFP will be addressed in the forthcoming Folsom Dam Water Control Manual Update consultation. However, these flows are represented throughout this BA as a part of the Future Without Project Condition.

Table 9 lists a sample of the current and future peak discharges for a range of flood events. It is anticipated that the values will be updated as part of the Folsom Water Control Manual Update evaluation.

Table 9. Comparison of Peak Discharges in the American River between Current and Future Events.

	Current Conditions	Future Conditions
50% (1/2) ACE (2-year)	30,200	25,200
10% (1/10) ACE (10-year)	43,100	71,700
4% (1/25) ACE (25-year)	99,700	115,000
2% (1/50) ACE (50-year)	115,000	115,000
1% (1/100) ACE (100-year)	145,000	115,000
0.5% (1/200) ACE (200-year)	320,000	160,000

4.2.2 American River Erosion Susceptibility

The Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events, evaluated the potential for erosion of grass-covered levees and overbanks in response to different stream discharges resulting from releases of various magnitudes from Folsom Dam (Ayers, 2004). This study concluded that the river system is degrading under present operating conditions because the lower American River is starved of sediments by Folsom Dam and Nimbus Dam. Hardpan has been reached in the channel bottom as far downstream as Guy West Bridge (RM 7.0), and this hardpan is slowing further degradation. With the river starved for sediment and unable to further scour its channel the river is now eroding laterally to satisfy its need for sediment. Erosion of the riverbank is occurring even at low flow conditions of 7,000 cfs, which was the peak flow from the 2003 runoff season. Ongoing erosion has scarred the channel banks leaving them susceptible to further erosion, especially during high flow events. Lateral erosion is further reducing the amount of berm separating the main channel from the levee. The loss of vegetation on the berm and bank is leaving bare soil, which is more susceptible to erosion at a lower velocity than if the berm or bank was covered with vegetation.

Figure 19 shows the velocities for a discharge of 115,000 cfs, which average about 6 to 8 feet per second in the channel with maximum velocities ranging up to about 12 feet per second. Figure 20 shows the velocities for a discharge of 160,000 cfs which average about 6 to 9 feet per second in the channel with maximum velocities ranging up to about 13 feet per second. Of concern in both of these figures are the proximities of the relatively high velocities to the levees along the Lower American River. Additionally, the range of the computed velocities is of concern since the magnitude of the velocities is great enough to erode many of the relatively fine grained material present in the channel lining. The results of the analysis indicate that the large discharge events are capable of eroding the material typically found along the Lower American River channel.

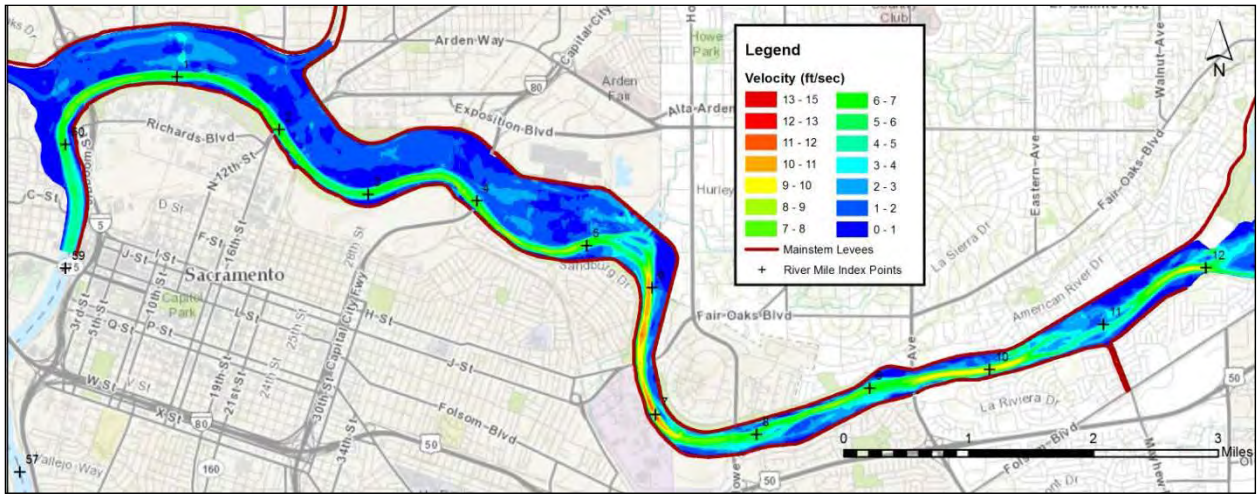

Figure 19. Velocities in the Lower American River at 115,000 cfs.

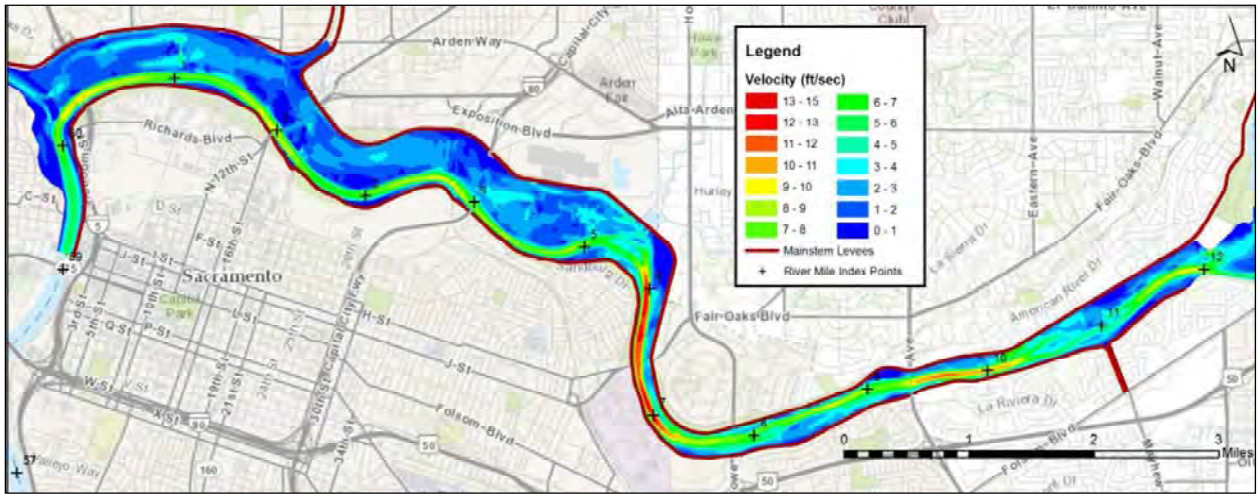

Figure 20. Velocities in the Lower American River at 160,000 cfs.

Figure 21 shows velocity contours in the area where erosion is greatest, between RM 6 and RM 7.5. As can be seen in Figure 21, velocities reach 11 feet per second for flows of 115,000 cfs, and get as high as 14 feet per second for 160,000 cfs. The study concluded that a flow of 145,000 cfs could cause damage at most of the study's identified priority sites, and could cause a levee failure to occur for at least one of the sites (Ayers, 2004). This reach of river represents the worst conditions regarding velocity (11 to 14 feet per second). Downstream and upstream of this reach, velocities in general for the same peak releases average in the 6 to 9 feet per second range.

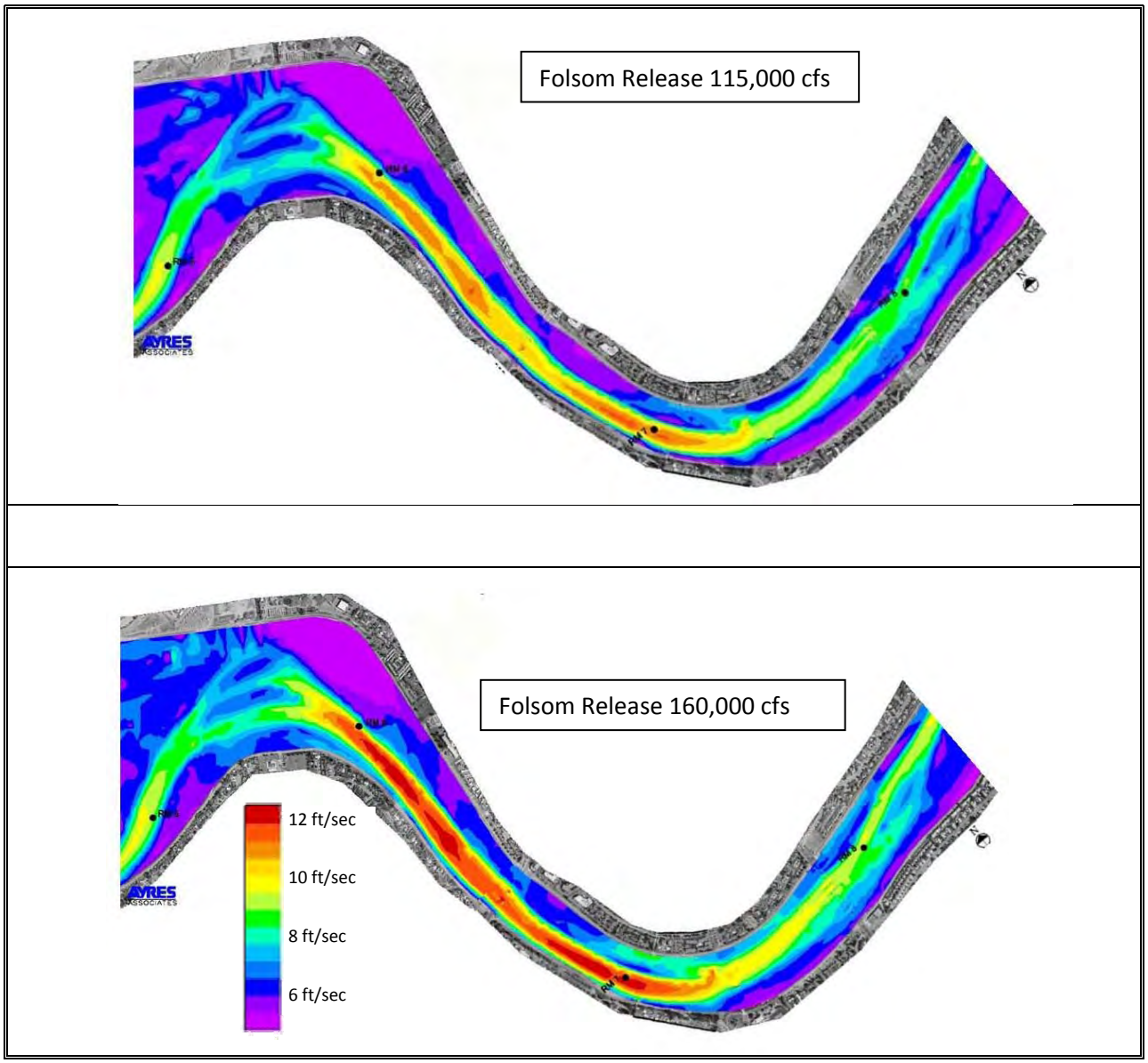

Figure 21. American River Velocity Contours.

Bare soil can withstand approximately 1.5 to 2.5 feet per second. Soil with good turf cover can withstand between 3.5 to 8 feet per second. The conditions of grass cover along the American River are not good and erosion occurs at velocities much less than the 11 to 14 feet per second in the RM 6 to RM 7.5 reach. This is illustrated by the fact that emergency erosion repairs have needed to occur as far downstream as near Highway 160 (RM 1.8) and as far upstream as between Watt Avenue and the Mayhew Drain (RM 10.2).

4.3 Affected Species in the Action Area

4.3.1 Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle is listed as a threatened species under the ESA (USFWS 1980). The valley elderberry longhorn beetle's range extends from southern Shasta County to Fresno County (Talley et al. 2006). Along the eastern edge of the species' range, adult beetles have been found in the foothills of the Sierra Nevada at elevations up to 2,220 feet, and beetle exit holes have been located on elderberry plants at elevations up to 2,940 feet. Along the western edge of the species' range, adult beetles have been found on the eastern slopes of the Coast Ranges at elevations of up to 500 feet, and beetle exit holes have been detected on elderberry plants at elevations up to 730 feet (Barr 1991).

Valley elderberry longhorn beetle is only found in close association with its host plant, elderberry (Sambucus spp.). Elderberry plants are found in or near riparian and oak woodland habitats. The valley elderberry longhorn beetle's life history is assumed to follow a sequence of events similar to those of related taxa. Female beetles deposit eggs in crevices in the bark of living elderberry plants. Presumably, the eggs hatch shortly after they are laid, and the larvae bore into the pith of the trunk or stem. When larvae are ready to pupate, they move through the pith of the plant, open an emergence hole through the bark, and return to the pith for pupation. Adults exit through the emergence holes and can sometimes be found on elderberry foliage, flowers, or stems or on adjacent vegetation. The entire life cycle of the valley elderberry longhorn beetle is thought to encompass 2 years, from the time eggs are laid and hatch until adults emerge and die (USFWS 1984).

The presence of exit holes in elderberry stems indicates previous valley elderberry longhorn beetle habitat use. Exit holes are cylindrical and approximately 0.25 inch in diameter. Exit holes can be found on stems that are 1 or more inches in diameter. The holes may be located on the stems from a few inches to about 9 to 10 feet above the ground (Barr 1991).

The valley elderberry longhorn beetle distribution decline is most likely related to the extensive loss of riparian forests in the Central Valley, which has reduced the amount of available habitat for the species, and has most likely decreased and fragmented the species' range (USFWS 1984). Insecticide drift from cultivated fields and orchards adjacent to elderberry plants may affect valley elderberry

longhorn beetle populations, if drift occurs at a time when adults are present on the shrubs (Barr 1991). Herbicide drift from agricultural fields and orchards can likewise affect the health of elderberry plants, thereby reducing their quantity and quality as valley elderberry longhorn beetle habitat.

The invasive Argentine ant (*Linepithema humile*) has been spreading in riparian habitats and may affect survival of the valley elderberry longhorn beetle. Argentine ants may predate valley elderberry longhorn beetle eggs although this interaction needs further exploration (Huxel, 2000). The spread of invasive exotic plants (e.g., giant reed [*Arundo donax*] may also negatively affect the valley elderberry longhorn beetle by affecting supporting riparian habitats. The presence of giant reed promotes a more frequent fire cycle and homogenous plant community (Talley et al. 2006).

Critical habitat for the valley elderberry longhorn beetle occurs in two locations near the City of Sacramento (USFWS 1980). One area is enclosed by the Western Pacific railroad tracks and Highway 160, approximately one-half mile north of the American River near its confluence with the Sacramento River. The second site is located along the south bank of the American River at Goethe Park, just upstream of RM 13.

VELB are known to occur throughout the ARCF GRR study area. The Corps conducted surveys in 2011 of the levee systems within the action area. The survey area consisted of the levee structures and 15 feet on both the waterside and landside; where access was available. The survey located elderberry clusters, however, actual shrubs, stem size, nor exit hole presence were determined. The surveys found the greatest amount of clusters on the south side of the American River and determined that both basins contain shrubs. All shrubs are considered to be in a riparian zone. Within the East Side Tributaries surveys were conducted identical to the American and Sacramento River. The only area where shrubs were located was along Arcade Creek, which contained two clusters of shrubs.

The American River Parkway has been the focus of a number of mitigation efforts from the confluence of the American and Sacramento Rivers (mitigation site 0.9, located at river mile [RM] 0.9 on the right side of the American River) up to Lake Natoma (Sailor Bar mitigation site located at RM 21 on the right side of the American River), elderberry mitigation sites create connectivity for potential translocation of valley elderberry longhorn beetles.

Additional VELB habitat within the Parkway has been created as part of previous Corps construction efforts, including:

- Site 0.9 on the right bank of American River at RM 0.9.
- Cal Expo: three distinct mitigation sites located between RM 3 and RM 4 on the right side of the American River.
- Site 11.5: elderberry mitigation site located near RM 11.5 on the right side of the American River.

- Mayhew: elderberry mitigation site located near RM 11 on the left side of the American River.
- River Bend Park: multiple mitigation sites located near RM 14 on the on the left side of the American River.
- Sailor Bar: mitigation site located near RM 21 on the right side of the American River.

These sites are currently being monitored and maintained by the Corps with annual reports provided to USFWS. Both the critical habitat are located in areas Operated and Maintained by the American River Flood Control District. The mitigation sites are maintained by SAFCA. Habitat maps of the American River Parkway showing locations of elderberry shrubs are included as Appendix F of the BA. Existing mitigation sites in the Parkway are identified in the maps in Appendix G of the BA.

Additional sites established by other agencies also exist along both sides of the American River, increasing connectivity to existing areas of critical habitat for the VELB. Additionally, future plans of restoration and mitigation could increase connectivity in large areas such as Woodlake, Bushy Lake, and Rossmoor. Smaller sites along the American River, including restoration efforts within the ARCF GRR construction footprint, would increase connectivity between these larger sites and the existing habitat within the American River Parkway. These additional sites would be assessed during the design phase of the ARCF GRR project for viability of future compensation efforts associated with this action.

4.3.2 Chinook Salmon and Steelhead

Four distinct runs of Chinook salmon occur in the ARCF action area: winter-run, spring-run, fall-run, and late fall–run. The runs are named after the season of adult migration, with each run having a distinct combination of adult migration, spawning, juvenile residency, and smolt migration periods. In general, fall- and late fall-run Chinook salmon spawn soon after entering their natal streams, while spring- and winter-run Chinook salmon typically hold in their natal streams for up to several months before spawning. Central Valley Steelhead also occurs in the ARCF action area. Immigration of adult steelhead in the Sacramento and American River's peaks in late September and October (Moyle 2002). The steelhead spawning season typically stretches from December through April. After several months, fry emerge from the gravel and begin to feed. Juveniles rear in fresh water from 1 to 4 years (usually 2 years), then migrate to the ocean as smolts in the spring (March through June).

During higher winter flow events in the East Side Tributaries there is suitable habitat in NEMDC, Arcade Creek and Dry/Robla Creek for the presence of fall/late-fall salmon. Central Valley steelhead are expected to occur in NEMDC as adults, migrating upstream to their spawning habitat, and as juveniles and smolts, rearing and migrating toward the ocean. Central Valley steelhead would not typically occur in Arcade Creek or Robla Creek, as these streams regularly lacks water quality conditions for spawning. NEMDC includes critical habitat for Central Valley steelhead, which uses this locations for juvenile

rearing, juvenile migration, and adult migration (NMFS 2014). There is no critical fish habitat designation for Arcade and Robla Creeks.

During the intermittent years when the Sacramento Bypass is flooded in the winter and spring all four runs of juvenile Chinook salmon and steelhead can potentially use the floodplain for rearing and migration.

4.3.3 Green Sturgeon

Green sturgeon are known to occur in the lower reaches of large rivers, including the Sacramento River (Moyle 2002) and more recently spawning has been observed in the lower Feather River, a tributary of the Sacramento River (Seesholtz et al. 2012). Adults of this species tend to be associated with marine environments more than the more common white sturgeon, although spawning populations have been identified in the Sacramento and Klamath Rivers (Corps 1993). Juvenile rearing (natal stream to estuary) can occur year round in the Sacramento River action area.

Critical habitat for the green sturgeon extends into the American River upstream to the Highway 160 bridge where there is a potential to encounter adults and/or rearing juvenile green sturgeon. The Sacramento Bypass, when flooded, can support juvenile green sturgeon during downstream migration and rearing.

4.3.4 Delta Smelt

Adult delta smelt begin spawning migration into the upper Delta in December or January. Migration may continue over several months. Spawning occurs between January and July, with peak spawning during April through mid-May (Moyle 2002). Spawning occurs along the channel edges in the upper Delta, including the Sacramento River above Rio Vista, Cache Slough, Lindsey Slough, and Barker Slough. Spawning has been observed in the Sacramento River up to Garcia Bend below the confluence of the American River on the Sacramento River action area during drought conditions, possibly attributable to adult movement farther inland in response to saltwater intrusion (Wang and Brown 1993). The typical pattern is for delta smelt to inhabit the oligohaline to freshwater portion of the estuary for much of the year until late winter and early spring, when many migrate upstream to spawn (Sommer et al. 2011). There is evidence that some may not migrate to spawn. After hatching, their larvae and post-larvae subsequently migrate downstream in spring towards the brackish portion of the estuary (Dege and Brown 2004; Sommer and Mejia 2013).

Key progress in our understanding of delta smelt is that they are strongly associated with turbid water (Feyrer et al. 2007). Their results showed that, during fall, delta smelt are only present at locations where Secchi depth is less than 1 meter. This finding is consistent with Grimaldo et al. (2009), who found that delta smelt were not present in upstream areas when turbidities were less than about 12 NTU

(Sommer and Mejia 2013). It is likely that the lack of turbidity in the American River would be unsuitable for delta smelt.

The general pattern is that delta smelt cannot tolerate temperatures higher than 25 °C (Swanson et al. 2000). Hence, the 25 °C is used as a general guideline to assess the upper limits for delta smelt habitat (Wagner et al. 2011; Cloern et al. 2011). Downstream of the Delta, the smallest channel where adults and juveniles have been reported is Spring Branch Slough in Suisun Marsh, which averages about 15-m wide (Meng et al. 1994; Matern et al. 2002; Sommer and Mejia 2013). Due to higher temperatures and lack of suitable channel width the East Side Tributaries would not be suitable habitat for the delta smelt.

The northern-most reach of delta smelt critical habitat in the study area includes the Sacramento River up to the I Street Bridge on the east side and on the west side the critical habitat extends up the Yolo Bypass to the Union Pacific Railroad tracks just below the Sacramento Bypass along the I-80 corridor.

4.3.5 Giant Garter Snake

The giant garter snake inhabits agricultural wetlands and other waterways such as irrigation and drainage canals, sloughs, ponds, small lakes, low gradient streams, and adjacent uplands in the Central Valley. Because of the direct loss of natural habitat, the giant garter snake relies heavily on rice fields in the Sacramento Valley, but also uses managed marsh areas in Federal National Wildlife Refuges and State Wildlife Areas. Habitat loss and fragmentation, flood control activities, changes in agricultural and land management practices, predation from introduced species, parasites, water pollution, and continuing threats are the main causes for the decline of this species.

Rice fields and their adjacent irrigation and drainage canals serve an important role as aquatic habitat for giant garter snake as is the case adjacent to the Sacramento Bypass. The land proposed to be incorporated into the Sacramento Bypass is currently agricultural fields producing row crops and nut orchards. The associated drainage ditches and farm canals in this area are considered aquatic GGS habitat.

Habitat elements for GGS do occur along the east side of the NEMDC and other waterways of the east side tributaries, however, due to current habitat conditions, such as close proximity to urban development, high levels of human disturbance, scarcity of upland habitat, and riparian vegetation along the banks of most channel reaches, giant garter snakes are unlikely to occur in the Arcade, Dry/Robla, and Magpie Creek and the southern portion of NEMDC below Dry/Robla Creek. Large waterways, such as the Sacramento and American Rivers, do not provide suitable habitat for giant garter snake.

4.3.6 Vernal Pool Fairy Shrimp

The vernal pool fairy shrimp lives in vernal pools and swales containing clear to turbid water and grassy bottoms in unplowed grasslands. The shrimp is ecologically dependent on seasonal fluctuations in its habitat, such as presence or absence of water during specific times of the year, duration of water, temperature, and quantities of dissolved oxygen (USFWS 1992b).

There are 32 known populations of the vernal pool fairy shrimp, extending from the Stillwater Plain in Shasta County through the Central Valley to Pixley in Tulare County. In addition, the shrimp occur along the central Coast Range from northern Solano County to Pinnacles National Monument in San Benito County. Critical habitat is designated for a number of sub-populations of fairy shrimp throughout California. The closest critical habitat to the action area is a sub-population of vernal pool fairy shrimp in vernal pools near Mather Field in south-eastern Sacramento County. In the action area, vernal pools are known to occur near Magpie Creek, and there are recorded occurrences of vernal pool fairy shrimp in the CNDDB from 1995 (CNDDB 2015).

Vernal pool habitat is known to occur near Magpie Creek. Alongside the Magpie Creek Diversion Canal, there are some lands which could support vernal pools or vernal pool fairy shrimp that would be impacted by project construction. At this time, a wetland delineation has not been conducted to verify the occurrence of vernal pools; however, a wetland delineation would occur prior to project construction. Since the ARCF GRR is adopting the design of the 2004 Magpie Creek Flood Control Project, the impacts to vernal pools at this time were assessed based on that project's consultation. The proposed project would result in 0.25-acre of indirect effects to vernal pools/swales of potentially suitable vernal pool fairy shrimp habitat.

Seasonal wetlands, which may provide suitable habitat for vernal pool invertebrates, occur in the vicinity of the NSS project's Robla woodland mitigation site A, however any vernal pools in this area would be avoided by these activities. With the implementation of at 250-foot buffer between vernal pools and construction activities there would be no direct or indirect impacts from activities at Robla woodland mitigation site A. As a result, any mitigation efforts at the Robla woodland mitigation site would are not likely to adversely affect vernal pool fairy shrimp.

4.3.7 Vernal Pool Tadpole Shrimp

The vernal pool tadpole shrimp lives in vernal pools and swales containing clear to highly turbid water. The shrimp is ecologically dependent on seasonal fluctuations in its habitat, such as presence or absence of water during specific times of the year, duration of water, temperature, and quantities of dissolved oxygen (USFWS 1992b).

There are 18 known populations of vernal pool tadpole shrimp in the Central Valley, ranging from east of Redding in Shasta County south to the San Luis National Wildlife Refuge in Merced County. In the action area, vernal pools are known to occur near Magpie Creek, and there are recorded occurrences of vernal pool tadpole shrimp in the CNDDB from 1998 (CNDDB 2015).

Vernal pool habitat is known to occur near Magpie Creek. Alongside the Magpie Creek Diversion Canal, there are some lands which could support vernal pools or vernal pool tadpole shrimp that would be impacted by project construction. At this time, a wetland delineation has not been conducted to verify the occurrence of vernal pools; however, a wetland delineation would occur prior to project construction. Since the ARCF GRR is adopting the design of the 2004 Magpie Creek Flood Control Project, the impacts to vernal pools at this time were assessed based on that project's consultation. The proposed project would result in 0.25-acre of indirect effects to vernal pools/swales of potentially suitable vernal pool tadpole shrimp habitat.

Seasonal wetlands, which may provide suitable habitat for vernal pool invertebrates, occur in the vicinity of the NSS project's Robla woodland mitigation site A, however any vernal pools in this area would be avoided by these activities. With the implementation of at 250-foot buffer between vernal pools and construction activities there would be no direct or indirect impacts from activities at Robla woodland mitigation site A. As a result, any mitigation efforts at the Robla woodland mitigation site would are not likely to adversely affect vernal pool tadpole shrimp.

4.3.8 Western Yellow-Billed Cuckoo

Western yellow-billed cuckoo is Federally listed as threatened. The cuckoo is typically found in riparian forests with dense deciduous trees and shrubs. Over the last 100 years, western cuckoo population declined dramatically due to extensive loss of suitable breeding habitat, primarily riparian forests and associated bottomlands dominated by willow (Salix spp.), cottonwood (Populus spp.), or mesquite (Prosopis spp.) (Gaines and Laymon 1984, Laymon and Halterman 1987, Hughes 1999, Halterman et al. 2001). Once considered a common breeder in California, by 1940 the Yellow-billed Cuckoo suffered severe population reduction and by 1987 was estimated to occupy only 30 percent of its historical range (Laymon and Halterman 1987).

Nesting usually occurs between late June and late July, but can begin as early as late May and continue until late September (Hughes 1999). Nests consist of a loose platform of twigs, which are built by both sexes and take one to two days to build (Hughes 1999), though occasionally the nest of another species is used (Jay 1911, Bent 1940, Payne 2005). There are no recent CNDDB occurrences in the vicinity of the action area, but migrant individuals are likely to pass through the area in transit to breeding sites along the Sacramento River north of Colusa. Cuckoos are unlikely to nest in the study area, although potential dispersal and foraging habitat is present in the American River Parkway and along the Sacramento River.

5.0 Effects of the Proposed Action

5.1 Invertebrates

5.1.1 Valley Elderberry Longhorn Beetle

Effects to valley elderberry longhorn beetle may occur if elderberry shrubs are incidentally damaged by construction personnel or equipment. Impacts may also occur if elderberry shrubs need to be transplanted because they are located in areas that cannot be avoided by construction activities. During the design phase of the project, a site-specific assessment would occur in coordination with County Parks, project stakeholders, and the Services to determine which erosion protection measure is appropriate for each location in the Parkway. This assessment would take into account hydraulic conditions as well as environmental conditions of the site and would avoid and minimize impacts to riparian habitat and elderberry shrubs to the maximum extent practicable within the framework of the proposed project. Impacts that cannot be avoided or minimized would be mitigated, as described in Section 2.5 above.

Potential impacts due to damage or transplantation include direct mortality of beetles and/or disruption of their lifecycle. Since the project would occur over a 10 year period and construction would occur during beetle flight season, there could be direct mortality caused by construction activities. Elderberry shrubs that cannot be avoided would be transplanted between November and mid-February when the plants are doormat. Transplanting procedures will comply with the Conservation Guidelines for the Valley Elderberry Longhorn Beetle, USFWS, 9 July 1999.

Along the American River portion of the project, there is approximately 65 acres of riparian habitat that would be impacted, which includes elderberry shrubs. In this 65 acres, approximately 250 shrubs would be transplanted within the American River Parkway outside of the 15 foot vegetation free zone. The habitat maps in Appendix F show the locations of elderberry shrubs within the Parkway in 2013. Impacts to shrubs would be limited to approximately 40-feet waterward of the levee in most places. While impacts to these 250 shrubs would likely result in adverse effects to VELB, the majority of the shrubs in the Parkway, including the mitigation and restoration sites delineated on the maps in Appendix G, would not be impacted by the project. The majority of the impacts to VELB would occur on the stretch of the American River between Howe and Watt Avenues. Without implementation of compensation within this reach, connectivity of VELB habitat could be adversely impacted by the proposed measures.

Seedlings and native plants could be planted on top of the constructed trench to create similar connectivity as the existing conditions, or on the protected berms above bank protection sites. However, temporal loss of habitat may occur due to transplantation of elderberry shrubs. With transplants, new shrubs, and associated natives installed on the surface of the launchable rock trenches

between Howe and Watt Avenues, and other compensation proposed in Section 2.5, connectivity for the beetle would be similar to the existing condition. Although compensation measures include restoration and creation of habitat, mitigation plantings would likely require one or more years to become large enough to provide supporting habitat. Furthermore, associated riparian habitats may take 25 years or longer to reach their full value.

Along the Sacramento River reach of the project, there is approximately 110 acres of riparian habitat that would be impacted, which includes elderberry shrubs. In this 110 acres, approximately 13 elderberry shrubs would be transplanted between November and mid-February. These shrubs would be transplanted to the River Bend Park mitigation site within the American River Parkway, or a new site coordinated with County Parks during the design phase of the project. Additionally, there is some potential for shrubs to be transplanted on site, where space is available, or to potential future mitigation sites in the Sacramento River corridor. Connectivity for the beetle could be affected by the reduction in shrubs if on-site compensation is not possible; however, impacts along this reach of the project are limited to the top half of the levee, which would be degraded in order to construct the slurry wall. The majority of the shrubs in this reach would likely not be located on the levee prism and would remain in place and provide sufficient connectivity.

For the NSS project, elderberry shrubs were not observed along Arcade Creek, NEMDC, or Borrow Site 2 during field surveys. Encroachment removal along Robla Creek would be limited to trimming back residential landscaping from a fence line and would have no potential for adverse impact to any elderberry shrubs, if present nearby. Elderberry shrubs could be present adjacent to potential woodland mitigation sites, including along Robla Creek. However, tree mitigation efforts would occur on open grassland areas and avoid disturbance of elderberry shrubs that may be nearby. Buffers would be established around elderberry shrubs in these areas as described in Section 2.5 above and would be maintained during all encroachment removal and mitigation installation activities. Further, implementation of the avoidance and minimization measures listed in Section 2.5 above would avoid the potential for direct and indirect effects on elderberry shrubs through the establishment of appropriate buffers.

Elderberry surveys done in 2011 by the Corps looked at the project area including the levee itself and 15 feet landside and 15 feet waterside. Only the locations of the shrubs were surveyed in order to get an idea of the magnitude of potential impacts. In order to determine affects to the beetle, detail elderberry shrub surveys from previous projects within the American River Parkway are being used as a representative sample for this project. The previous surveys were completed for other ARCF Projects along the American River Parkway within the project vicinity. These representative samples take into effect all project-related impacts to elderberry shrubs that would require mitigation, including incidental trimming of full stems for the purposes of providing access for project activities. The representative sample calculations are as follows; each shrub contains 13 stems measuring between 1 and 3 inches with no exit holes; 5 stems between 3 and 5 inches with .02 exit holes; and 2 stems greater than 5 inches with .07 exit holes. All shrubs are assumed to be in riparian habitat. Tables 10 and 11

include calculations of stems that would be affected with the implementation of this project and proposed compensation.

Table 10. American River Elderberry Shrub Effects and Proposed Compensation.

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios[1,2]	Elderberry Plantings	Associated Native Planting	Associated Native Ratios
non-riparian	greater than or = 1" & less than or = 3"	No	0	1	0	0	1
		yes	0	2	0	0	2
non-riparian	greater than 3" & less than 5"	No	0	2	0	0	1
		yes	0	4	0	0	2
non-riparian	greater than or = 5"	No	0	3	0	0	1
		yes	0	6	0	0	2
riparian	greater than or = 1" & less than or = 3"	No	1,998	2	3,996	3,996	1
		yes	0	4	0	0	2
riparian	greater than 3" & less than 5"	No	790	3	2,370	2,370	1
		yes	16	6	96	192	2
riparian	greater than or = 5"	No	312	4	1,248	1,248	1
		yes	23	8	184	368	2
TOTAL			**3,139**		**7,894**	**8,174**	
				Calculations:	natives-elderberries	280	
				basins or credits	1,578.8	28	
				total basins or credits=	1,606.8		
					2,892,240		
				total acres need for compensation	66.39669421		

1 Affected elderberry plant minimization ratios based on location, stem diameter, and presence of exit holes

2 Multiply No. of stems by this for planting counts

Table 11. Sacramento River Elderberry Shrub Effects and Proposed Compensation.

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios[1,2]	Elderberry Plantings	Associated Native Plantings	Associated Native ratios
non-riparian	greater than or = 1" & less than or = 3"	No	0	1	0	0	1
		yes	0	2	0	0	2
non-riparian	greater than 3" & less than 5"	No	0	2	0	0	1
		yes	0	4	0	0	2
non-riparian	greater than or = 5"	No	0	3	0	0	1
		yes	0	6	0	0	2
riparian	greater than or = 1" & less than or = 3"	No	104	2	208	208	1
		yes	0	4	0	0	2
riparian	greater than 3" & less than 5"	No	40	3	120	120	1
		yes	1	6	6	12	2
riparian	greater than or = 5"	No	16	4	64	64	1
		yes	2	8	16	32	2
TOTAL			**163**		**414**	**436**	
				Calculations:	natives-elderberries	22	
				basins or credits	82.8	2.2	
				total basins or credits=	85		
					153000		
				total acres need for compensation	3.512396694		

1 Affected elderberry plant minimization ratios based on location, stem diameter, and presence of exit holes

2 Multiply No. of stems by this for planting counts

Operation and Maintenance

As part of long-term O&M, elderberry shrubs will be trimmed by the three levee maintenance districts. Table 12 describes the maximum amount of elderberry acreage that will be trimmed each year as a result of O&M. Trimming consists of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. Up to a third of a shrub will be trimmed in a single season. Trimming will occur between November 1 and March 15. Loss of habitat will be offset through the development of a conservation area as described in the conservation measures below. Each year the local maintaining authority will document the amount of valley elderberry longhorn beetle habitat that they have trimmed and report that number to the Corps to ensure compliance with this biological opinion. If the local maintaining agency has a need to exceed the amount of valley elderberry longhorn beetle habitat which needs to be trimmed or affected due to routine maintenance then they will request the Corps reinitiate consultation on this biological opinion for those actions.

Table 12. O&M Elderberry Shrub Effects and Compensation.

O&M Agency	Annual Acreage Trimmed[1]	Life of Project Acreage[2]
American River Flood Control District	0.5 acre	25 acres
Maintenance Area 9	0.2 acre	10 acres
City of Sacramento	0.1 acre	5 acres

[1] Acreage was estimated based on a measurement of 0.009-acre per every 1/3rd of a shrub trimmed.
[2] Life of project is estimated to be 50 years.

5.1.2 Vernal Pool Fairy Shrimp

Effects to vernal pool fairy shrimp associated with the ARCF GRR's proposed Magpie Creek measures were addressed in the 2004 Biological Opinion for the Magpie Creek Flood Control Project (Appendix E).

For the NSS project, seasonal wetland habitat is present in annual grassland north of Robla Creek, including in the eastern portion of Robla woodland mitigation site A. Although riparian planting activities would not directly affect the seasonal wetland habitat, these activities could indirectly affect potentially suitable habitat for vernal pool invertebrates in this area by altering hydrology and/or degrading water quality. These effects could result in temporary loss of individuals, but the population could persist if the habitat is restored to its prior condition. However, implementation of the avoidance and minimization measures listed in Section 2.5 above would avoid and minimize the potential for indirect effects on suitable habitat for vernal pool invertebrates through the establishment of appropriate buffers.

5.1.3 Vernal Pool Tadpole Shrimp

Effects to vernal pool tadpole shrimp associated with the ARCF GRR's proposed Magpie Creek measures were addressed in the 2004 Biological Opinion for the Magpie Creek Flood Control Project (Appendix E).

For the NSS project, seasonal wetland habitat is present in annual grassland north of Robla Creek, including in the eastern portion of Robla woodland mitigation site A. Although riparian planting activities would not directly affect the seasonal wetland habitat, these activities could indirectly affect potentially suitable habitat for vernal pool invertebrates in this area by altering hydrology and/or degrading water quality. These effects could result in temporary loss of individuals, but the population could persist if the habitat is restored to its prior condition. However, implementation of the avoidance and minimization measures listed in Section 2.5 above would avoid and minimize the potential for indirect effects on suitable habitat for vernal pool invertebrates through the establishment of appropriate buffers.

5.2 Fish Species

The assessment of effects on fish considers the potential occurrence of protected species and life stages relative to the location, magnitude, timing, frequency, and duration of project actions. Species habitat attributes potentially affected by project implementation include spawning habitat area and quality, rearing habitat area and quality, migration habitat conditions, and water quality.

Short-term construction related effects on fish species include effects on individuals (e.g., displacement, disruption of essential behaviors, mortality) and immediate, short-term effects on habitat. These short-term effects are evaluated qualitatively and generally mitigated through the use of construction BMPs and limitations on construction windows.

Long-term effects typically last months or years, and generally involve physical alteration of the bank and riparian vegetation adjacent to the water's edge, with consequent impacts upon SRA cover, nearshore cover, and shallow water habitat (Fris and DeHaven 1993).

The operation and maintenance of the bank protection sites would include allowing the vegetation to grow to maturity and provide SRA habitat. There would be no sediment removal or clearing of vegetation along the planted bench after construction. The following statements will be added to the O&M manual once construction is completed to ensure sustainability of the created habitat. Therefore, affects from O&M activities would not be affect listed fish species and are not discussed in detail below.

Trees, either preserved or planted, on the berm within the project footprint of the bank protection site shall not be removed as part of normal maintenance as long as they remain healthy. As unhealthy trees are removed or fall over, any subsequent cavities in the rock must be filled in a timely manner with rock material equal to the surrounding repair. Leave the fallen trees in place.

Mitigation plantings installed on this site shall be left in a natural state. Following successful establishment of the habitat, no additional maintenance such as irrigation or mowing shall be required as a part of normal maintenance.

Soil placed on/in rock as a part of the original repair and all associated vegetation (grasses & woody shrubs/trees) within the footprint of the bank protection site does not require replacement as a part of normal maintenance. In other words if the soil is washed out it does not need to be replaced and re-vegetated.

During typical summer-fall conditions, focus fish species which include salmon, steelhead, green sturgeon, and delta smelt are generally absent in the Sacramento and Yolo Bypass. During winter-spring conditions, assuming inundation, the Yolo Bypass provides a large amount of available floodplain habitat for migration and rearing. Under the "worst case scenario" assumptions, project actions along the Sacramento Bypass levee reach would result in the removal of all trees and vegetation; due to the abundance of floodplain habitat during increased inundation with the widening of the Sacramento Bypass, it is highly unlikely that the loss of these shoreline habitat features would impact overall habitat that would be available and most likely utilized by salmon, steelhead, green sturgeon, and delta smelt in the Sacramento Bypass during winter-spring conditions.

5.2.1 Sacramento River Winter-Run Chinook Salmon

Potential project effects from the actions are described below for each life stage and its habitat. Effects on designated critical habitat are addressed via description of habitat effects for each applicable species.

Construction-Related Effects

Adult Migration

Construction activities may affect but are not likely to adversely affect winter-run adults because construction will avoid the primary migration period (December through July), will be restricted to the channel edge, and will include implementation of the avoidance and minimization measures

described in Section 2.5. The work windows for all listed fish species that could be impacted by the project are shown on Table 13 below.

Spawning

Winter-run Chinook salmon do not spawn in the ARCF GRR action area. Therefore, the project will have no effect on winter-run Chinook salmon spawning or spawning habitat.

Juvenile Rearing and Migration

Rearing and emigrating juveniles and smolts may be found in the action area during the fall, winter, and spring. The abundance of juvenile winter-run Chinook salmon moving downstream peaks at Red Bluff in September and October and continues until mid March in drier years (Vogel and Marine 1991). Downstream migration may be triggered by storm events and the resulting high flow and turbidity, although the relative importance of various outmigration cues remains unclear.

Implementation of the bank erosion protection measures may result in adverse effects to juvenile and smolt winter-run Chinook salmon and their critical habitat. Construction activities that increase noise, turbidity, and suspended sediment may disrupt feeding or temporarily displace fish from preferred habitat. Rearing or outmigrating salmon may not be able to readily move away from nearshore areas that are directly affected by construction activities such as placement of rock revetment; these effects could result in stress, injury, or mortality. Take of juvenile or smolt winter-run Chinook salmon could therefore occur via mortality or injury during construction activity, or by the impairment of essential behaviors such as feeding or escape from predators. Substantial increases in suspended sediment could temporarily bury substrates that support benthic macroinvertebrates, an important food source for juvenile salmonids. However, due to the limited duration and spatial extent of project actions, effects on salmonid feeding are expected to be minimal. In addition, spills or leakage of gasoline, lubricants, or other petroleum products from construction equipment or storage containers could result in physiological impairment or mortality to rearing or outmigrating salmon in the vicinity of the project sites. With implementation of best management practices, the impacts due to spills should be minimal.

Restricting in-water activities to the August 1 through November 30 work window (beginning on July 1 for sites upstream of RM 60) and implementing the avoidance and minimization measures described in Section 2.5 will minimize, but may affect and is likely to adversely affect potential construction-related effects on juveniles and smolts.

Table 13. Assumed Life Stage Timing and Distribution of Special Status Fish Species.

Life Stage	Distribution	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Late Fall–Run Chinook Salmon													
Adult Migration	SF Bay to Upper Sac River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement and Rearing	Upper Sacramento River and Tributaries												
Fall-Run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River and Tributaries												
Spawning[1]	Upper Sacramento River and Tributaries												
Egg Incubation[1]	Upper Sacramento River and Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Spring-Run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Winter-Run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River												
Spawning	Upper Sacramento River												
Egg Incubation	Upper Sacramento River												
Juvenile Rearing (Natal Stream)	Upper Sacramento River to SF Bay												
Smolt Outmigration	Sacramento River and tributaries, Delta												
Juvenile Movement and Rearing	Upper Sacramento River to SF Bay												
Central Valley Steelhead													
Adult Migration	SF Bay to Upper Sacramento River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Rearing	Upper Sacramento River and Tributaries to SF Bay												
Smolt Outmigration	Sacramento River and tributaries, Delta												

Life Stage	Distribution	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Delta Smelt													
Adult Migration	Delta												
Spawning	Delta, Suisun Marsh												
Larval and Early Juvenile Rearing	Delta, Suisun Marsh												
Estuarine Rearing: Juveniles/Adults	Lower Delta, Suisun Bay												
Green Sturgeon													
Adult Migration	Delta to Upper Sacramento River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Movement and Rearing	Sacramento River and Tributaries to SF Bay												

Notes: SF Bay = San Francisco Bay.

[1] Spawning and incubation occurs from October to February in the Feather, American, and Mokelumne Rivers

Sources: Brown 1991; Wang and Brown 1993; U.S. Fish and Wildlife Service 1996; McEwan 2001; Moyle 2002; Hallock 1989; U.S. Army Corps of Engineers 2006.

Long-Term Effects

The ARCF GRR action area does not support spawning habitat for winter-run Chinook salmon, therefore the projects long-term effects will have no effect to spawning habitat.

Winter-run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River Standard Assessment Methodology (SAM) and American River SAM analysis reach over the lifetime of the project (Appendix B). Figures 22 through 24 below show the long term condition changes at a typical bank protection site over 10 years. Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. The maximum habitat deficit identified is -1,291 ft for the juvenile migration life stage of Spring-run Chinook salmon in the fall of year 11. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions.

Winter-run Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Winter-run Chinook salmon should exhibit a negative response by year 1. The maximum habitat deficit identified is -188 ft for the juvenile migration life stage of Winter-run Chinook salmon in the spring of year 2. Short term and long term habitat deficits will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir.

Figure 22. Bank Protection Site R4 in Planting Year 2001 on the American River.

Figure 23. Bank Protection Site 4R in 2005

Figure 24. Bank Protection Site 4R in 2010.

5.2.2 Central Valley Spring-Run Chinook Salmon

Potential project effects for spring-run Chinook salmon are described below for each life stage and its habitat, including effects on designated critical habitat.

Construction-Related Effects

Adult Migration

Adult spring-run Chinook salmon migrate up the Sacramento River from March through September although most individuals have entered tributary streams by mid-June and will not be affected by construction activities. Therefore, potential for construction-related ARCF GRR project effects will be similar to that described for winter-run Chinook salmon.

Spawning

Spring-run Chinook salmon do not spawn in the ARCF GRR action area. Therefore, the project will have no effect on spring-run Chinook salmon spawning or spawning habitat.

Juvenile Rearing and Migration

Similar to winter-run Chinook salmon, spring-run Chinook salmon typically spend up to 1 year rearing in fresh water before migrating to sea. Therefore, potential for construction-related effects will be similar to that described for winter-run Chinook salmon above.

Restricting in-water activities to the August 1 through November 30 work window and implementing the avoidance and minimization measures described in Section 2.5 will minimize, but may affect and is likely to adversely affect potential construction-related effects on juveniles and smolts.

Long-Term Effects

The ARCF GRR area does not support spawning habitat for spring-run Chinook salmon, therefore the projects long-term effects will have no effect to spawning habitat.

Spring-run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River SAM and American River analysis reaches over the lifetime of the project (Appendix B). Figures 22 through 24 show the long term condition changes at a typical bank protection site over 10 years. Spring-run Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for spring-run Chinook salmon. The maximum habitat deficit identified is -1,440 feet for the juvenile migration life stage of spring-run Chinook salmon in the summer of year 10. Short term habitat deficits will result

from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions. For juvenile spring-run Chinook salmon, the bank protection measures will generally provide long-term increases in bank shading at project sites. The plantings of native grasses and willows are designed to benefit juvenile Chinook salmon by increasing the availability (habitat area) and quality (shallow water and instream cover) of nearshore aquatic habitat and SRA relative to current conditions. Long term effects may affect but are not likely to adversely affect critical habitat for spring-run Chinook salmon juvenile rearing and migration.

Spring–run Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a negative response by year 1. The maximum habitat deficit identified is -188 feet for the juvenile migration life stage of spring-run Chinook salmon in the spring of year 2. Short term and long term habitat deficits will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir.

5.2.3 Central Valley Steelhead

Potential project effects for steelhead are described below for the relevant life stages and their habitat, including effects on designated critical habitat.

Construction-Related Effects

The levees along NEMDC are devoid of any tall vegetation or instream woody material and subsequently, construction activities would be approximately 100 feet from the east levee toe, outside of the wetted channel. As a result, the NSS levee improvements would not result in construction-related effects to steelhead.

Adult Migration

In the Sacramento River, adult steelhead migrate upstream during most months of the year, beginning in July, peaking in September, and continuing through February or March. Adults use the river channel in the action area as a migration pathway to upstream spawning habitat, and may also use deep pools with instream cover as resting and holding habitat. The potential for construction-related effects on migrating adult steelhead would be similar to that described above for adult winter-run Chinook salmon with the determination being that the construction-related activities may affect but are not likely to adversely affect adult migration.

Spawning

Within the ARCF GRR action area, potential spawning habitat is present in the American River, NEMDC, and Dry/Robla Creek. Steelhead spawn in late winter and late spring outside of the August 1-November 30 construction window; therefore, construction-related effects may affect but are not likely to adversely affect steelhead spawning or their spawning habitat.

Juvenile Rearing and Migration

Central Valley steelhead rear year-round in the cool upstream reaches of the mainstem Sacramento River and its major tributaries. Juveniles and smolts are most likely to be present in the action area during their downstream migration to the ocean, which may begin as early as December and peaks from January to May. The importance of main channel and floodplain habitats in the lower Sacramento River to rearing steelhead is becoming more understood.

Steelhead smolts have been found in the Yolo Bypass during the period of winter and spring inundation (Sommer 2002). Sommer et al. (2001) found that Juvenile Chinook salmon that reared within a large, engineered floodplain of the Sacramento River (the Yolo Bypass) had higher rates of growth and survival than fish that reared in the main-stem river channel during their migration. For purposes of this analysis, rearing juvenile steelhead are assumed to use nearshore and off-channel habitat in the action area. The potential for construction-related effects on steelhead juveniles and smolts and their habitat will therefore be similar to that described above for winter-run Chinook salmon which may affect and is likely to adversely affect.

Long-Term Effects

Steelhead are expected to show a long term positive response to project actions in the Sacramento River SAM and American River SAM analysis reaches over the lifetime of the project (Appendix B). Figures 22 through 24 show the long term condition changes at a typical bank protection site over 10 years. Steelhead should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Steelhead. The maximum habitat deficit identified is -1,330 ft for the juvenile migration life stage of Steelhead in the fall of year 11. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions.

Steelhead are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Steelhead should exhibit a negative response by year 1. The maximum habitat deficit identified is -174 ft for the juvenile migration life stage in the spring of year 2. Short term and long term habitat deficits will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir.

The NSS project would result in long-term indirect effects on steelhead through modification of riparian and aquatic habitat, including channel bed and bank substrate. Additionally, SRA habitat would be impacted through the removal of approximately 5 trees. These impacts would be unlikely to adversely affect steelhead with the implementation of the measures described in Section 2.5 above.

5.2.4 Delta Smelt

Primary Constituent Elements

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation (50 CFR 424.12[b]). The Service is required to list the known primary constituent elements together with a description of any critical habitat that is proposed. Such physical and biological features (i.e., primary constituent elements) include, but are not limited to, the following:

- Space for individual and population growth, and for normal behavior;
- Food, water, air, light, minerals, or other nutritional or physiological requirements;
- Cover or shelter;
- Sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and
- Generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The primary constituent elements essential to the conservation of the delta smelt are physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (NMFS 1994a).

Spawning Habitat

Delta smelt adults seek shallow, fresh or slightly brackish backwater sloughs and edgewaters for spawning. To ensure egg hatching and larval viability, spawning areas also must provide suitable water quality (i.e., low concentrations of pollutants) and substrates for egg attachment (e.g., submerged tree roots and branches and emergent vegetation). Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay. The spawning season varies from year to year and may start as early as December and extend until July (NMFS 1994a).

Larval and Juvenile Transport

To ensure that delta smelt larvae are transported from the area where they are hatched to shallow, productive rearing or nursery habitat, the Sacramento and San Joaquin Rivers and their tributary channels must be protected from physical disturbance (e.g., sand and gravel mining, diking, dredging, and levee or bank protection and maintenance) and flow disruption (e.g., water diversions that result in entrainment and in-channel barriers or tidal gates). Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay. Additionally, river flow must be adequate to prevent interception of larval transport by the State and Federal water projects and smaller agricultural diversions in the Delta. To ensure that suitable rearing habitat is available in Suisun Bay, the 2 ppt isohaline must be located westward of the Sacramento-San Joaquin River confluence during the period when larvae or juveniles are being transported, according to the historical salinity conditions which vary according to water-year type. Reverse flows that maintain larvae upstream in deep-channel regions of low productivity and expose them to entrainment interfere with these transport requirements. Suitable water quality must be provided so that maturation is not impaired by pollutant concentrations. The specific geographic area important for larval transport is confined to waters contained within the legal boundary of the Delta, Suisun Bay, and Montezuma Slough and its tributaries. The specific season when habitat conditions identified above are important for successful larval transport varies from year to year, depending on when peak spawning occurs and on the water-year type. The Service identified situations in the biological opinion for the delta smelt (1994) where additional flows might be required in the July-August period to protect delta smelt that were present in the south and central Delta from being entrained in the State and Federal project pumps, and to avoid jeopardy to the species. The long-term biological opinion on CVP-SWP operations will identify situations where additional flows may be required after the February through June period identified by EPA for its water quality standards to protect delta smelt in the south and central Delta (USFWS 1994).

Rearing Habitat

Maintenance of the 2 ppt isohaline according to the historical salinity conditions described above and suitable water quality (low concentrations of pollutants) within the Estuary is necessary to provide delta smelt larvae and juveniles a shallow, protective, food-rich environment in which to mature to adulthood. This placement of the 2 ppt isohaline also serves to protect larval, juvenile, and adult delta smelt from entrainment in the State and Federal water projects. An area extending eastward from Carquinez Strait, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of tidal excursion when the historical salinity conditions described above are implemented. Protection of rearing habitat conditions may be required from the beginning of February through the summer (USFWS 1994).

Adult Migration

Adult delta smelt must be provided unrestricted access to suitable spawning habitat in a period that may extend from December to July. Adequate flow and suitable water quality may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas also should be protected from physical disturbance and flow disruption during migratory periods (USFWS 1994).

Construction-Related Effects

Delta smelt in the Sacramento River have been documented upstream as far as the city of Sacramento (RM 60) (Moyle 2002), and may be present throughout their life cycle. Potential project effects are described below for relevant life stages and their habitats, including effects on designated critical habitat.

Adult Migration

Adult Delta smelt migrate upstream between December and January and spawn between January and July, with a peak in spawning activity between April and mid-May (Moyle 2002). Potential construction-related effects to physical habitat, water, river flow, and salinity concentrations for migrating adult Delta Smelt will be avoided or minimized by restricting in water construction activities on the Sacramento River to the August 1 through November 30 work window allowing for unrestricted access to suitable and important spawning habitat. If there is any change in effect due to construction constraints outside the work window, consultation will be initiated. Construction-related effects may affect but are not likely to adversely affect adult migration.

Spawning

Potential spawning habitat includes shallow channel edge waters in the Delta and Sacramento River. Specific areas that have been identified below the ARCF GRR project area as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay. As a result, potential construction-related effects to delta smelt physical habitat would include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, alteration of spawning and incubation habitat, and loss of shallow water habitat for spawning.

The erosion repair is likely to somewhat reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment prospective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems. All of the available sediment in the American River watershed is being contained behind

Folsom Dam. The site specific designs will be constrained from allowing any velocity increases outside the erosion repair site (Schlunegger 2014).

In response to a USFWS request for more data on July 23, 2014, the Corps conducted an analysis of existing shallow water habitat in the ARCF GRR project area, and the effect of the proposed project on that habitat. The results of this analysis are included as Appendix C to this report. This analysis was based on a cross section geometry with the assumption that the sediment or sand will be converted to rock revetment. The conclusion of the analysis was that approximately 14 acres of shallow water habitat would be permanently lost as a result of implementation of the ARCF GRR with 46 acres of spawning habitat being affected by a long-term change in substrate from sand to rock. The footprint could be minimized as site-specific designs are developed during the PED phase of the project and will be further coordinated with USFWS at that time. Compensation would involve the purchase of 42 credits of shallow water habitat replacement and 32 credits to compensate for the permanent change in spawning substrate at a USFWS-approved mitigation bank.

Construction-related effects on delta smelt spawning and incubation will be minimized by restricting in-water construction activities on the Sacramento River and Sacramento Weir and Bypass to the August 1 through November 30 work window, thereby avoiding the seasons when spawning is most likely to occur, however construction activities may affect and is likely to adversely affect delta smelt spawning habitat.

Juvenile Rearing and Migration

Juvenile delta smelt may be subject to disturbance or displacement caused by construction activities that would alter physical habitat, water, and river flow in the form of increased noise, turbidity, and suspended sediment. Delta smelt may not be readily able to move away from channel or nearshore areas that are directly affected by construction activities (i.e., removal or placement of instream woody material, placement of rock revetment). Larvae may be disrupted during summer months as they migrate downstream to rear in the Delta. Incidental take of delta smelt may occur from direct mortality or injury during a construction activity, or by the impairment of essential behavior patterns (i.e., feeding, escape from predators). Salinity concentrations would not be affected by the construction activity. Construction-related effects on delta smelt rearing and migration will be minimized by restricting in-water construction activities on the Sacramento River to the August 1 through November 30 work window, thereby avoiding the seasons when these life stages are most likely to occur. Construction-related activities may affect and is likely to adversely affect juvenile rearing and migration.

Long-Term Effects

Non-native species may exploit the warmer water temperature in the shallow bench habitat created as an on-site mitigation feature and prey on delta smelt eggs and larvae; however, bench habitat would most likely not bring in more predatory fish that don't already exist in the project area. A 2013 long-term aquatic monitoring program draft report by FishBio for the Corps noted that Black bass

(largemouth and smallmouth bass) have the highest probability of habitat occupancy at both Sacramento River Bank Protection Project (SRBPP) sites with bench features and sites with no bench features. Unlike previous years, when highest bass abundance was typically associated with wetland trench designs (not included in the suite of monitored sites in 2013), the highest likelihood of encountering black bass was observed at no bench and bench sites, in particular those near rivermile 70, well above the project area (Corps 2013b). Proposed planting of emergent vegetation will enhance habitat complexity by providing cover and incubation habitat, especially during high winter and spring flows.

5.2.5 Green Sturgeon

Potential project effects are described below for each life stage of green sturgeon and its habitat. An accurate assessment of potential project effects on green sturgeon and its habitat is difficult due to the limited information available on distribution, seasonal abundance, habitat preferences, and other life history requirements of this species.

Construction-Related Effects

Adult Migration

Adult green sturgeon are believed to move upstream through the Sacramento River ARCF action area from February through late July (NMFS 2005c). Construction activities occurring outside of these time periods are not likely to affect migrating green sturgeon adults. Construction activities during July, however, may have adverse impacts on any adult green sturgeon that are still migrating upstream. Because construction activities will largely avoid the peak migration period, will be restricted to the channel edge, and will implement the avoidance and minimization measures described in Section 2.5, construction-related activities may affect but are not likely to adversely affect adult migration.

Spawning

Spawning migrations of Green Sturgeon typically occur during the months of March through June (Thomas et al. 2013). The Sacramento River downstream of Knights Landing (RM 90) is not believed to have suitable spawning habitat for green sturgeon, primarily due to lack of suitable coarse bottom substrate such as large cobbles (Corps 2012). Therefore, the ARCF GRR project will have no affect on spawning green sturgeon or their habitat.

Juvenile Rearing and Migration

Based on general knowledge of green sturgeon life history, larvae may occur in the Sacramento River and Delta shortly after spawning, from February through late July (peak spawning from April through June) (Emmett et al. 1991 as cited in Moyle 2002). Restricting in-water construction activities to

the August 1 through November 30 work window and implementing the avoidance and minimization measures described in Section 2.5, will minimize potential impacts of in-water construction activities on green sturgeon larvae. However, if larvae or juveniles are present during construction, in-water activities could result in localized displacement and possible injury or mortality to individuals that do not readily move away from the channel or nearshore areas. Project actions associated with bank protection measures may increase sediment, silt, and pollutants, which may affect and is likely to adversely affect rearing habitat or reduce food production, such as aquatic invertebrates, for larval and juvenile green sturgeon.

Widening of the weir and bypass will increase the entrainment and stranding exposure and rates of juveniles. When the weir is overtopping and water is flowing down the bypass, adult fish are attracted to the flow and follow it upstream in an attempt to reach their holding and spawning habitat. Widening the weir and bypass would increase the amount of water going over the weir and increase the attraction rate of sturgeon, salmon, and steelhead. Without fish passage in place, the stranding rates of these fish would increase. This is significant, especially for sturgeon. Population viability modeling, funded in part by the Corps, concluded that without the fish rescue that took place, the loss of the green sturgeon stranded behind the Fremont and Tisdale weirs in 2011 would have significantly reduced the viability the species and increased their extinction risk (Thomas, et. al, 2013). We believe that because of its location and design, the Sacramento weir poses a similar risk and widening the weir would add to the effect. Given that green sturgeon are long-lived species that have the strongest upstream migration and cohort replacement rates during wet water years and especially after high river flow conditions, the effect of the stranding occurring only two to three times over a 50 year period could adversely impact juvenile green sturgeon.

Long-Term Effects

SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species. SAM values for green sturgeon generally indicate a negative response or no response to typical onsite mitigative features. Green sturgeon are expected to show long term negative response to project actions in the Sacramento River SAM analysis reach for several life stages at all seasonal habitat conditions over the lifetime of the project. Project actions in the American River SAM analysis reach will also mimic SRBPP repair site onsite mitigative features. SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species; green sturgeon will exhibit a negative response for juvenile rearing in the summer/fall to these onsite mitigative features. However, during the winter/spring green sturgeon juvenile rearing life stages will exhibit a positive response to these onsite mitigative features. Green Sturgeon are expected to show a long term positive response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project for the fry and juvenile rearing life stages in the winter/spring/summer/fall of year 1 (See Appendix B of the ARCF GRR BA for a more detailed analysis).

Long-term changes in nearshore habitat are expected to have negligible effects on adult green sturgeon because adult sturgeon use deep, mid-channel habitat during migration. If juvenile green sturgeon use nearshore areas of the Sacramento River as foraging habitat or refuge from predators, the general long-term effects of bank protection on nearshore habitat values may affect, and is likely to adversely affect rearing juvenile green sturgeon critical habitat.

5.3 Giant Garter Snake

Much of the project area is unlikely to provide GGS aquatic habitat because it consists of larger rivers and flood control features, often surrounded by riparian vegetation and steep banks. GGS have not been documented in the east side tributaries (CDFW 2014), and historical habitat conditions are thought to have limited dispersal of the species east of NEMDC (E. Hansen, pers. comm., 2015). Based on these factors and current habitat conditions, such as close proximity to urban development, high levels of human disturbance, scarcity of upland habitat, and riparian vegetation along the banks of most channel reaches, GGS are unlikely to occur in the east side tributaries and the southern portion of NEMDC. Therefore, all proposed project elements that would occur in these areas are unlikely to directly or indirectly impact GGS or adversely affect habitat occupied by the species.

The quality of habitat for GGS improves along NEDMC north of Dry Creek, where aquatic habitat is more extensive, very little riparian vegetation is present, urban development is less extensive, and large areas of open grasslands are present landside of the levees. GGS are known to occur in rice fields, associated canals, and managed marshes in the Natomas Basin. Additionally, the Sacramento Bypass is considered GGS habitat.

Short-Term Effects

There is the potential for short-term effects to GGS upland habitat during construction of the Sacramento Bypass widening. Construction activities could disturb GGS due to vibration, noise, and dust. During construction, equipment could possibility harm or kill a snake if the snakes are present. In addition to these short-term construction related effects, there would be temporary impacts to approximately 25 acres of aquatic GGS habitat and 50 acres of upland habitat from the relocation of the Sacramento Bypass levee toe drain. To minimize potential impacts to GGS, the avoidance and minimization measures discussed in Section 2.5 above would be implemented. These short-term effects are anticipated to occur over a single construction season and would return to the pre-existing conditions once completed. If construction were to occur in GGS habitat areas for more than one construction season, then additional mitigation would be required in accordance with the measures discussed in Section 2.5 above.

Based on habitat conditions and known occurrences of giant garter snake, NSS project's Borrow Site 2 is located immediately east of NEMDC and supports suitable upland habitat for GGS. If GGS are present during borrow activities, these activities would result in direct and indirect effects to this species. Approximately 5.5 acres of GGS upland habitat would be impacted by the borrow activities. Ground disturbing activities at Borrow Site 2, where uplands adjacent to suitable aquatic habitat would be disturbed, could result in direct displacement, injury, or death of snakes if the habitat is used for basking, hibernating, or aestivating. Indirect effects could occur if snakes are displaced from occupied habitat or disturbed by nearby construction activities. Displacement and disturbance resulting from human activity, construction noise, and equipment vibrations could affect the ability of snakes to conduct essential life history functions, such as dispersal, movement, or foraging, and could result in increased competition for food and space and vulnerability to predation.

However, all project-related impacts at Borrow Site 2 would occur within one active season and, therefore, are considered temporary. Borrow Site 2 would be restored/enhanced and re-graded to a condition that exceeds the pre-project condition by lowering the land surface closer to the low flow channel elevation and through establishment of a more diverse mosaic of aquatic and wetland habitat components. Additionally, with the implementation of the proposed avoidance and minimization measures discussed in Section 2.5, the use of Borrow Site 2 may affect, but is not likely to adversely affect GGS.

Table 14. Impacts to Giant Garter Snake Habitat.

Location	**Area of Impact (acres) / Impact Type**
NEMDC/NSS Borrow Site 2	5.5 acres / Temporary Upland
Sacramento Bypass Drainage Ditches/Irrigation Canals	15 acres / Permanent Aquatic 30 acres / Permanent Upland
Sacramento Bypass Levee Toe Drain	25 acres / Temporary Aquatic 50 acres / Temporary Upland
Total Impacts to GGS Habitat	**Permanent Aquatic - 15 acres** **Permanent Upland – 30 acres** **Temporary Aquatic – 25 acres** **Temporary Upland – 55.5 acres**

Long-Term Effects

GGS habitat at the NSS Borrow Site 2 would be restored to pre-project conditions, resulting in no long-term loss of upland GGS habitat in this portion of the project area. The Borrow Site will be planted to create freshwater marsh and seasonal wetland habitat, which will provide mitigation for potential unavoidable impacts to jurisdictional wetland habitat occurring during the North Sacramento

Streams Levee Improvement Project. Upland areas disturbed during borrow activities will be seeded with native perennial grasses.

In the Sacramento Bypass, there would be a permanent loss of approximately 15 acres of GGS aquatic habitat from the removal of the drainage ditches and farm canals in the extended Bypass area and approximately 30 acres of associated upland habitat. Compensation would occur through the purchase of credits at a USFWS-approved mitigation bank. This compensation would be in accordance with the ratios established in Section 2.5.

Additionally, since the land within the expanded bypass area would be removed from agricultural production and added to the wildlife area, there is the potential for wetlands to form in this area, which could improve the habitat conditions of the area long term. Long-term adverse impacts could result from O&M activities. These activities include mowing, rodent control, and grouting any new rodent holes that form in the new levee. Additionally, driving near habitat could disturb GGS due to vibration, noise, and dust. Maintenance activities would occur during the GGS active season to reduce impacts to the snake. Overall, these activities are considered less than significant, because they are short term activities and because O&M reduces the potential impacts associated with future levee repairs.

Operation of the expanded Sacramento Weir and Bypass was described in Section 2.2.6 above, and would result in an increase of water surface elevation of approximately 0.5-foot on the levee slopes on either side of the Yolo Bypass. However, when this increase would occur, during a 200-year flood event, the Yolo Bypass levees already contain water up to a 21 foot depth. As a result, GGS burrows would likely already be saturated before the additional water associated with the widened Sacramento Bypass is a factor. The additional 0.5-foot resulting from this action would not significantly change the timing or duration of this flooding and would not result in further impacts to GGS habitat. As a result, operation of the widened Sacramento Weir and Bypass may affect, but is not likely to adversely impact the GGS.

5.4 Western Yellow-Billed Cuckoo

The project area is unlikely to support western yellow-billed cuckoo nesting habitat. However, migrant individuals are likely to pass through the area in transit to breeding sites along the Sacramento River north of Colusa. Overall, cuckoos are unlikely to occur in the action area, although potential dispersal and foraging habitat is present in the American River Parkway and along the Sacramento River.

Short-Term Effects

Prior to construction, surveys would be conducted to determine the presence of cuckoos within the project area in accordance with any required USFWS survey protocols and permits at the time of construction. If cuckoos are determined to be present, there is the potential for short term, temporary

impacts during construction from dust, noise, and vibration. However, since construction would occur in the summer months when the cuckoo is nesting (June 1 through September 30), and cuckoos are unlikely to be nesting in the study area, these effects would not adversely effect the species. If cuckoos are determined to the present prior to construction, the Corps would reinitiate consultation in order to coordinate the appropriate avoidance and minimization measures that should be implemented in order to reduce impacts to the cuckoo.

Long-Term Effects

Potential long-term effects to the cuckoo could result from the loss of 65 acres of riparian habitat in the footprint of the rock trench sites within the American River Parkway. For the American River, impacts to trees would be the width of the launchable rock trenches (currently proposed at approximately 40-feet wide) for a total of approximately 65 acres. This habitat is suitable for the yellow-billed cuckoo due to the significant width of the riparian corridor along the American River Parkway, ranging from approximately 75 feet in some of the more narrow stretches to over 1,000 feet in other locations. The Corps would compensate for riparian vegetation removed as a result of construction within the Parkway and on-site to the maximum extent practicable. There would remain a significant temporal loss of riparian habitat for the cuckoo during their migration, however in time it is anticipated that with the implementation of the compensation proposed by the Corps, the riparian corridor would recover and would provide a suitable level of habitat for the cuckoo long-term.

Additionally, approximately 70 acres of riparian habitat would be impacted along the Sacramento River; however the Sacramento River's riparian corridor is very narrow (approximately 100 feet wide in most locations) and would not likely provide quality habitat for the cuckoo, who require a minimum of 20 hectares of riparian corridor to nest. However, they are expected to use this area as a migration corridor. Impacts to riparian vegetation along the Sacramento River could remove approximately a 60-foot wide segment of the 100-foot wide riparian corridor. However, with the implementation of on-site mitigative features associated with the construction of the bank protection, as described in Section 2.2.3, the project would add an additional 25-foot wide corridor of SRA/riparian vegetation along the river bank. The result would be a remaining impact of approximately 35 feet of riparian corridor loss, or approximately 40 acres. This remaining impact would be compensated either through the creation of off-site mitigation near the Sacramento River, or through the purchase of credits from a USFWS-approved mitigation bank. With the implementation of compensation for the loss of riparian habitat, the long-term effect of the removal of riparian vegetation along the Sacramento and American Rivers may affect, but is not likely to adversely affect the western yellow-billed cuckoo.

5.5 Ongoing Project Actions

As described in Section 2.5, in-water construction work will be completed during established work windows for salmonids and delta smelt. Maintenance activities may occur year-round in the dry areas. Effects from on-going activities (e.g., maintenance) are expected to be similar to effects described in Section 5.2, although the effects' magnitudes will be less.

5.6 Effects on the Environmental Baseline

Effects of the proposed action include reductions in nearshore aquatic and riparian habitat that is used by aquatic and terrestrial species. Placement of revetment on earthen banks alters natural fluvial processes that sustain high-value nearshore and floodplain habitats in alluvial river systems.

5.7 Effects on Essential Elements of Critical Habitat

The project actions may adversely modify designated critical habitat for the valley elderberry longhorn beetle, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and green sturgeon. Any project action within the Sacramento River waterway from the confluence of the American River downstream to Freeport RM 46 may also affect designated critical habitat for delta smelt (USFWS 2003). Potential impacts of the project actions on critical habitat for listed species are discussed separately for each species in the effects analysis discussion above (Sections 5.1 to 5.3).

5.8 Cumulative Effects

5.8.1 ESA Cumulative Effects Analysis

The ESA requires the action agency, NMFS, and USFWS to evaluate the cumulative effects of the proposed actions on listed species and designated critical habitat, and to consider cumulative effects in formulating Biological Opinions (USFWS and NMFS 2002c). The ESA defines cumulative effects as "those effects of future State or private actions, not involving Federal activities that are reasonably certain to occur within the action area" of the proposed action subject to consultation (USFWS and NMFS 2002b). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Federal ESA. For the purposes of this BA, the area of cumulative effects analysis is defined as the Sacramento River watershed.

A number of other commercial and private activities, including hatchery operations, timber harvest, recreation, as well as urban and rural development, could potentially affect listed species in the Sacramento River basin. Levee maintenance activities by state agencies and local reclamation districts are likely to continue, although any effects on listed species will be addressed through Section 10 of the ESA. Ongoing non-federal activities that affect listed salmonids, green sturgeon, delta smelt, valley elderberry longhorn beetle, giant garter snake and their habitat, will likely continue in the short-term, at intensities similar to those of recent years. However, some activities associated with the State's proposed Central Valley Flood Protection Plan or state or local efforts to implement the ETL could result in increased effects on listed species. The extent and pace of those activities are not yet known.

Cumulative effects may also include non-federal rock revetment projects. Some non-federal rock revetment projects carried out by State or local agencies (e.g., reclamation districts) that do not fill wetlands or occur above the ordinary high water line will not need Section 404 (Clean Water Act) permits from the Corps and resulting Section 7 (ESA) consultation, but any effects on listed species should be addressed through Section 10 of the ESA. These types of actions are possible at many locations throughout the ARCF action area and could contribute to cumulative impacts to waters of the U.S. These impacts could include similar effects to those associated with the ARCF proposed bank protection measure, including loss of Delta smelt shallow water and spawning habitat, loss of green sturgeon benthic habitat, loss of SRA habitat, and loss of riparian habitat along the Sacramento and American River corridors. Without appropriate mitigation, these effects would contribute to an adverse effect on these species. However, since the ARCF project is proposing to restore impacted SRA and riparaian habitat and compensate for any permanent loss of in-water habitat, the ARCF project would not be expected to combine to create an adverse cumulative effect with these actions.

Potential cumulative effects on fish may include any continuing or future non-federal diversions of water that may entrain adult or larval fish or that may incrementally decrease outflows, thus changing the position of habitat for these species. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses and power production. Several new diversions are in various stages of action. The introduction of exotic species may also occur under numerous circumstances. Exotic species can displace native species that provide food for larval fish.

Potential cumulative effects on all species addressed in this BA could include: wave action in the water channel caused by boats that may degrade riparian and wetland habitat and erode banks; dumping of domestic and industrial garbage; land uses that result in increased discharges of pesticides, herbicides, oil, and other contaminants; and conversion of riparian areas for urban development. In addition, routine vegetation clearing and mowing associated with agricultural practices may affect or remove habitat for the valley elderberry longhorn beetle and giant garter snake.

5.8.2 Federal Cumulative Effects Analysis

While cumulative effects analyses in ESA consultations are specifically to address non-federal actions as explained above, the following cumulative analysis of Federal actions is being provided to inform the agencies of federal actions affecting listed species in the general local area. The Corps has initiated consultation with USFWS and NMFS on four different Federal actions which could create a cumulative effect on listed species in the Sacramento area. These four projects include the West Sacramento Project, the Southport Early Implementation Project, the American River Common Features Project (including the North Sacramento Streams project), and the Sacramento River Bank Protection Project (SRBPP).

The purpose of the West Sacramento Project is to investigate and determine the extent of Federal interest in plans that reduce flood risk to the City of West Sacramento. The proposed alternative for this project consists of levee improvements to 50 miles of existing levees surrounding the city and extending down along the Sacramento Deep Water Ship Channel to address identified seepage, stability, and erosion concerns through the construction of slurry walls and bank protection. In addition, the project proposes to set back the Sacramento River levee in the Southport area of West Sacramento. The West Sacramento Project includes the geographic area and project features that are also being considered in the Southport Early Implementation Project. The Southport Early Implementation Project is being proposed by the West Sacramento Area Flood Control Agency and the State of California to provide 200-year protection consistent with the State's goal for urbanized areas, as well as to provide opportunities for ecosystem restoration and public recreation. The Southport Early Implementation Project's proposed alternative includes the Sacramento River setback levee in the Southport area of West Sacramento. The Southport project is planned to begin construction in 2015.

The SRBPP was authorized to protect the existing levees and flood control facilities of the SRFCP. The SRBPP is a long-range program of bank protection authorized by the Flood Control Act of 1960. The SRBPP directs the Corps to provide bank protection along the Sacramento River and its tributaries, including that portion of the lower American River bordered by Federal flood control project levees. Beginning in 1996, erosion control projects at five sites covering almost two miles of the south and north banks of the lower American River have been implemented. Additional sites at RM 149 and 56.7 on the Sacramento River totaling one-half mile have been constructed since 2001. During 2005 through 2007, 29 critical sites totaling approximately 16,000 linear feet were constructed under the Declaration of Flood Emergency by Governor Schwarzenegger. This is an ongoing project, and additional sites requiring maintenance will continue to be identified indefinitely until the remaining authority of approximately 24,000 linear feet is exhausted over the next 3 years. WRDA 2007 authorized an additional 80,000 linear feet of bank. For implementation of the 80,000 additional linear feet of bank protection, the Corps has submitted a biological assessment and initiated formal consultation with NMFS and USFWS.

Potential cumulative impacts from the combination of these projects to each of the listed species included in this consultation are below. The construction periods and related effects from these projects could all occur simultaneously. For the ARCF and West Sacramento projects, this means that

similar construction-related effects such as rock placement or tree removal could be occurring at the same time for the stretch of the projects from the I Street Bridge to the Stone Locks. During preconstruction engineering and design, the Corps designs will avoid impacts to special status species, where possible, or otherwise minimize effects to each of these species including designs to have negligible effects on velocities. There may be localized effects; the change in bank composition to rock may result in short term slight increase of velocities, but installation of vegetation on site would result in a much greater long-term reduction of velocities. The site would be designed to ensure that any increase in velocity does not extend downstream of the sites. Additionally, the two projects would coordinate to ensure that construction sites are offset from each other (i.e., sites directly across the Sacramento River from each other where there is bank protection being installed, specifically from the I-Street Bridge downstream to the Barge canal, would not be constructed in the same construction season). These are also different styles of bank protection. The West Sacramento side has some berm between the levee and the channel, and therefore it is really a "bank" fix, while the ARCF side has levee toe underwater and includes rock berm.

Valley Elderberry Longhorn Beetle

Concurrent construction of multiple projects over the next 10 to 15 years within the Sacramento Metropolitan area would likely cause mortality to beetles due to construction operations. Construction activities for the multiple projects would occur each year during the flight season of beetles. Since construction activities would be adjacent to known VELB locations it is likely that some mortality may occur. No designated critical habitat would be affected with the construction of any of the projects.

Shrubs within the each project footprint would be transplanted to areas in close proximately to the current locations. Additionally, compensation would be located within the vicinity of impacted shrubs. Transplanting of shrubs and planting of seedlings and natives within the project vicinity would provide connectivity for the beetle within the American River Parkway. Connectivity is a primary cause of the beetle decline and an important element in the recovery and sustainability for the beetle. Habitat maps of the Parkway that show individual shrub locations are included in Appendix F. Appendix G includes maps of the Corps' existing compensation sites within the Parkway. The Corps would coordinate with County Parks to determine appropriate locations for newly established elderberry mitigation sites within the Parkway, with connectivity being one of the goals in site selection. The transplanting of shrubs and compensation within the same area as the potential impacts would result in effects to the beetle but not result in jeopardy to the valley elderberry longhorn beetle.

Salmon, Steelhead, and Sturgeon

The proposed projects could adversely modify critical habitat or contribute to the loss or degradation of sensitive habitats for listed species such as the Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, and green sturgeon in the greater project vicinity. However, with site specific erosion repair designs, retention of SRA through vegetation variances, and the installation of riparian plantings and instream large woody material, the

proposed projects are expected to increase habitat values over time by increasing the amount of riparian habitat, SRA cover, and floodplain habitat available to listed fish over a broad range of flows.

The erosion repair activities of these combined projects would likely reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment perspective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems. All of the available sediment in the American River watershed is being contained behind Folsom Dam. The site specific designs will be constrained from allowing any velocity increases outside the erosion repair site (Schlunegger 2014).

Site specific designs such as setback levees, IWM, and shallow bank slopes within the SRBPP, Common Features, West Sacramento, and Southport EIP projects would be incorporated to address erosion repair while including features for increasing habitat for listed fish. The levee setback component of the Southport EIP and West Sacramento projects would result in the restoration of historical Sacramento River floodplain in the project areas, with a diverse mosaic of seasonal floodplain, wetland, riparian, and upland habitat. The goals of the offset area restoration designs are to increase river-floodplain connectivity, restore ecologically functional floodplain habitat, and meet the flood risk–reduction objectives of the projects. Based on the SAM, establishing connectivity of the floodplain to the river will result in large and rapid gains in habitat quantity and quality that will fully compensate for initial habitat deficits on the existing levee and result in significant long-term species benefits (improved growth and survival) relative to existing conditions. Although not addressed by the SAM, these benefits will be enhanced over time by revegetation of the floodplain and development of a diverse mosaic of wetland, riparian and upland plant communities that will further improve the habitat and ecosystem functions of the restored floodplain. In addition to increasing the amount of structural cover available to fish along the shoreline, the installation of IWM is also expected to promote sediment deposition on the rock bench as observed at locations where similar designs have been used to address the compensation needs of listed fish species. Project actions are unlikely to result in long-term habitat losses to Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, and green sturgeon.

The American River Common Features and West Sacramento Projects would have initial cover losses due to project actions but will be partially offset by installing riparian plantings and native grasses along the lower slopes. These features will increase the availability of high quality shallow water habitat for juvenile Chinook salmon and steelhead, and possibly juvenile green sturgeon during the annual high-flow period (late fall, winter, and spring). Because of the vegetation variance that the Corps will be seeking, tree removal would be limited to no more than the upper one-half of the waterside of the levees therefore leaving the lower one-half or more of the trees in place on the Sacramento River within the study area. SRA would not be compromised, thus maximizing existing SRA values in the study area. The establishment and growth of planted riparian vegetation is expected to increase habitat values over time by increasing the extent of overhead cover available to listed fish species.

Delta Smelt

The proposed projects, with the implementation of site specific designs and purchase of credits at a USFWS-approved mitigation bank, would provide long-term net benefits to delta smelt as explained above in for the other fish species. However, there are four specific significant threats to the delta smelt that have been identified by the USFWS: direct entrainments by State and Federal water export facilities, summer and fall increases in salinity, summer and fall increases in water clarity, or effects from introduced species (USFWS 2015). Bank protection has also been identified as a significant threat to delta smelt shallow water habitat for spawning, incubation, and rearing within the Sacramento River portion of the ARCF project area.

Implementation of the various projects would not affect direct entrainments by State and Federal water export facilities. The ARCF project would release of more water down the Sacramento Bypass into the Yolo Bypass during high water events. The excess water that would normally be moving downriver through the Sacramento area would enter the system farther down in the Delta area. Since adult delta smelt are moving up the system to spawn at this time this would not affect entrainment in the water export facilities.

Summer and fall increases in salinity is driven more by low flow drought years and water releases in the Sacramento tributaries then site specific designs for erosion protection in the project areas. Summer and fall increases in water clarity are associated with, among other factors, invasive non-native clam species and non-native plant species, which are generally located down in the Delta below the project areas, that are filtering out vital chlorophyll and plankton that would normally increase turbidity which helps the delta smelt avoid predators. However, as mentioned above, the erosion repair component of the ARCF, West Sacramento, and SRBPP would likely reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, as explained above, from a system sediment perspective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems.

Increases of bank substrate size over sand and sediment resulting in reductions in instream habitat are assumed to reduce the availability and suitability of habitat for spawning, incubation, and rearing. As a result, potential cumulative effects include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae. A permanent loss of approximately 14 acres with an additional 46 affected acres of sandy shallow water spawning and incubation habitat in the ARCF GRR project area would result from sand to rock conversion and would eliminate areas for successful egg deposition and survival due to the change in preferred substrate. However, the ARCF project would mitigate for the loss of shallow water habitat through the purchase of credits at a USFWS-approved mitigation bank. As a result, the cumulative impact of these projects may affect, but is not likely to adversely affect the Delta Smelt.

Giant Garter Snake

The giant garter snake could be affected by multiple projects being constructed within the Sacramento Metropolitan area over the next 10 to 15 years. Primarily habitat loss would occur on the West Sacramento side of the Sacramento River adjacent to the Sacramento Bypass and the West Sacramento and Southport construction areas. Short term impacts would occur for a single construction season along haul routes and within borrow sites. To minimize potential impacts to snakes work within giant garter snake habitat would be conducted between May 1 and October 1 when snakes are active and can move out of the construction area. Snake mortality could occur during construction along haul routes, however, the snakes are mobile and would likely move out of the way from construction equipment. There would be a permanent loss of a few irrigation canals in the Sacramento Bypass and some existing wetlands adjacent to the levees in the West Sacramento study area.

Western Yellow-Billed Cuckoo

Concurrent construction of the ARCF, West Sacramento, and SRBPP projects over the next 10 to 15 years within the Sacramento Metropolitan area could result in adverse effects to Western yellow-billed cuckoo through the removal of trees within the riparian corridors. Construction activities for the multiple projects would occur each year during nesting season, which could disrupt nesting birds, if present. However, the cuckoo is not known to nest in the Sacramento River or its tributaries below Colusa, therefore the tree removal would not effect Western yellow-billed cuckoo nesting habitat. Additionally, any tree removal would likely occur outside of the nesting season. No designated critical habitat would be affected with the construction of any of the projects.

Prior to construction, each project would be required to conduct surveys to determine the presence of the cuckoo. Nesting birds are not expected to be present, but migrating cuckoos could use riparian habitat in these reaches as they pass through the area. If cuckoos are found during surveys, additional measures would be proposed by each of the projects, which may include biological monitoring.

Planting of seedlings and native trees within the project vicinity would mitigate for the loss of trees within the riparian corridor and would likely improve the habitat in the area long-term by filling gaps in the riparian canopy. While the short term impact would be significant, over time these compensation measures within the same area as the potential impacts would result in less than significant effects to the cuckoo. Since the cuckoo is not likely to be nesting within the area, and while the cumulative impact to the riparian corridor from tree removal would be significant, there still remains a significant amount of trees that could be used by the cuckoo, particularly in the American River Parkway, as described in Section 5.9.5 above. As a result, the cumulative effect from these projects may affect, but is not likely to adversely affect the yellow-billed cuckoo.

5.9 Conclusion and Effects Determination for Listed Species

5.9.1 Valley Elderberry Longhorn Beetle

The project construction would result in the transplanting of a maximum of 270 elderberry shrubs during the 13 year construction timeframe. Compensation for the transplanting of the shrubs would be on-site where possible and within the same region when off-site. The replacement plantings would result in habitat connectivity for the beetle within the project area. In consideration of this information, the project actions are unlikely to result in long-term habitat losses to valley elderberry longhorn beetle, as long as the applicable mitigation and compensation measures are implemented. However, ARCF GRR project actions may adversely affect valley elderberry longhorn beetles due to potential take during construction.

Additionally, approximately 90 shrubs could be trimmed each year by the maintaining agencies for O&M activities. The trimming are not expected to reduce the habitat overall for the beetle as the shrubs would remain in the existing location. The maintaining agencies would purchase credits in a mitigation bank to offset any potential affects that may occur due to trimming.

5.9.2 Fish

Anadromous Fish Species

The ARCF GRR is expected to result in adverse short-term, construction- and O&M-related effects on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, southern DPS North American green sturgeon, and their designated critical habitat. Project effects may include localized incidental take due to disturbance, displacement, or impairment of feeding or other essential behaviors of adult and juvenile salmon, steelhead, and green sturgeon during construction and operations and maintenance (O&M) activities. Injury or mortality of juvenile salmonids, and green sturgeon, could occur, if individuals are unable to readily move away from channel or nearshore areas directly affected by construction activities. Accidental discharge of toxic substances during construction could cause physiological impairment or mortality of listed fish and other aquatic species at or immediately downstream of project sites. Other potential stressors include noise, suspended sediment, turbidity, and sediment deposition generated during in-water construction activities. These effects could also occur in areas downstream of project sites, because noise and sediment may be propagated downstream. Restricting in-water activities to the August 1 through November 30 work window, and implementing BMPs, will minimize the potential for adverse effects.

Long-term project effects on the habitat of listed fish species include instream and overhead cover, and substrate conditions along the seasonal low- and high-flow shorelines of the erosion sites. Implementation of the project will result in temporary losses of instream structure and riparian

vegetation along the summer-fall and winter-spring shorelines and will also limit long-term fluvial functioning necessary for the development and renewal of SRA habitat in the future.

Initial cover losses due to project actions will be partially offset by installing riparian plantings and native grasses along the lower slopes. These features will increase the availability of high quality shallow water habitat for juvenile Chinook salmon and steelhead, and possibly juvenile green sturgeon during the annual high-flow period (late fall, winter, and spring). Because we will not be removing any trees on the lower one-third of the waterside of the levees in the Sacramento River area, SRA will not be compromised thus maximizing existing SRA values in the action area. The establishment and growth of planted riparian vegetation is expected to increase habitat values over time by increasing the extent of overhead cover available to listed fish species.

These features will increase the availability of high quality shallow water habitat for juvenile Chinook salmon and steelhead, incubating delta smelt, and possibly juvenile green sturgeon during the annual high-flow period (late fall, winter, and spring). Because we will not be removing any trees on the lower one-third of the waterside of the levees in the Sacramento River area, SRA will not be compromised thus maximizing existing SRA values in the action area. The establishment and growth of planted riparian vegetation is expected to increase habitat values over time by increasing the extent of overhead cover available to listed fish species.

In consideration of the above information, the project actions are not likely to result in long-term habitat losses to Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, delta smelt, and green sturgeon as long as the applicable mitigation and compensation measures are implemented. This conclusion is based on the Corps' commitment to: (1) minimize temporary habitat losses through the incorporation of on-site mitigation features (e.g., vegetated riparian and wetland benches, riparian plantings, and no planned tree removal) in the project area measures; and (2) implementation of off-site habitat compensation measures (e.g., riparian planting, rock removal) prior to or concurrent with project construction. However, project actions may adversely affect these focus species due to: (1) incidental take during construction and; (2) fragmentation of existing natural bank habitats due to the placement of revetment; and (3) the potential loss of long-term fluvial functioning necessary for the development and renewal of shaded riverine aquatic habitat.

Determinations

Section 7 of the Endangered Species Act requires that Federal agencies ensure, in consultation with the U.S. Fish and Wildlife Service, that any action they authorize, fund, or carry out is not likely to result in the destruction or adverse modification of critical habitat. Effects to critical habitat are discussed for each fish species in Section 5.2. Based on those assessments, project actions:

- May affect, likely to adversely affect designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Green sturgeon;
- May affect, likely to adversely affect designated critical habitat for delta smelt within the ARCF GRR project area which includes the Sacramento River upstream to approximately RM 60 (U.S. Fish and Wildlife Service 2003a).

5.9.3 Giant Garter Snake

To minimize the potential for adverse effects on GGS in the Sacramento Bypass, GGS habitat will be designated as an environmentally sensitive area delineated with signs or fencing, and if possible, avoided by all construction personnel. Additional measures and habitat compensation as outlined in Section 2.5.3 will also be implemented to avoid and minimize potential temporary effects to GGS during construction. There would be approximately 15 acres of GGS aquatic habitat permanently removed due to removal of the drainage canals within the widened bypass. Compensation for this loss would occur in accordance with the measures discussed in Section 2.5.3. Temporary effects during construction would disturb approximately 30 acres of upland GGS habitat for one construction season. Compensation for these temporary impacts would occur in accordance with the measures discussed in Section 2.5.3.

In consideration of the above information, the project actions are unlikely to result in long-term habitat losses to the giant garter snake, as long as the applicable mitigation and compensation measures are implemented. However, even with on-site mitigation and off-site compensation, the project actions may adversely affect giant garter snakes due to: (1) take during construction and O&M activities; and (2) habitat fragmentation. Ground disturbing activities at NSS Borrow Site 2 could result in direct displacement, injury, or death of snakes. These effects, which could affect the ability of snakes to conduct essential life history functions, such as dispersal, movement, or foraging, would be temporary (occurring during one active season). Construction activities could temporarily degrade aquatic habitat, but the overall result of implementing the proposed site restoration at Borrow Site 2 would be an enhancement of habitat quality.

5.9.4 Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp

Approximately 0.25-acre of vernal pool habitat has the potential to be indirectly impacted by project construction near Magpie Creek. The Corps proposes to either purchase 1 acre of credits at a mitigation bank, or compensate for the loss of 1 acre of habit through enhancement of the habitat in the 79 acres of land being acquired under this project as a flood overflow area. The project actions are unlikely to result in long-term habitat losses to the vernal pool fairy shrimp and vernal pool tadpole shrimp, with the implementation of the mitigation and compensation measures proposed. As a result,

the project actions may affect, but are not likely to adversely affect the vernal pool fairy shrimp and vernal pool tadpole shrimp.

5.9.5 Western Yellow-billed Cuckoo

Potential long-term effects to the cuckoo could result from the loss of 175 acres of riparian habitat. However, this long term effect would be significantly reduced with the receipt of a vegetation variance and implementation of the SWIF. There would remain a significant temporal loss of riparian habitat for the cuckoo during their migration, however in time it is anticipated that the riparian corridor would recover with the implementation of the compensation proposed by the Corps. While the removal of trees from the construction footprint is a significant effect, the majority of the trees within the cuckoo's migration corridor would not be impacted by construction activities, particularly within the American River Parkway. In the Parkway, the maximum footprint of impact would be 65 feet from the levee toe, while portions of the Parkway include a corridor of150 to 500 feet wide. As a result, the long-term effect of the removal of riparian vegetation may affect, but is not likely to adversely affect the western yellow-billed cuckoo.

5.10 Effects of the Proposed Action on Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 et seq.), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans. Federal action agencies must consult with NMFS on any activity that they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH of Pacific salmon pursuant to Section 305 (b) (2) of the MSA appropriate determinations for EFH as either; (1) will not adversely effect, or (2) may adversely affect. Important components of EFH for Chinook salmon spawning, rearing, and migration include:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
    a) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
    b) Water quality and forage supporting juvenile development; and
    c) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction and excessive predation with:
    a) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
    b) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and
    c) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The ARCF GRR includes habitat on the Sacramento River, American River, and the Sacramento Bypass that have been designated as EFH for Chinook salmon, a major contributor to Pacific Coast salmon fisheries. The Pacific Coast salmon fishery EFH extends along the Pacific Coast from Washington to Point Conception in California. Freshwater EFH includes all habitats currently and historically accessible to salmon and is based on descriptions of habitat used by coho and Chinook salmon. The EFH excludes areas above naturally occurring barriers such as waterfalls, which have been present for several hundred years, and impassible dams identified on large rivers (NMFS 1997). The following analysis of EFH does not include effects to the fish species, just the species habitat as defined in the MSA. Results for the effects of EFH for winter-run, spring-run, and fall/late-fall-run Chinook salmon in the ARCF GRR action area were based on the SAM analysis detailed in Appendix B.

5.10.1 Effects of the Proposed Action on EFH

Site specific project designs were unavailable for the ARCF GRR project reach at the time of this SAM analysis. The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the ARCF GRR project area under existing or pre-project conditions:

- The Corps' Sacramento River revetment database – This database was used to stratify the project reach into subreaches that encompass relatively uniform bank conditions based on their general physical characteristics (USACE 2007). This database was used to characterize existing habitat conditions within individual subreaches where more recent data were unavailable.
- Aerial images of the ARCF GRR project reach (Google™ Earth), provided current and historical images of bank conditions that were used to address gaps or uncertainties related to existing cover characteristics within individual subreaches.

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of the winter-run, spring-run, and fall/late-fall-run Chinook species:

- Bank slope—average bank slope of each average seasonal water surface elevation;
- Floodplain availability—ratio of wetted channel and floodplain area during the 2-year flood, to the wetted channel area during average winter and spring flows;
- Bank substrate size—the median particle diameter of the bank (i.e., D50) along each average seasonal water surface elevation;
- Instream structure—percent of shoreline coverage of instream woody material along each average seasonal water surface elevation;
- Aquatic vegetation—percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation; and
- Overhanging shade—percent of the shoreline coverage of shade along each average seasonal water surface elevation.

Sacramento River SAM EFH Analysis

The Sacramento River SAM analysis reach includes the entire left bank (east side) of the Sacramento River from the American River confluence to approximately 4,020 linear feet (lf) below the Freeport Bridge.

Short Term

Short term construction activities may adversely affect Chinook EFH. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions most positively associated with fry and juvenile rearing and migration.

Long Term

Long term construction actions will not adversely affect EFH on the Sacramento River portion of the ARCF GRR action area. EFH is expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Positive EFH response would be most likely associated with long term growth of SRA (overhanging shade) and aquatic vegetation.

American River SAM EFH Analysis

The American River SAM analysis (ARN A-B and ARS A-C) reaches include portions of the right and left bank of the American River from Goethe Park to the confluence of the Sacramento. It also includes portions of NEMDC, Arcade Creek, Magpie Creek, and Dry/Robla Creek.

Short Term

Short term construction activities may adversely affect Chinook EFH. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions most positively associated with fry and juvenile rearing and migration.

Long Term

Long term construction actions will not adversely affect EFH on the Sacramento River portion of the ARCF GRR action area. EFH is expected to show a long term positive response to project actions in the American River SAM (Appendix B) analysis reach over the lifetime of the project. Positive EFH response would be most likely associated with long term growth of SRA (overhanging shade) and aquatic vegetation.

Sacramento Bypass SAM EFH Analysis

The Sacramento Bypass SAM analysis reach includes the right bank (north side) of the Sacramento Bypass levee in its entirety from the confluence of the Sacramento River to its termination at the Yolo Bypass.

Short Term

Short term construction activities may adversely affect Chinook EFH. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at the portion of the Sacramento Bypass associated with the removal of the SRA habitat to allow expansion of the Sacramento Bypass Weir. There is no planned vegetation removal for the levee widening.

Long Term

Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a negative response by year 1. The maximum habitat deficit identified is -188 ft for the juvenile migration life stage of spring-run and winter-run Chinook salmon in the spring of year 2. Long term habitat deficits would be associated with the permanent removal of SRA habitat for the expansion of the weir portion of the project not the levee portion.

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Appendix A

Species Lists

U.S. Fish & Wildlife Service
Sacramento Fish & Wildlife Office

Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 141222022932

Current as of: December 22, 2014

Quad Lists

CLARKSBURG (497A)

Listed Species

Invertebrates

Branchinecta conservatio
- Conservancy fairy shrimp (E)

Branchinecta lynchi
- vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
- valley elderberry longhorn beetle (T)

Lepidurus packardi
- vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
- green sturgeon (T) (NMFS)

Hypomesus transpacificus
- Critical habitat, delta smelt (X)
- delta smelt (T)

Oncorhynchus mykiss
- Central Valley steelhead (T) (NMFS)
- Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
- Central Valley spring-run chinook salmon (T) (NMFS)
- Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
- Critical habitat, winter-run chinook salmon (X) (NMFS)
- winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
- California tiger salamander, central population (T)

Rana draytonii
- California red-legged frog (T)

Reptiles

Thamnophis gigas
- giant garter snake (T)

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (T)

RIO LINDA (512B)
Listed Species

Invertebrates
Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish
Hypomesus transpacificus
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians
Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles
Thamnophis gigas
giant garter snake (T)

SACRAMENTO EAST (512C)
Listed Species

Invertebrates
Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
Critical habitat, valley elderberry longhorn beetle (X)
valley elderberry longhorn beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish
Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (T)

SACRAMENTO WEST (513D)

Listed Species

Invertebrates

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (T)

Vireo bellii pusillus
Least Bell's vireo (E)

County Lists

No county species lists requested.

Key:

(E) *Endangered* - Listed as being in danger of extinction.

(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.

(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.

(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.

Critical Habitat - Area essential to the conservation of a species.

(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.

(C) *Candidate* - Candidate to become a proposed species.

(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.

(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be

found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be March 22, 2015.

Appendix B

American River Common Features GRR SAM Analysis

American River Common Features
General Reevaluation Report

Standard Assessment Methodology Analysis

July 2015

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1.0 Introduction

This document provides the background data and assumptions for the Standard Assessment Methodology (SAM) effects analysis of the American River Common Features General Reevaluation Report (ARCF GRR) project on the following focus fish species (Table 1).

Table 1. ARCF GRR Project Focus Fish Species.

Species/ESUs	Federal Status
Chinook salmon (*Oncorhynchus tshawytscha*)	
Central Valley spring-run ESU	Threatened
Central Valley fall-run ESU	Species of concern
Central Valley late fall-run ESU	Species of concern
Sacramento River winter-run ESU	Endangered
Central Valley steelhead DPS (*Oncorhynchus mykiss*)	Threatened
green sturgeon (*Acipenser medirostris*)	Threatened

1.1 Background

The U.S. Army Corps of Engineers (Corps) initiated formal Section 7 consultation with the National Marine Fisheries Service (NMFS) for the ARCF GRR on June 27, 2014. The original SAM analysis included in the Section 7 consultation for the ARCF GRR was determined to be insufficient in detail. Through internal discussions and interagency coordination with the NMFS, a revised set of parameters was developed to better assess the project's impact on focus fish species and their habitat. This report documents and provides justification for the revised SAM analysis and should replace the analysis included in the original Biological Assessment (BA) Appendix B.

1.2 SAM Modeling Approach

Long-term effects of the ARCF GRR project on focus fish species and their habitat were estimated using the SAM. The SAM computations were performed using the SAM Electronic Calculation Template (ECT) Version 4.0 (April 2012) developed by the Corps and Stillwater Sciences, in consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife Service (CDFW), and California Department of Water Resources (DWR), academic contributions from the University of California at Davis and Humboldt State University, and peer reviewed by sixteen professionals in fish biology, river geomorphology, environmental sciences, and engineering (USACE 2012). The SAM allows agencies to quantitatively assess the potential effects of bank protection and stream restoration projects to ensure that these activities do not jeopardize Chinook salmon, steelhead, and green sturgeon, or destroy or adversely modify their critical habitat. The

SAM can also determine suitable compensation for habitat loss, by evaluating the benefits of certain design features (e.g., planted emergent vegetation) to target fish species.

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of listed fish species:

- *bank slope*—average bank slope of each average seasonal water surface elevation;
- *floodplain availability—ratio of wetted channel and floodplain area during the 2-year flood, to the wetted channel area during average winter and spring flows;*
- *bank substrate size—the median particle diameter of the bank (i.e., D50) along each average seasonal water surface elevation;*
- *instream structure*—percent of shoreline coverage of instream woody material along each average seasonal water surface elevation;
- *aquatic vegetation*—percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation; and
- *overhanging shade*—percent of the shoreline coverage of shade along each average seasonal water surface elevation.

The SAM does not directly model changes in the above variables. Instead, habitat changes are estimated separately by the user and entered into an input data file to an electronic calculation template (ECT) developed within an MS Access database to track species responses to project actions over time. Changes in habitat variables may be fixed in time, such as installation of revetment at a particular slope and substrate size. In other circumstances, habitat evolution over time may be represented by more gradual changes in variables such as changes in floodplain inundation due to meander migration or changes in shade due to growth of planted vegetation. Typically, habitat evolution modeling is restricted to shade estimates from riparian growth models, but the SAM accommodates any number of other habitat modeling approaches such as meander migration modeling or large woody debris recruitment modeling.

Once a particular time series of habitat variable estimates is developed and entered into an ECT input file fish responses are calculated using previously developed relationships between habitat variables and species/life stage responses (USACE 2012). The response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (e.g., with- or without-project), the ECT uses these relationships to determine the responses of individual species and life stages to the measured or predicted values of each variable, for each season and target year; the ECT then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear distance or area of bank to which it applies; the product is then integrated through time, generating a weighted species response index (WRI expressed as ft or ft^2) in each year of the analysis. The WRI

provides a common metric that can be used to quantify habitat values over time, compare project designs to existing conditions, and evaluate the effectiveness of on-site and off-site habitat compensation actions.

2.0 Habitat Analysis

Following procedures described in the SAM (USACE 2012), construction activities at each site were translated into habitat variables for pre-project and with project conditions in each of four seasons using available data sources. The relevant habitat conditions to encode the conceptual response models for the focus fish species from the present to the future (t = 0, 1, 5, 15, 25, and 50 yrs), and under pre-project and with-project conditions are described below. Revisions to the original SAM analysis are summarized in the discussion.

2.1 Project Description

The ARCF GRR project tentatively selected plan – Alternative 2 – Sacramento Bypass and Improve Levees, involves the construction of fix-in-place levee remediation measures along the Sacramento River, American River, and north side tributaries as well as widening of the Sacramento Weir and Bypass. Proposed repair actions for each waterway are presented below (Table 2). This SDAM analysis groups project actions into 4 SAM reaches based on hydrologic connectivity: American River North (ARN_AB), American River South (ARS_ABC), Sacramento River South (ARS_DEFG), and the Sacramento Bypass (SBP).

2.1.1 Sacramento River

The levees along the Sacramento River under Alternative 2 would be improved to address identified seepage, stability, erosion, and a minimal amount of height concerns. Most height concerns along the Sacramento River would be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass.

2.1.2 American River

Levees along the American River under Alternative 2 require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion to the river bank and levee, which could potentially undermine the levee foundation. There are two measures proposed for the American River levees: (1) bank protection, and (2) launchable rock trench. Both of these measures are described in detail in the BA.

2.1.3 East Side Tributaries

Natomas East Main Drain Canal (NEMDC) requires improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A conventional open trench cutoff wall would be constructed at these locations to address the seepage and stability problems. The NEMDC east levee also has height issues which will be addressed with construction of a new floodwall. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction.

We will be doing no in-water work on NEMDC under the Alternative 2 scenario and after consultation with NMFS, NEMDC was left out of the SAM analyses.

2.1.4 Sacramento Weir and Bypass

Under Alternative 2, the width of the Sacramento Weir and Bypass would be roughly doubled to accommodate increased bypass flows. The expanded Sacramento Weir and Bypass would generally result in an additional 25,000 cfs flow during high water conditions. The frequency of water diversion is expected to be the same, which is to use the current Sacramento Weir operation based on a stream gage at the I Street Bridge (Schlunegger 2014). Under normal flow conditions the Sacramento Weir and Bypass would be operating at pre-existing conditions described in detail in the ARCF GRR biological assessment (USACE 2014). Implementation of this action would result in the degradation of the existing north levee of the Sacramento Bypass and construction of a new levee approximately 1,500 feet to the north. The existing Sacramento Weir would be expanded to match the wider bypass. At this time, it is not known whether the new segment of weir would be constructed consistent with the 1916 design described above, or whether it would be designed to be a gravity-type weir. The new north levee of the bypass would be designed to be consistent with the existing Sacramento Bypass north levee, however, it would also include a 300-foot-wide seepage berm on the landside with a system of relief wells.

Table 2. ARCF GRR Project Alternative 2 – Proposed Remediation Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall	Bank Protection	Sacramento Bypass and Weir Widening, Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall
Arcade Creek	Cutoff Wall	Cutoff Wall	---	Floodwall
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek[2]	---	---	---	Floodwall, Levee Raise

[1]American River seepage, stability, and overtopping measures were addressed in the American River Common Features, WRDA 1996 and 1999 construction projects.
[2]In addition to the Floodwall, Magpie Creek will include construction of a new levee along Raley Boulevard south of the creek, and construction of a detention basin on both sides of Raley Boulevard. In addition, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek Bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

2.1.5 Construction Schedule

The ARCF GRR project reach will be implemented in increments. The timing of each project reach (Table 3) is based on the proposed schedule provided in the Biological Assessment: American River Common Features General Reevaluation Report (USACE 2014).

Table 3. Tentative Construction Schedule for the Recommended Plan.

PRIORITY	WATERWAY	REACH[1]	YEAR OF PROJECT CONSTRUCTION												
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	Sacramento River	ARS F													
2	Sacramento River	ARS E													
3	American River	ARS A													
4	Sacramento River	ARS G													
5	Sacramento River	ARS D													
6	American River	ARS B													
7	American River	ARN A													
8	American River	ARS C													
9	American River	ARN B													
10	Sacramento Weir & Bypass	--													
11	Arcade Creek	ARN D													
12	NEMDC	ARN F													
13	Arcade Creek	ARN E													
14	NEMDC	ARN C													
15	Dry/Robla Creek	ARN G													
16	Magpie Creek	ARN I													

2.1.6 Vegetation on Levees

Compliance with Engineering Technical Letter 1110-2-571 (ETL) vegetation requires implementation of a vegetation-free zone within 15 ft of the waterside and landside toes of a levee. The levees along the Sacramento and American rivers were often set close to the river which has resulted in limited riparian vegetation in the project reach. The Corps is seeking a variance from the ETL vegetation requirements along the Sacramento River and American River portions of this project. This SAM analysis assumes that a Vegetation Variance Request (VVR) was assumed to be in place for the Sacramento and American River reaches. The Corps will obtain an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The Corps will be complying with the ETL on the American River via a System Wide Implementation Framework (SWIF). The VVR is not assumed to apply to the SBP.

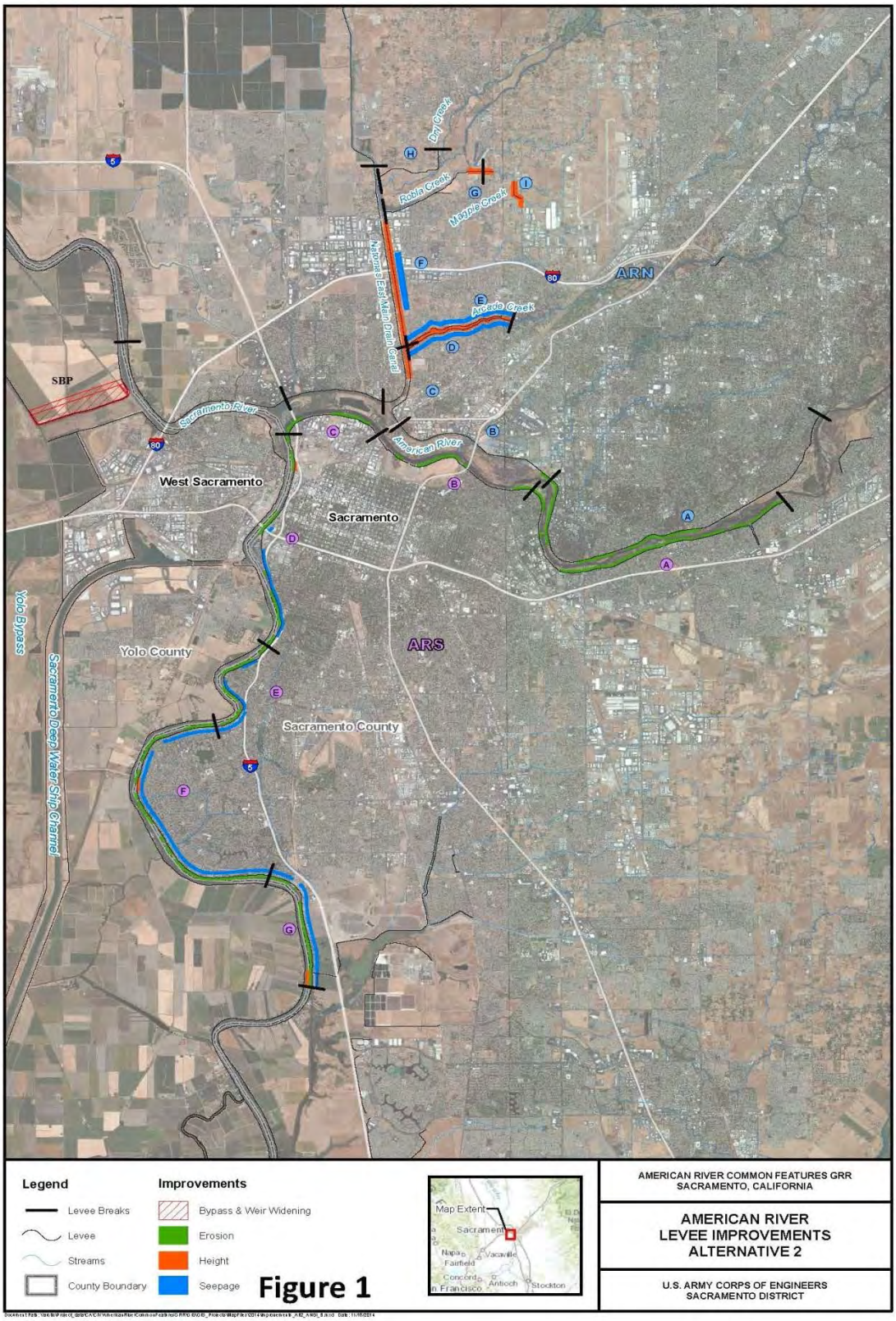


Figure 1. ARCF GRR Study Area with Reach Identification.

2.2 Characterization of Existing Conditions

The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the ARCF GRR project area under existing or pre-project conditions.

Sacramento River Revetment Database – This database was used to stratify the project reach into subreaches that encompass relatively uniform bank conditions based on their general physical characteristics (USACE 2007). This database was used to characterize existing habitat conditions within individual reaches where more recent data were unavailable.

Aerial images of the ARCF GRR project reach (Google™ Earth Pro), provided current and historical images of bank conditions that were used to address gaps or uncertainties related to existing cover characteristics within individual subreaches.

The following describes how input values for each of these attributes were derived for existing conditions in the SAM assessment. Specific input values for each site can be seen below at the end of report in (Tables 6-25).

2.2.1 Bank Slope

In the SAM, bank slope serves as an indicator of the availability of shallow-water habitat and is obtained from point estimates of bank slope (horizontal change to vertical change, dW:dH) along each seasonal shoreline (i.e., the line where the water surface intersects the bank on average fall, winter, spring, and summer) (USACE 2012). Existing bank slopes were extrapolated from cross sections along the Sacramento River, American River, and existing SAM analyses performed on regionally analogous sites. Bank slope along all reaches was assumed to be 2 for existing conditions.

2.2.2 Floodplain Availability

In the SAM, floodplain habitat availability is considered important for juvenile life stages and is defined by areas that are flooded by the 2-year flood event (Q2) and measured by calculating a Floodplain Inundation Ratio (USACE 2012). This ratio is calculated by dividing the wetted channel and inundated floodplain areas during the 2- year flood event (AQ2) by the wetted channel area (AQavg) during average winter and spring flows. The amount of available floodplain habitat is consequently proportional to the ratio's positive deviation from unity (i.e., values greater than 1) (USACE 2012).

In this SAM analysis, it was assumed that the with-project floodplain inundation ratios would be the same as pre-project values, which is consistent with assumptions made during the pre-construction SAM analyses. As a result, no impacts to habitat quality at the ARCF GRR reaches are expected with respect to this habitat variable.

2.2.3 Bank Substrate Size

The median substrate size (D_{50}) along the summer-fall and winter-spring shorelines of the project reach was determined through by referencing the Revetment Database (USACE 2007) and current and historical aerial images. Based on previous analysis of Sacramento River Bank Protection Project (SRBPP) sites (USACE 2008, USACE 2013) sections of shoreline with natural substrate were assigned a D_{50} of 0.25 inches. Sections of shoreline with rock revetment were assigned a D_{50} of 10 inches.

2.2.4 Instream Structure

The shoreline coverage of Instream Woody Material (IWM) along the average summer-fall and winter-spring shorelines of the ARCF GRR project reach were determined by referencing the revetment database (USACE 2007). The revetment database uses four classes of instream structure, based on ranges of percent shoreline having IWM. Table 4 indicates how these revetment database attribute values were converted to a single value for input to SAM. These values were assumed to be appropriate for both the summer-fall and winter-spring seasons. For sub-reaches without available data, an estimate was based on shoreline conditions assessed from aerial images. Shorelines with dense riparian canopy were assigned 5% shoreline coverage of IWM. Shorelines without dense riparian canopy were assigned 0% shoreline coverage of IWM.

Table 4. Conversion of Revetment Database Instream Woody Material Classes to SAM Attribute Value for Instream Structure.

Revetment Database IWM Class	SAM Input Value
None	0%
1 - 10%	5%
11 - 50%	30%
> 50%	75%

2.2.5 Aquatic Vegetation

The revetment database attribute for Emergent Vegetation was used for summer-fall aquatic vegetation characterization, and the Ground Cover attribute was used for winter-spring characterization. Within the ARCF GRR project reaches, this approach generally gave a vegetation value of zero for summer-fall conditions, which is appropriate given the scarcity of emergent aquatic vegetation. Table 5 summarizes the conversion of revetment database attribute values for input to the SAM analysis.

Table 5. Conversion of Revetment Database Emergent Vegetation and Ground Cover Classes to SAM Attribute Values for Vegetation.

	Revetment Database IWM Class	SAM Input Value
Summer and Fall	False	0%
Revetment Database:	PEM 1 - 5%	3%
"Emergent Vegetation" Attribute	PEM 6 - 25%	15%
	PEM 26 – 75%	50%
	PEM >75%	85%
Winter and Spring	<25%	13%
Revetment Database:	26-50%	38%
"Ground Cover" Attribute	51-75%	63%
	>75%	88%

2.2.6 Overhanging Shade

The extent of overhanging shade along the summer-fall and winter-spring shorelines was determined through analysis of current and historic aerial images. Summer-fall conditions were analyzed using imagery from late summer and early fall months, typically representative of low water conditions. Winter-spring conditions were analyzed using imagery from late winter and early spring months, typically representative of high water conditions. Values for overhanging shade at winter and spring habitat conditions were modified by factors of 0.25 and 0.75 respectively to account for seasonal defoliation.

2.3 Characterization of With-Project Conditions

The with-project conditions were characterized using the project description outlined for Alternative 2 in the ARCF GRR BA. This analysis was conducted at a feasibility level of design; specific project designs will be developed under a Planning and Engineering Design phase. In the absence of more specific designs, this SAM analysis was developed using a set of "reasonable worst-case"

parameters. The parameters were developed by evaluating the applicability of past levee repair designs to the project reach. Past levee repairs were conducted under the Sacramento River Bank Protection Project (SRBPP) within each of the sub-reaches (USACE 2008, USACE 2013). Applicability of design features was evaluated using the professional judgment and experience of the project team. In cases where the applicability of a particular design feature for a particular reach was in question, the analysis erred on the side of caution and applied reduced values or omitted the feature from final analysis. The set of reasonable worst-case parameters is designed to provide a maximum estimation of impact for the purpose of consultation at feasibility planning level. A Vegetation Variance Request (VVR) was assumed to be in place for the Sacramento and American River reaches. The Corps will obtain an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The Corps will be complying with the ETL on the American River via a SWIF. The VVR is not assumed to apply to the SBP. Specific habitat attributes are provided by site in (Tables 6-25) and specific justifications for each variable is also provided in those tables.

The following describes how input values for each of the SAM habitat attributes were derived for with-project conditions:

2.3.1 Bank Slope

In the SAM, bank slope serves as an indicator of the availability of shallow-water habitat and is obtained from point estimates of bank slope (horizontal change to vertical change, dW:dH) along each seasonal shoreline (i.e., the line where the water surface intersects the bank on average fall, winter, spring, and summer) (USACE 2004). With-project bank slopes were based on the description of project actions for each reach. Bank slopes for the Sacramento and American River reaches were assumed to be analogous to associated SRBPP repair sites that were in close proximity to the reach being analyzed. Consequently, bank slopes with a summer-fall slope of 3 and winter-spring slope of 10 were used.

2.3.2 Floodplain Availability

The with-project floodplain inundation ratios used in this SAM analysis remained unchanged from existing conditions. Levee repair and bank stabilization actions typically do not increase floodplain availability (with exception of constructing setback levees). In the absence of levee setback actions, the amount of available floodplain areas and channel cross sections would not be greatly altered during levee repair activities.

In this SAM analysis, it was assumed that the with-project floodplain inundation ratios would be the same as pre-project values. As a result, no impacts to habitat quality at the ARCF GRR reaches are expected with respect to this habitat variable.

2.3.3 Bank Substrate Size

The median substrate size (D_{50}) along the summer-fall and winter-spring shorelines of the project reach were based on the description of project actions for each sub-reach. Bank substrate size along the American River sub-reaches were assumed to be 18 inch rock revetment at summer-fall shoreline and 0.25 inch natural substrate at winter-spring shoreline. Bank substrate size along the Sacramento River sub-reaches were assumed to be 12 inch rock revetment at summer-fall shoreline and 0.25 inch natural substrate at winter-spring shoreline.

2.3.4 Instream Structure

The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines was based on the description of project actions for each reach. In the SAM analysis, IWM coverage along the Sacramento and American River reaches were assumed to include installation of 40% shoreline coverage at summer-fall and winter-spring shoreline conditions.

2.3.5 Aquatic Vegetation

The shoreline coverage of aquatic vegetation along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Aquatic vegetation along the Sacramento and American River sub-reaches were assumed to be analogous to SRBPP repair sites. The vegetation growth models below applied to the Sacramento and American River sub-reaches were taken from previous SAM analysis'. For the American River (ARN_AB, ARS_ABC) four previously constructed SRBPP sites within the ARCF GRR project area were used for analysis (LAR 0.3L, LAR 2.8L, LAR 10.0L, and LAR 10.6L)(USACE, 2013). For the Sacramento River 15 previously constructed SRBPP sites within the ARCF GRR project area were used for analysis (SAC 49.7L, SAC 52.3L, and SAC 53.5R)(USACE 2013) and (RM 47.0L, RM 47.9R, RM 48.2R, RM 49.6R, RM 49.9L, RM 50.2L, RM 50.4L, RM 50.8L, RM 51.5 L, RM 52.4L, RM 53.1L, and RM 56.7L)(USACE 2008). Relevant O&M activities were considered but excluded from this analysis. The assumed vegetation variance would apply to woody vegetation only and O&M activities would be expected to result in the removal of shrubs on the slope of the levee; however, it was assumed that typical SRBPP repair designs would locate the planted riparian bench at appropriate elevations and distance from the levee to allow for revegetation efforts. Any removal of shrubby vegetation as the result of O&M activities would take place on the upper slope of the levee and would not impact the habitat considered in a typical SAM analysis.

2.3.6 Overhanging Shade

The shoreline coverage of overhanging shade along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Overhanging shade along the Sacramento and American River sub-reaches were assumed to be analogous to SRBPP repair sites. It was assumed that a variance would be in place allowing for retention of woody vegetation along the lower 2/3 of the levee slope. As the result of constructing a planted bench, it was assumed that the with-project seasonal shoreline would be shifted away from the existing shade providing canopy. Under this assumption, existing summer-fall values for overhanging shade were taken as the starting point for with-project winter-spring conditions. The with-project winter-spring values were further reduced by 75% (winter) and 25% (spring) to account for defoliation. As a final step, these winter-spring values were reduced by 20% to account for trees removed for construction equipment access. With-project overhanging shade values were expected to start at 0% as the result of a constructed bench shifting the shoreline away from the existing canopy. The shade growth models below were applied to the starting seasonal values for overhanging shade described above along the Sacramento and American River sub-reaches. These shade growth models were taken from previous SRBPP SAM analysis' conducted within the ARCF GRR project area.

3.0 Results

The SAM results are presented as weighted response indices (WRI), that give a relative indication of fish response to a project action over time. A negative WRI can be interpreted as a reduction in habitat value and a positive WRI can be interpreted as a increase in habitat value Although the WRI values are not directly representative of actual lengths or areas, the resource agencies have used those values as proxies in determining mitigative requirements. Appropriate mitigation is typically determined by identifying the maximum negative WRI for critical life stages (spawning and egg incubation, fry and juvenile rearing, and juvenile migration) on a site-by-site basis. Therefore this section will present results with a focus on the identification of maximum negative WRIs.

As described above, the ARCF GRR project reaches were grouped into four SAM analysis reaches based on hydrologic connectivity. Results are presented below by reach and species and are summarized in tables 30-32 and figures 2-22 at the end of the document.

3.1 Sacramento River SAM Analysis (ARS_DEFG)

The Sacramento River SAM analysis reach includes the entire left bank (east side) of the Sacramento River from the American River confluence to approximately 4,020 linear feet (lf) below the Freeport Bridge. The response of all runs of Chinook salmon, steelhead, and green sturgeon to project actions were included in the analysis of this reach. The green sturgeon spawning and egg incubation life stage was excluded from the analysis because spawning does not occur in the project area.

3.1.1 Spring/ Fall/ Late-Fall/ Winter Run Chinook Salmon

Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a positive response by year 5 in the winter-spring when most juvenile Chinook salmon are expected in the ARCF GRR project area. Short term negative WRI are expected within the recommended recovery period for Chinook salmon. The maximum negative WRI identified is -4,258 ft for the juvenile migration life stage of Chinook salmon in the summer of year 9. Short term negative WRI values will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions. The SAM data iterations for the various life stages for Chinook salmon can be seen in (Table 28). The WRI response curves for juvenile migration and rearing can be located in (Figures 4 and 7). The NMFS SAM effects analysis summary tables can be seen in (Table 32).

3.1.2 Steelhead

Steelhead are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Steelhead should exhibit a positive response by year 4 in the winter-spring when most juvenile steelhead will be migrating and rearing through the project area. The maximum negative WRI identified is -3,985 ft for the juvenile migration life stage of steelhead in the fall of year 10. Short term negative WRI values will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions. The WRI response curves for juvenile migration and rearing can be located in (Figures 10 and 13).

3.1.3 Green Sturgeon

SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species. SAM WRI's for green sturgeon generally indicate a negative response or no response to typical onsite mitigative features. Green sturgeon are expected to show long term negative response to project actions in the Sacramento River SAM analysis reach for several life stages at all seasonal habitat conditions over the lifetime of the project. The maximum negative WRI identified is -5,009 for fry and juvenile rearing in the summer of year 1. Negative WRI displayed a general trend toward decreasing beyond the lifetime of the project for fry and juvenile rearing life stages. Negative WRI values for adult life stages will result from the creation of a 10:1 planted bench at winter/spring habitat conditions. The WRI response curves for juvenile rearing can be located in (Figure 16).

3.2 American River SAM Analysis (ARN_AB and ARS_ABC)

The American River SAM analysis reaches include portions of the right and left bank of the American River from Goethe Park to the confluence of the Sacramento. The response of spring and fall runs of Chinook salmon, steelhead, and green sturgeon were included in the analysis of these reaches. Additional seasonal fall run juvenile migration life stage analysis was conducted after consultation with NMFS. Green sturgeon analysis was also included because of critical habitat in the lowest sub-reach (ARS_C) of the American River project area.

3.2.1 Spring/ Fall Chinook Salmon

Chinook salmon are expected to show a long term positive response to project actions in the American River SAM analysis reaches over the lifetime of the project when both IWM and planted benches are incorporated into the with-project conditions. Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. The maximum negative WRI value identified for the American River SAM ARN_AB and ARS_ABC is -3,129 ft for the juvenile migration life stage of fall-run Chinook salmon in the summer

of year 1. Short term negative WRI values will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions. The SAM data iterations for the various life stages for Chinook salmon can be seen in (Tables 26-27). The WRI response curves for juvenile migration and rearing can be located in (Figures 2,3,5,and 6). Additional fall-run Chinook salmon juvenile migration life stages not normally set as default in SAM were included on the American River reaches per NMFS request.

3.2.2 Steelhead

Steelhead are expected to show a long term positive response to project actions in the American River SAM analysis reach over the lifetime of the project. Steelhead should exhibit a positive response by year 4. Short term habitat deficits are expected within the recommended recovery period for steelhead. The maximum negative WRI value identified for the American River SAM analysis is -3,061 ft for the adult residence life stage in the summer of year 1 (Figures 20 and 21). Short term negative WRI values will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions. The WRI response curves for juvenile migration and rearing can be located in (Figures 8,9,11, and 12).

3.2.3 Green Sturgeon

Project actions in the American River SAM analysis reach will mimic SRBPP repair site onsite mitigative features. SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species; green sturgeon will exhibit a negative response for juvenile rearing in the summer/fall to these onsite mitigative features. However, during the winter/spring green sturgeon juvenile rearing life stages will exhibit a positive response to these onsite mitigative features. The maximum negative WRI value identified is -7,118 ft for the fry and juvenile rearing life stage in the summer of year 1. The WRI response curves for juvenile rearing can be located in (Figures 14 and 15).

3.3 Sacramento Bypass and Weir SAM Analysis

The Sacramento Bypass SAM analysis reach includes the right bank (north side) of the Sacramento Bypass levee in its entirety from the confluence of the Sacramento River to its termination at the Yolo Bypass. The response of all runs of Chinook salmon, steelhead, and green sturgeon were included in the analysis of this reach.

3.3.1 Spring/ Fall/ Late-Fall/ Winter Run Chinook Salmon

Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a negative response by year 1. The maximum negative WRI value identified is -188 ft for the juvenile migration life stage of Spring and Winter-run Chinook salmon in the spring of year 2. Short term and long term negative WRI values will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir. The SAM data iterations for the various life stages for Chinook salmon can be seen in (Table 29). The NMFS SAM effects analysis summary tables can be seen in (Table 33).

3.3.2 Steelhead

Steelhead are also expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Steelhead should exhibit a negative response by year 1. The maximum negative WRI value identified is -174 ft for the juvenile migration life stage in the spring of year 2. Short term and long term negative WRI values will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir. The NMFS SAM effects analysis summary tables can be seen in (Table 33).

3.3.3 Green Sturgeon

Green Sturgeon are expected to show a long term positive response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project for the fry and juvenile rearing life stages in the winter/spring/summer/fall of year 1. The maximum negative WRI value identified is -8 ft for the adult residence life stage of green sturgeon in the winter/spring/summer of year 1 which carries over through the life of the project into year 50. The SAM data iterations for the various life stages for green sturgeon can be seen in (Table 29). The NMFS SAM effects analysis summary tables can be seen in (Table 33).

4.0 Discussion

The SAM analysis indicates that the project actions in the Sacramento River SAM analysis reach, American River SAM analysis reach, and the Sacramento Bypass SAM analysis reach would result in short and longer-term impacts for focus fish species. Impacts to Chinook salmon, Central Valley steelhead, and green sturgeon are generally the result of reduction in the available natural substrate, shade and the alteration of near-shore slope resulting from bank armoring. Long term recovery of onsite vegetation, addition of IWM, and retention of existing vegetation are all expected to minimize impact as well as contribute to long term gains in habitat value.

This SAM analysis employed a set of worst case scenario parameters developed to capture the maximum potential impacts of the project for the Section 7 consultation process. Future implementation of the project is expected to result in significantly lower impacts. Project actions along portions of the American River reach will likely not include bank armoring in their final design, which will significantly reduce estimated impacts to fish species. Additional mitigative design features or improved erosion repair designs may result in reduced impact compared to the legacy designs used for the basis of this analysis. Site specific designs will be implemented on a site by site basis in consultation with resource agencies and project partners to minimize impacts as well as maximize opportunities for implementing onsite mitigative features.

During project implementation, site specific SAM analyses will be run on final designs to better evaluate impact. SAM results will be used by the Corps and NMFS in the negotiation of appropriate mitigation for project actions. Although short term impacts are generally self mitigating through the development of onsite mitigative features, the Corps will compensate for the temporal impacts to habitat through the purchase of offsite mitigative credits. Typically appropriate mitigation will be based on the identification of maximum negative WRI values. By mitigating for the maximum negative WRI, lesser impacts are expected to be appropriately mitigated. As a general rule, the SAM applies any habitat characteristics at summer/fall conditions to winter/spring conditions with the assumption that those characteristics would provide similar value during inundation. Onsite mitigation at summer/fall conditions is expected to provide similar habitat benefit for winter/spring conditions. Offsite mitigation is expected to provide mitigative value at all seasonal habitat conditions. Longer term impacts to habitat may not recover to baseline conditions over the life of the project due to design restrictions. These impacts to habitat will be compensated through the purchase of offsite mitigative credits as well as the incorporation of additional onsite mitigative features (ie. low water plantings, additional IWM, additional revegetation).

Additional mitigative concerns, not considered in a SAM analysis, will be addressed along the Sacramento Bypass reach, including potential adult and juvenile passage issues, loss of shoreline riparian vs. gain in floodplain, and contradicting ESA species habitat requirements. These issues will be considered and appropriate actions will be taken where possible in coordination with other agencies.

4.1 Chinook Salmon

Impacts to Chinook salmon were analyzed for the Sacramento River SAM analysis reach (ARS_DEFG), American River SAM analysis reach (ARN_AB, ARS_ABC) and the Sacramento Bypass SAM analysis reach. In the Sacramento River SAM analysis reach, negative WRI values are due to short term removal of aquatic vegetation and overhanging shade caused by the repair action. The SAM analysis indicates that repair actions would result in a maximum negative WRI value of -4,258 ft. This value is based on the maximum negative WRI value observed for juvenile migration life stage of Chinook salmon in the summer of year 9. USACE will mitigate for -4,258 ft of equivalent habitat as described above in Section 4.0.

In the American River SAM analysis reaches ARN_AB and ARS_ABC negative WRI values are due to short term removal of aquatic vegetation and overhanging shade caused by the repair action. The SAM analysis incorporating planted benches and IWM indicates that repair actions would result in a maximum habitat deficit of -3,129 ft. This value is based on the maximum negative WRI value observed for the juvenile migration life stage of spring and fall-run Chinook salmon in the summer and fall of year 1. USACE will mitigate for -3,129 ft of equivalent habitat as described above in Section 4.0.

There were no initial construction impact negative WRI values for the juvenile rearing life stage of Chinook salmon in the winter and spring water levels on the American and Sacramento River reaches. A possible explanation is that the SAM ECT does not produce an output at Year-0. It does not calculate the difference from the baseline to with-Project results. SAM at Year-0 is zero. The relative response for Year-1 is actually the Year-0 results+Year-1 results divided by 2, see pages 5-29 to 5-31 in the SAM Certification Update for SAM formula detailed explanation. In Year-0 revetment will be added, vegetation will be removed and slope will have a positive change. In Year-1 IWM will be added, soil and planting on the bench will occur, and the VVR will kick in. Year-0 habitat deficits would be more than the Year-1 deficits where the positive and negative deficits are equal.

In the Sacramento Bypass SAM analysis reach negative WRI values are due to short and long term removal of aquatic vegetation and overhanging shade for the upstream extension of the Sacramento Bypass Weir. The SAM analysis indicates that repair and removal actions would result in a maximum negative WRI value of -146 ft. This value is based on the maximum negative WRI value observed for juvenile migration of Chinook salmon in the winter of year 1. USACE will mitigate for -146 ft of equivalent habitat as described above in Section 4.0.

4.2 Steelhead

Impacts to steelhead were analyzed for the Sacramento River SAM analysis reach, American River SAM analysis reach, and the Sacramento Bypass SAM analysis reach. The Sacramento River SAM analysis indicates that repair actions would result in maximum negative WRI values of -3,985 ft. This value is based on the maximum negative WRI value observed for the juvenile migration life stage of steelhead in the fall of year 10.

The American River SAM analysis ARN_AB and ARS_ABC indicates that repair actions would result in negative WRI values of -3,061 ft. This negative WRI is expected to be adequately compensated through mitigation of a greater negative WRI for Chinook salmon.

There were no initial construction impact negative WRI values for the juvenile rearing life stage of steelhead in the winter and spring water levels on the Sacramento River reaches. A possible explanation is that the SAM ECT does not produce an output at Year-0. It does not calculate the difference from the baseline to with-Project results. SAM at Year-0 is zero. The relative response for Year-1 is actually the Year-0 results+Year-1 results divided by 2, see pages 5-29 to 5-31 in the SAM Certification Update for SAM formula detailed explanation. In Year-0 revetment will be added, vegetation will be removed and slope will have a positive change. In Year-1 IWM will be added, soil and planting on the bench will occur, and the VVR will kick in. Year-0 habitat deficits would be more than the Year-1 habitat deficits where the positive and negative deficits are equal.

The Sacramento Bypass SAM analysis indicates that repair actions would result in maximum negative WRI values of -174 ft. This value is based on the maximum negative WRI value observed for the juvenile migration life stage of steelhead in the spring of year 4. This negative WRI is expected to be adequately compensated through mitigation of a greater negative WRI for Chinook salmon.

4.3 Green Sturgeon

Impacts to green sturgeon were analyzed for the Sacramento and American River SAM and Sacramento Bypass analysis reaches. Green sturgeon critical habitat in the American River extends from the confluence of the Sacramento River to the Highway 160 bridge (ARS_C). Additional SAM elements were incorporated to address potential green sturgeon effects in the American River reaches (ARN_AB and ARS_AB), as per NMFS request, even though use of these reaches by green sturgeon has not been documented. Recently a white sturgeon (161mm) was collected in a rotary screw trap (RST) by the U.S. Fish and Wildlife Service (USFWS) at the Watt Avenue bridge, the first such documented catch of a sturgeon since records have been kept dating back to approximately 1996. There have been no green sturgeon collected, and the correlation of green sturgeon presence to white sturgeon presence is not well understood for larval life stages in this region of the river. This additional analysis allowed for a more conservative estimate of impacts and may not necessarily reflect the true impacts from the project.

The habitat requirements of green sturgeon are not well understood; assumptions built into the SAM on fish response to shoreline features were based on limited information. Habitat use of the American River, Sacramento River, and Sacramento Bypass project reaches by green sturgeon are likely limited to use as a migration corridor by adults and potential rearing area by juvenile life stages. Although the SAM indicates negative response to habitat by adult life stages, it is unlikely that shoreline repair activities would significantly impact the river for residence or as a migration corridor. SRBPP style repairs are designed to mimic naturally occurring habitat types and are not expected to significantly alter the width of the river. USACE does not expect any significant impacts to the adult residence or adult migration life stages in the American or Sacramento River and does not propose any additional mitigation.

No suitable spawning habitat exists in the Sacramento River, American River, and Sacramento Bypass project reaches. Green sturgeon spawning with concurrent egg incubation and early life history primarily takes place upriver of Colusa on the Sacramento River and in the lower Feather River outside of the project area. Because no suitable spawning habitat is present in the project reaches under existing conditions, USACE does not expect any significant impacts to the spawning and egg incubation life stage of green sturgeon and does not propose any additional mitigation.

The American River SAM analysis ARN_AB and ARS_ABC indicates that repair actions would result in a maximum negative WRI values of -7,118 ft. for fry and juvenile rearing in the summer of year one. The Sacramento River SAM analysis ARS_DEFG indicates that repair actions would result in a maximum negative WRI values of -5,009 for fry and juvenile rearing in the summer of year one.

The Sacramento Bypass SAM analysis indicates that repair actions would result in maximum negative WRI values of -8 ft in response to the removal of aquatic vegetation and SRA for the expansion of the Sacramento Bypass and Weir. This value is based on the maximum negative WRI values observed for the adult residence life stage of green sturgeon in the winter/spring /summer of year 1 continuing through the life of the project to year 50.

Little is known about the fry and juvenile rearing and juvenile migration life stages of green sturgeon. The SAM does not evaluate response to specific habitat attributes for the juvenile migration life stage. For the purpose of this analysis it is assumed that these life stages exhibit similar responses to analogous life stages of Chinook and steelhead. This approach assumes that fry and juvenile rearing and juvenile migration life stages of green sturgeon will exhibit a positive response to “good riparian habitat” (i.e. increased shoreline coverage of overhanging shade, aquatic vegetation, and IWM). During the planning and design phase of the project, opportunities for the incorporation of additional onsite mitigative features will be evaluated in coordination with resource agencies to ensure the projected longer term impacts are appropriately compensated for green sturgeon. Potential onsite mitigative features include the planting of vegetation at the low water line, the incorporation of additional IWM, and limitations in instream revetment.

Table 6

SAM data summary of existing conditions at site Lower American River RM 10.0L and 10.6L (ARN_AB).

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2024	18,576	18,576	18,576	18,576
	2074	18,576	18,576	18,576	18,576
Bank Slope (dH:dV) [2]	2024	2	2	2	2
	2074	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	2.5	2.5	2.5	2.5
	2074	2.5	2.5	2.5	2.5
Instream Structure (% shoreline) [5]	2024	31	31	31	31
	2074	31	31	31	31
Vegetation (% shoreline) [6]	2024	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [7]	2024	60	15	45	60
	2074	60	15	45	60

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 2 SRBPP repair sites modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 7

SAM data summary of with-project conditions at site Lower American River RM 10.0L and 10.6L (ARN_AB).

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2024	18,576	18,576	18,576	18,576
	2074	18,576	18,576	18,576	18,576
Bank Slope (dH:dV) [2]	2024	2	3	3	3
	2025	3	10	10	3
	2074	3	10	10	3
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	2.5	18	18	18
	2025	18	0.25	0.25	18
	2074	18	0.25	0.25	18
Instream Structure (% shoreline) [5]	2024	31	0	0	0
	2025	40	40	40	40
	2074	40	40	40	40
Vegetation (% shoreline) [6]	2024	0	0	0	0
	2025	0	25	50	0
	2029	0	88	88	0
	2039	0	88	88	0
	2049	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [6]	2024	0	13	38	0
	2025	0	13	40	0
	2029	0	25	75	0
	2039	100	25	75	100
	2049	100	25	75	100
	2074	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 18 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee.

Table 8

SAM data summary of existing conditions at site Lower American River RM 10.0L and 10.6L (ARS_A).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2020	14,345	14,345	14,345	14,345
	2070	14,345	14,345	14,345	14,345
Bank Slope (dH:dV) [2]	2020	2.00	2.00	2.00	2.00
	2070	2.00	2.00	2.00	2.00
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	1.2	1.2	1.2	1.2
	2070	1.2	1.2	1.2	1.2
Instream Structure (% shoreline) [5]	2020	1.7	1.7	1.7	1.7
	2070	1.7	1.7	1.7	1.7
Vegetation (% shoreline) [6]	2020	0	63	63	0
	2070	0	63	63	0
Shade (% shoreline) [7]	2020	42	11	32	42
	2070	42	11	32	42

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

2 Existing slopes taken from 2 SRBPP repair sites modeled by SAM.

3 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.

4 Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D50 of 10 inches.

5 Instream Structure data taken from USACE Revetment Database (2007).

6 Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.

7 Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 9

SAM data summary of with-project conditions at site Lower American River RM 10.0L and 10.6L (ARS_A).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2020	14,345	14,345	14,345	14,345
	2070	14,345	14,345	14,345	14,345
Bank Slope (dH:dV) [2]	2020	2.0	3.0	3.0	3.0
	2021	3.0	10.0	10.0	3.0
	2070	3.0	10.0	10.0	3.0
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	1.2	18	18	18
	2021	18	0.25	0.25	18
	2070	18	0.25	0.25	18
Instream Structure (% shoreline) [5]	2020	1.7	0.0	0.0	0
	2021	40	40	40	40
	2070	40	40	40	40
Vegetation (% shoreline) [6]	2020	0	0	0	0
	2021	0	25	50	0
	2025	0	88	88	0
	2035	0	88	88	0
	2045	0	88	88	0
	2070	0	88	88	0
Shade (% shoreline) [6]	2020	0	9	27	0
	2021	0	9	29	0
	2025	0	24	74	0
	2035	100	25	75	100
	2045	100	25	75	100
	2070	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 18 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 10

SAM data summary of existing conditions at site Lower American River RM 2.8L (ARS_B).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2023	5,472	5,472	5,472	5,472
	2073	5,472	5,472	5,472	5,472
Bank Slope (dH:dV) [2]	2023	2	2	2	2
	2073	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2023	1	1	1	1
	2073	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2023	1.5	1.5	1.5	1.5
	2073	1.5	1.5	1.5	1.5
Instream Structure (% shoreline) [5]	2023	5	5	5	5
	2073	5	5	5	5
Vegetation (% shoreline) [6]	2023	0	65	65	0
	2073	0	65	65	0
Shade (% shoreline) [7]	2023	30	7	22	30
	2073	30	7	22	30

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
2 Existing slopes taken from 1 SRBPP repair site modeled by SAM.
3 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
4 Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D50 of 10 inches.
5 Instream Structure data taken from USACE Revetment Database (2007).
6 Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
7 Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 11

SAM data summary of with-project conditions at site Lower American River RM 2.8L (ARS_B).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2023	5,472	5,472	5,472	5,472
	2073	5,472	5,472	5,472	5,472
Bank Slope (dH:dV) [2]	2023	2	3	3	3
	2024	3	10	10	3
	2073	3	10	10	3
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2023	1	1	1	1
	2073	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2023	1.5	18	18	18
	2024	18	0.25	0.25	18
	2073	18	0.25	0.25	18
Instream Structure (% shoreline) [5]	2023	5	0	0	0
	2024	40	40	40	40
	2073	40	40	40	40
Vegetation (% shoreline) [6]	2023	0	0	0	0
	2024	0	25	50	0
	2028	0	88	88	0
	2038	0	88	88	0
	2048	0	88	88	0
	2073	0	88	88	0
Shade (% shoreline) [6]	2023	0	7	20	0
	2024	0	7	22	0
	2028	0	22	67	0
	2038	100	25	75	100
	2048	100	25	75	100
	2073	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

2 Assume no significant change to Bank Slope.

3 Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

4 Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

5 Assume installation of rock revetment at summer/fall (D50 of 18 in) and natural substrate at winter/spring (D50 of 0.25 in).

6 Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

6 Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 12

SAM data summary of existing conditions at site Lower American River RM 0.3L (ARS_C).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2026	3,988	3,988	3,988	3,988
	2076	3,988	3,988	3,988	3,988
Bank Slope (dH:dV) [2]	2026	2	2	2	2
	2076	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2026	1	1	1	1
	2076	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2026	0.25	0.25	0.25	0.25
	2076	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [5]	2026	5	5	5	5
	2076	5	5	5	5
Vegetation (% shoreline) [6]	2026	0	88	88	0
	2076	0	88	88	0
Shade (% shoreline) [7]	2026	67	16	50	67
	2076	67	16	50	67

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

2 Existing slopes taken from 1 SRBPP repair site modeled by SAM.

3 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.

4 Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D50 of 10 inches.

5 Instream Structure data taken from USACE Revetment Database (2007).

6 Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.

7 Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 13

SAM data summary of with-project conditions at site Lower American River RM 0.3L (ARS_C).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2026	3,988	3,988	3,988	3,988
	2076	3,988	3,988	3,988	3,988
Bank Slope (dH:dV) [2]	2026	2	3	3	3
	2027	3	10	10	3
	2076	3	10	10	3
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2026	1	1	1	1
	2076	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2026	0.25	18	18	18
	2027	18	0.25	0.25	18
	2076	18	0.25	0.25	18
Instream Structure (% shoreline) [5]	2026	5	0	0	0
	2027	40	40	40	40
	2076	40	40	40	40
Vegetation (% shoreline) [6]	2026	0	0	0	0
	2027	0	25	50	0
	2031	0	88	88	0
	2041	0	88	88	0
	2051	0	88	88	0
	2076	0	88	88	0
Shade (% shoreline) [6]	2026	0	14	42	0
	2027	0	14	44	0
	2031	0	25	75	0
	2041	100	25	75	100
	2051	100	25	75	100
	2076	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

2 Assume no significant change to Bank Slope.

3 Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

4 Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

5 Assume installation of rock revetment at summer/fall (D50 of 18 in) and natural substrate at winter/spring (D50 of 0.25 in).

6 Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

6 Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 14

SAM data summary of existing conditions at site Sacramento River RM 56.7L (ARS_D).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2025	9,131	9,131	9,131	9,131
	2075	9,131	9,131	9,131	9,131
Bank Slope (dH:dV) [2]	2025	1.8	1.8	1.8	1.8
	2075	1.8	1.8	1.8	1.8
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2025	1	1	1	1
	2075	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2025	7.6	7.6	7.6	7.6
	2075	7.6	7.6	7.6	7.6
Instream Structure (% shoreline) [5]	2025	22	22	22	22
	2075	22	22	22	22
Vegetation (% shoreline) [6]	2025	0	88	88	0
	2075	0	88	88	0
Shade (% shoreline) [7]	2025	40	10	30	40
	2075	40	10	30	40

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
2 Existing slopes taken from 1 SRBPP repair site modeled by SAM.
3 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
4 Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D50 of 10 inches.
5 Instream Structure data taken from USACE Revetment Database (2007).
6 Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
7 Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 15

SAM data summary of with-project conditions at site Sacramento River RM 56.7L (ARS_D).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2025	9,131	9,131	9,131	9,131
	2075	9,131	9,131	9,131	9,131
Bank Slope (dH:dV) [2]	2025	2.5	1.5	1.5	1.5
	2026	1.5	6.5	6.5	1.5
	2075	1.5	6.5	6.5	1.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2025	1	1	1	1
	2075	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2025	7.6	12	12	12
	2026	12	0.25	0.25	12
	2075	12	0.25	0.25	12
Instream Structure (% shoreline) [5]	2025	22	0	0	0
	2026	0	0	0	0
	2075	0	0	0	0
Vegetation (% shoreline) [6]	2025	0	0	0	0
	2026	0	0	0	0
	2030	10	60	60	10
	2040	10	88	88	10
	2050	10	88	88	10
	2075	10	88	88	10
Shade (% shoreline) [6]	2025	0	8	24	0
	2026	0	8	25	0
	2030	0	9	35	0
	2040	61	13	66	61
	2050	97	15	75	97
	2075	99	15	75	99

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

2 Assume no significant change to Bank Slope.

3 Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

4 Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

5 Assume installation of rock revetment at summer/fall (D50 of 12 in) and natural substrate at winter/spring (D50 of 0.25 in).

6 Assume no installation of shoreline coverage of IWM at summer/fall and winter/spring.

6 Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 16

SAM data summary of existing conditions at site Sacramento River RM 53.1L and RM 53.5R (ARS_E).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2021	9,149	9,149	9,149	9,149
	2071	9,149	9,149	9,149	9,149
Bank Slope (dH:dV) [2]	2021	1.7	1.7	1.7	1.7
	2071	1.7	1.7	1.7	1.7
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2021	1	1	1	1
	2071	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2021	7	7	7	7
	2071	7	7	7	7
Instream Structure (% shoreline) [5]	2021	30	30	30	30
	2071	30	30	30	30
Vegetation (% shoreline) [6]	2021	0	88	88	0
	2071	0	88	88	0
Shade (% shoreline) [7]	2021	60	15	45	60
	2071	60	15	45	60

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 2 SRBPP repair sites modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 17

SAM data summary of with-project conditions at site Sacramento River RM 53.1L and 53.5R (ARS_E).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2021	9,149	9,149	9,149	9,149
	2071	9,149	9,149	9,149	9,149
Bank Slope (dH:dV) [2]	2021	1.7	2	2	2
	2022	2	6	6	2
	2071	2	6	6	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2021	1	1	1	1
	2071	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2021	7	12	12	12
	2022	12	0.25	0.25	12
	2071	12	0.25	0.25	12
Instream Structure (% shoreline) [5]	2021	30	0	0	0
	2022	40	40	40	40
	2071	40	40	40	40
Vegetation (% shoreline) [6]	2021	0	0	0	0
	2022	0	50	50	0
	2026	0	88	88	0
	2036	0	88	88	0
	2046	0	88	88	0
	2071	0	88	88	0
Shade (% shoreline) [6]	2021	0	12	36	0
	2022	0	12	37	0
	2026	0	13	42	0
	2036	61	17	75	61
	2046	97	19	75	97
	2071	99	19	75	99

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 12 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 18

SAM data summary of existing conditions at site Sacramento River RM 48.2L-52.4L (ARS_F).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2020	21,379	21,379	21,379	21,379
	2070	21,379	21,379	21,379	21,379
Bank Slope (dH:dV) [2]	2020	1.8	1.8	1.8	1.8
	2070	1.8	1.8	1.8	1.8
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	8.7	8.7	8.7	8.7
	2070	8.7	8.7	8.7	8.7
Instream Structure (% shoreline) [5]	2020	17	17	17	17
	2070	17	17	17	17
Vegetation (% shoreline) [6]	2020	0	88	88	0
	2070	0	88	88	0
Shade (% shoreline) [7]	2020	73	18	54	73
	2070	73	18	54	73

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

2 Existing slopes taken from 10 SRBPP repair sites modeled by SAM.

3 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.

4 Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D50 of 10 inches.

5 Instream Structure data taken from USACE Revetment Database (2007).

6 Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.

7 Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 19

SAM data summary of with-project conditions at site Sacramento River RM 48.2L-52.4L (ARS_F).

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2020	21,379	21,379	21,379	21,379
	2070	21,379	21,379	21,379	21,379
Bank Slope (dH:dV) [2]	2020	1.8	2.0	2.0	2
	2021	2	6	6	2
	2070	2	6	6	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	8.7	12	12	12
	2021	12	0.25	0.25	12
	2070	12	0.25	0.25	12
Instream Structure (% shoreline) [5]	2020	17	0	0	0
	2021	40	40	40	40
	2070	40	40	40	40
Vegetation (% shoreline) [6]	2020	0	0	0	0
	2021	0	50	50	0
	2025	0	88	88	0
	2035	0	88	88	0
	2045	0	88	88	0
	2070	0	88	88	0
Shade (% shoreline) [6]	2020	0	14	43	0
	2021	0	14	44	0
	2025	0	15	54	0
	2035	61	19	75	61
	2045	97	21	75	97
	2070	99	21	75	99

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

2 Assume no significant change to Bank Slope.

3 Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

4 Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

5 Assume installation of rock revetment at summer/fall (D50 of 12 in) and natural substrate at winter/spring (D50 of 0.25 in).

6 Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

6 Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 20

SAM data summary of existing conditions at site Sacramento River RM 47.0L and 47.9R (ARS_G).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2024	11,066	11,066	11,066	11,066
	2074	11,066	11,066	11,066	11,066
Bank Slope (dH:dV) [2]	2024	2	2	2	2
	2074	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	9.40	9.40	9.40	9.40
	2074	9.40	9.40	9.40	9.40
Instream Structure (% shoreline) [5]	2024	5.5	5.5	5.5	5.5
	2074	5.5	5.5	5.5	5.5
Vegetation (% shoreline) [6]	2024	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [7]	2024	90	22	67	90
	2074	90	22	67	90

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
2 Existing slopes taken from 2 SRBPP repair sites modeled by SAM.
3 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
4 Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D50 of 10 inches.
5 Instream Structure data taken from USACE Revetment Database (2007).
6 Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
7 Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 21

SAM data summary of with-project conditions at site Sacramento River RM 47.0L and 47.9R (ARS_G).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2024	11,066	11,066	11,066	11,066
	2074	11,066	11,066	11,066	11,066
Bank Slope (dH:dV) [2]	2024	2.5	3	3	3
	2025	3	10	10	3
	2074	3	10	10	3
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	9.4	12	12	12
	2025	12	0.25	0.25	12
	2074	12	0.25	0.25	12
Instream Structure (% shoreline) [5]	2024	5.5	0	0	0
	2025	40	40	40	40
	2074	40	40	40	40
Vegetation (% shoreline) [6]	2024	0	0	0	0
	2025	0	50	50	0
	2029	0	88	88	0
	2039	0	88	88	0
	2049	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [6]	2024	0	18	54	0
	2025	0	18	55	0
	2029	0	19	65	0
	2039	100	23	75	100
	2049	100	25	75	100
	2074	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

1 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

2 Assume no significant change to Bank Slope.

3 Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

4 Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

5 Assume installation of rock revetment at summer/fall (D50 of 12 in) and natural substrate at winter/spring (D50 of 0.25 in).

6 Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.
6 Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 22

SAM data summary of existing conditions at site Sacramento River 50.0L (SBP Levee).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Wetted Area (square feet) [1]	2012	8,799,296	8,799,296	8,799,296	8,799,296
	2062	8,799,296	8,799,296	8,799,296	8,799,296
Shoreline Length (feet) [2]	2012	9,047	9,047	9,047	9,047
	2062	9,047	9,047	9,047	9,047
Bank Slope (dH:dV) [3]	2012	2	2	2	2
	2062	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [4]	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [5]	2012	2.4	2.4	2.4	2.4
	2062	2.4	2.4	2.4	2.4
Instream Structure (% shoreline) [6]	2012	3.9	3.9	3.9	3.9
	2062	3.9	3.9	3.9	3.9
Vegetation (% shoreline) [7]	2012	0	71	71	0
	2062	0	71	71	0
Shade (% shoreline) [8]	2012	48	12	36	48
	2062	48	12	36	48

1 Wetted area estimated from aerial images in Google Earth Pro. Length x Width
2 USACE Revetment Database (2007) and Google Earth Pro.
3 Repairs not expected to affect slope, assume slope of 2 for consistency with USACE standards.
4 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.
5 Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D50 of 10 inches.
6 Instream Structure data taken from USACE Revetment Database (2007).
7 Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
8 Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 23

SAM data summary of with-project conditions at site Sacramento River RM 50.0L (SBP Levee).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Wetted Area (square feet) [1]	2012	23,022,296	23,022,296	23,022,296	23,022,296
	2062	23,022,296	23,022,296	23,022,296	23,022,296
Shoreline Length (feet) [2]	2012	9,047	9,047	9,047	9,047
	2062	9,047	9,047	9,047	9,047
Bank Slope (dH:dV)	2012	2.5	2.5	2.5	2.5
	2013	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg)	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [3]	2012	2.4	2.4	2.4	2.4
	2013	2.4	2.4	2.4	2.4
	2062	2.4	2.4	2.4	2.4
Instream Structure (% shoreline) [3]	2012	3.9	3.9	3.9	3.9
	2013	3.9	3.9	3.9	3.9
	2062	3.9	3.9	3.9	3.9
Vegetation (% shoreline) [3]	2012	0	71	71	0
	2013	0	71	71	0
	2017	0	71	71	0
	2027	0	71	71	0
	2037	0	71	71	0
	2062	0	71	71	0
Shade (% shoreline)[3]	2012	48	12	36	48
	2013	48	12	36	48
	2017	48	12	36	48
	2027	48	12	36	48
	2037	48	12	36	48
	2062	48	12	36	48

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

1 Wetted area calculated by aerial images and a length x width with-project conditions

2 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

3 Assumed to stay the same due to only degrading and moving levee

Table 24

SAM data summary of existing conditions at site Sacramento River RM 50.0L (SBP Weir).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Wetted Area (square feet) [1]	2012	283,968	283,968	283,968	283,968
	2062	283,968	283,968	283,968	283,968
Shoreline Length (feet) [2]	2012	1,500	1,500	1,500	1,500
	2062	1,500	1,500	1,500	1,500
Bank Slope (dH:dV) [3]	2012	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [4]	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [5]	2012	10	10	10	10
	2062	10	10	10	10
Instream Structure (% shoreline) [6]	2012	0	0	0	0
	2062	0	0	0	0
Vegetation (% shoreline) [7]	2012	0	88	88	0
	2062	0	88	88	0
Shade (% shoreline) [8]	2012	48	12	36	48
	2062	48	12	36	48

1 Wetted area estimated from aerial images in Google Earth Pro. Length x Width
2 USACE Revetment Database (2007) and Google Earth Pro.
3 Repairs not expected to affect slope, assume slope of 2 for consistency with USACE standards.
4 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.
5 Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D50 of 10 inches.
6 Instream Structure data taken from USACE Revetment Database (2007).
7 Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
8 Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation

Table 25

SAM data summary of with-project conditions at site Sacramento River RM 50.0L (SBP Weir).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Wetted Area (square feet) [1]	2012	742,968	742,968	742,968	742,968
	2062	742,968	742,968	742,968	742,968
Shoreline Length (feet) [2]	2012	1,500	1,500	1,500	1,500
	2062	1,500	1,500	1,500	1,500
Bank Slope (dH:dV) [3]	2012	2.5	2.5	2.5	2.5
	2013	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [4]	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [5]	2012	10	10	10	10
	2013	10	10	10	10
	2062	10	10	10	10
Instream Structure (% shoreline) [6]	2012	0	0	0	0
	2013	0	0	0	0
	2062	0	0	0	0
Vegetation (% shoreline) [6]	2012	0	0	0	0
	2013	0	0	0	0
	2017	0	0	0	0
	2027	0	0	0	0
	2037	0	0	0	0
	2062	0	0	0	0
Shade (% shoreline) [6]	2012	0	0	0	0
	2013	0	0	0	0
	2017	0	0	0	0
	2027	0	0	0	0
	2037	0	0	0	0
	2062	0	0	0	0

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

1 Wetted area calculated by aerial images and a length x width with-project conditions

2 Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

3 Repairs not expected to affect slope, assume slope of 2.5 for consistency with USACE standards.

4 Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

5 Assume installation of rock revetment at summer/fall (D50 of 12 in) and natural substrate at winter/spring (D50 of 0.25 in).

6 Assume no vegetation variance and no placement of IWM and O&M activities

Table 26 American River SAM Analysis Reach

ARN_AB

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
0			0	0				0	0				0					0		
1			-366	-1,945				59	-3,002				124					-421		
2			-365	-2,166				411	-1,357				634					-392		
3			-365	-2,240				564	-662				827					-383		
4			-364	-2,277				667	-201				941					-378		
5			-364	-2,299				751	167				1,024					-375		
6			-361	-2,303				816	450				1,085					-370		
7			-353	-2,288				863	653				1,129					-360		
8			-341	-2,260				897	805				1,161					-348		
9			-328	-2,225				925	924				1,187					-334		
10			-314	-2,183				946	1,018				1,207					-319		
11			-298	-2,138				964	1,096				1,224					-303		
12			-282	-2,089				979	1,160				1,238					-287		
13			-265	-2,038				991	1,215				1,250					-270		
14			-248	-1,985				1,002	1,261				1,260					-252		
15			-230	-1,930				1,011	1,302				1,268					-234		
25			-124	-1,600				1,063	1,529				1,317					-126		
50			-44	-1,352				1,102	1,699				1,354					-45		
Fall-run Chinook																				
0	0	0	0	0		0	0	0	0			0	0	0					0	
1	-877	0	-366	-1,945		-759	0	59	-3,002			0	124	-2,681					-3,129	
2	-853	0	-365	-2,166		-339	0	411	-1,357			0	634	-755					-2,759	
3	-845	0	-365	-2,240		-180	0	564	-662			0	827	-80					-2,635	
4	-841	0	-364	-2,277		-87	0	667	-201			0	941	282					-2,573	
5	-839	0	-364	-2,299		-20	0	751	167			0	1,024	519					-2,536	
6	-828	0	-361	-2,303		29	0	816	450			0	1,085	686					-2,501	
7	-804	0	-353	-2,288		64	0	863	653			0	1,129	805					-2,457	
8	-773	0	-341	-2,260		90	0	897	805			0	1,161	894					-2,408	
9	-736	0	-328	-2,225		111	0	925	924			0	1,187	963					-2,356	
10	-695	0	-314	-2,183		127	0	946	1,018			0	1,207	1,018					-2,302	
11	-652	0	-298	-2,138		141	0	964	1,096			0	1,224	1,064					-2,245	
12	-606	0	-282	-2,089		152	0	979	1,160			0	1,238	1,102					-2,188	
13	-559	0	-265	-2,038		161	0	991	1,215			0	1,250	1,134					-2,129	
14	-511	0	-248	-1,985		170	0	1,002	1,261			0	1,260	1,161					-2,069	
15	-462	0	-230	-1,930		177	0	1,011	1,302			0	1,268	1,185					-2,009	
25	-164	0	-124	-1,600		216	0	1,063	1,529			0	1,317	1,318					-1,647	
50	59	0	-44	-1,352		245	0	1,102	1,699			0	1,354	1,418					-1,375	

4.0 defaults used for all response curves

Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 26 (cont.)
American River SAM Analysis Reach
ARN_AB
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Steelhead																				
0	0		0		0	0	0	0		0	0	0	0	0	0			0	0	0
1	-1,554		-701		-1,554	-1,558	0	-36		-1,558	-1,635	0	-1	-2,096	-1,635			-833	-3,013	-3,061
2	-1,508		-708		-1,508	-701	0	519		-701	-739	0	734	-520	-739			-774	-2,634	-2,262
3	-1,493		-711		-1,493	-381	0	750		-381	-411	0	1,009	23	-411			-755	-2,507	-1,996
4	-1,486		-712		-1,486	-195	0	900		-195	-225	0	1,168	309	-225			-745	-2,444	-1,862
5	-1,481		-712		-1,481	-63	0	1,018		-63	-96	0	1,282	491	-96			-739	-2,406	-1,782
6	-1,463		-707		-1,463	34	0	1,109		34	-3	0	1,365	617	-3			-729	-2,369	-1,714
7	-1,423		-693		-1,423	103	0	1,174		103	63	0	1,424	708	63			-712	-2,323	-1,639
8	-1,371		-674		-1,371	155	0	1,222		155	113	0	1,469	775	113			-691	-2,271	-1,559
9	-1,309		-651		-1,309	196	0	1,260		196	152	0	1,504	828	152			-666	-2,215	-1,477
10	-1,242		-626		-1,242	228	0	1,290		228	183	0	1,531	870	183			-639	-2,156	-1,392
11	-1,170		-599		-1,170	254	0	1,315		254	209	0	1,554	904	209			-611	-2,095	-1,307
12	-1,095		-571		-1,095	276	0	1,335		276	230	0	1,573	933	230			-582	-2,033	-1,220
13	-1,017		-541		-1,017	295	0	1,353		295	248	0	1,589	957	248			-551	-1,970	-1,133
14	-937		-511		-937	311	0	1,367		311	263	0	1,603	978	263			-520	-1,906	-1,044
15	-855		-480		-855	325	0	1,380		325	276	0	1,615	996	276			-489	-1,841	-956
25	-362		-293		-362	402	0	1,453		402	351	0	1,681	1,097	351			-298	-1,450	-422
50	8		-153		8	460	0	1,507		460	407	0	1,731	1,173	407			-156	-1,157	-22
Green Sturgeon																				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	-3,250	-2,873	0	-11	0	-3,250	-5,020	0	-2,750	0	-3,250	-5,020	0	-2,750	0	-6,500	-7,118	0	-942
2	0	-4,875	-4,304	0	-16	0	-1,625	-3,280	0	-3,194	0	-1,625	-3,280	0	-3,194	0	-6,500	-6,426	0	-482
3	0	-5,417	-4,781	0	-18	0	-1,083	-2,699	0	-3,343	0	-1,083	-2,699	0	-3,343	0	-6,500	-6,196	0	-328
4	0	-5,688	-5,019	0	-19	0	-812	-2,409	0	-3,417	0	-812	-2,409	0	-3,417	0	-6,500	-6,081	0	-252
5	0	-5,850	-5,162	0	-20	0	-650	-2,235	0	-3,461	0	-650	-2,235	0	-3,461	0	-6,500	-6,011	0	-206
6	0	-5,958	-5,258	0	-20	0	-541	-2,119	0	-3,491	0	-541	-2,119	0	-3,491	0	-6,500	-5,965	0	-175
7	0	-6,036	-5,326	0	-20	0	-464	-2,036	0	-3,512	0	-464	-2,036	0	-3,512	0	-6,500	-5,932	0	-153
8	0	-6,094	-5,377	0	-20	0	-406	-1,974	0	-3,528	0	-406	-1,974	0	-3,528	0	-6,500	-5,908	0	-137
9	0	-6,139	-5,417	0	-20	0	-361	-1,926	0	-3,540	0	-361	-1,926	0	-3,540	0	-6,500	-5,888	0	-124
10	0	-6,175	-5,448	0	-21	0	-325	-1,887	0	-3,550	0	-325	-1,887	0	-3,550	0	-6,500	-5,873	0	-114
11	0	-6,205	-5,475	0	-21	0	-295	-1,855	0	-3,558	0	-295	-1,855	0	-3,558	0	-6,500	-5,860	0	-105
12	0	-6,229	-5,496	0	-21	0	-271	-1,829	0	-3,565	0	-271	-1,829	0	-3,565	0	-6,500	-5,850	0	-98
13	0	-6,250	-5,515	0	-21	0	-250	-1,807	0	-3,570	0	-250	-1,807	0	-3,570	0	-6,500	-5,841	0	-92
14	0	-6,268	-5,530	0	-21	0	-232	-1,787	0	-3,575	0	-232	-1,787	0	-3,575	0	-6,500	-5,833	0	-87
15	0	-6,283	-5,544	0	-21	0	-216	-1,771	0	-3,579	0	-216	-1,771	0	-3,579	0	-6,500	-5,827	0	-83
25	0	-6,370	-5,620	0	-21	0	-130	-1,678	0	-3,603	0	-130	-1,678	0	-3,603	0	-6,500	-5,790	0	-58
50	0	-6,435	-5,677	0	-21	0	-65	-1,608	0	-3,621	0	-65	-1,608	0	-3,621	0	-6,500	-5,762	0	-40
4.0 defaults used for all response curves																				
Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)																				

4.0 defaults used for all response curves

Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 27

American River SAM Analysis Reach

ARS_ABC

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
0			0	0				0	0				0					0		
1			-200	-620				114	-333				194					-229		
2			-192	-507				366	912				561					-207		
3			-201	-522				467	1,280				689					-214		
4			-212	-557				571	1,647				816					-225		
5			-217	-568				691	2,137				965					-228		
6			-224	-588				779	2,453				1,068					-234		
7			-229	-602				861	2,736				1,169					-239		
8			-229	-595				947	3,058				1,278					-237		
9			-224	-577				1,019	3,328				1,368					-232		
10			-216	-549				1,079	3,554				1,441					-223		
11			-206	-513				1,131	3,748				1,502					-212		
12			-193	-471				1,175	3,915				1,553					-199		
13			-179	-422				1,213	4,056				1,596					-184		
14			-163	-369				1,246	4,177				1,634					-167		
15			-145	-312				1,275	4,283				1,666					-150		
25			-11	126				1,440	4,881				1,849					-14		
50			100	488				1,564	5,329				1,986					99		
Fall-run Chinook																				
0	0	0	0	0		0	0	0	0			0	0	0					0	
1	9	0	-200	-620		456	0	114	-333			0	194	52					-967	
2	284	0	-192	-507		783	0	366	912			0	561	1,529					-681	
3	347	0	-201	-522		886	0	467	1,280			0	689	1,860					-694	
4	399	0	-212	-557		994	0	571	1,647			0	816	2,176					-728	
5	463	0	-217	-568		1,119	0	691	2,137			0	965	2,612					-705	
6	497	0	-224	-588		1,202	0	779	2,453			0	1,068	2,845					-723	
7	536	0	-229	-602		1,282	0	861	2,736			0	1,169	3,072					-735	
8	592	0	-229	-595		1,367	0	947	3,058			0	1,278	3,353					-712	
9	646	0	-224	-577		1,436	0	1,019	3,328			0	1,368	3,577					-681	
10	701	0	-216	-549		1,492	0	1,079	3,554			0	1,441	3,758					-642	
11	758	0	-206	-513		1,539	0	1,131	3,748			0	1,502	3,908					-598	
12	815	0	-193	-471		1,580	0	1,175	3,915			0	1,553	4,034					-548	
13	875	0	-179	-422		1,614	0	1,213	4,056			0	1,596	4,141					-494	
14	936	0	-163	-369		1,643	0	1,246	4,177			0	1,634	4,232					-436	
15	999	0	-145	-312		1,669	0	1,275	4,283			0	1,666	4,311					-374	
25	1,452	0	-11	126		1,815	0	1,440	4,881			0	1,849	4,755					89	
50	1,821	0	100	488		1,926	0	1,564	5,329			0	1,986	5,088					469	

4.0 defaults used for all response curves

Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 27 (cont.)

American River SAM Analysis Reach

ARS_ABC

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Steelhead																				
0	0		0		0	0	0	0		0	0	0	0	0	0			0	0	0
1	203		-406		203	979	0	83		979	1,019	0	146	-10	1,019			-482	-970	90
2	763		-399		763	1,642	0	489		1,642	1,715	0	686	1,201	1,715			-437	-677	707
3	899		-419		899	1,857	0	633		1,857	1,938	0	857	1,465	1,938			-454	-688	821
4	1,016		-444		1,016	2,080	0	779		2,080	2,169	0	1,026	1,715	2,169			-477	-720	926
5	1,156		-458		1,156	2,337	0	955		2,337	2,437	0	1,231	2,066	2,437			-485	-694	1,084
6	1,235		-474		1,235	2,507	0	1,077		2,507	2,615	0	1,366	2,250	2,615			-500	-711	1,160
7	1,325		-487		1,325	2,673	0	1,190		2,673	2,789	0	1,497	2,431	2,789			-512	-722	1,248
8	1,442		-489		1,442	2,849	0	1,312		2,849	2,974	0	1,643	2,656	2,974			-511	-697	1,375
9	1,552		-484		1,552	2,990	0	1,414		2,990	3,122	0	1,762	2,835	3,122			-504	-663	1,492
10	1,660		-472		1,660	3,106	0	1,499		3,106	3,243	0	1,859	2,980	3,243			-490	-621	1,606
11	1,765		-456		1,765	3,203	0	1,571		3,203	3,343	0	1,939	3,099	3,343			-472	-573	1,716
12	1,872		-435		1,872	3,286	0	1,634		3,286	3,427	0	2,007	3,198	3,427			-450	-519	1,827
13	1,980		-411		1,980	3,356	0	1,687		3,356	3,499	0	2,065	3,283	3,499			-425	-460	1,938
14	2,089		-384		2,089	3,416	0	1,732		3,416	3,560	0	2,114	3,355	3,560			-396	-397	2,051
15	2,200		-354		2,200	3,468	0	1,773		3,468	3,614	0	2,157	3,418	3,614			-366	-330	2,164
25	2,988		-124		2,988	3,766	0	2,002		3,766	3,914	0	2,399	3,769	3,914			-131	171	2,967
50	3,627		67		3,627	3,991	0	2,175		3,991	4,140	0	2,581	4,033	4,140			64	583	3,616
Green Sturgeon																				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	-2,510	-714	0	564	0	-2,510	-876	0	-980	0	-2,510	-876	0	-980	0	-5,020	-2,496	0	417
2	0	-3,765	-1,071	0	846	0	-1,255	468	0	-1,323	0	-1,255	468	0	-1,323	0	-5,020	-1,962	0	772
3	0	-4,183	-1,190	0	940	0	-1,156	654	0	-1,482	0	-1,156	654	0	-1,482	0	-5,339	-2,046	0	846
4	0	-4,632	-1,344	0	1,021	0	-1,106	807	0	-1,661	0	-1,106	807	0	-1,661	0	-5,738	-2,183	0	916
5	0	-5,092	-1,512	0	1,096	0	-885	1,104	0	-1,821	0	-885	1,104	0	-1,821	0	-5,977	-2,183	0	1,013
6	0	-5,399	-1,624	0	1,147	0	-854	1,249	0	-1,943	0	-854	1,249	0	-1,943	0	-6,253	-2,236	0	1,061
7	0	-5,718	-1,707	0	1,197	0	-831	1,416	0	-2,072	0	-831	1,416	0	-2,072	0	-6,550	-2,276	0	1,109
8	0	-6,045	-1,771	0	1,247	0	-727	1,634	0	-2,193	0	-727	1,634	0	-2,193	0	-6,772	-2,268	0	1,171
9	0	-6,299	-1,820	0	1,286	0	-647	1,803	0	-2,287	0	-647	1,803	0	-2,287	0	-6,945	-2,263	0	1,218
10	0	-6,502	-1,860	0	1,317	0	-582	1,939	0	-2,362	0	-582	1,939	0	-2,362	0	-7,084	-2,258	0	1,256
11	0	-6,668	-1,893	0	1,343	0	-529	2,050	0	-2,423	0	-529	2,050	0	-2,423	0	-7,197	-2,254	0	1,287
12	0	-6,807	-1,920	0	1,364	0	-485	2,142	0	-2,475	0	-485	2,142	0	-2,475	0	-7,292	-2,251	0	1,313
13	0	-6,924	-1,943	0	1,382	0	-448	2,220	0	-2,518	0	-448	2,220	0	-2,518	0	-7,371	-2,249	0	1,335
14	0	-7,024	-1,962	0	1,397	0	-416	2,287	0	-2,555	0	-416	2,287	0	-2,555	0	-7,440	-2,247	0	1,354
15	0	-7,111	-1,979	0	1,411	0	-388	2,346	0	-2,587	0	-388	2,346	0	-2,587	0	-7,499	-2,245	0	1,370
25	0	-7,599	-2,075	0	1,486	0	-233	2,671	0	-2,767	0	-233	2,671	0	-2,767	0	-7,832	-2,234	0	1,461
50	0	-7,964	-2,146	0	1,542	0	-116	2,915	0	-2,902	0	-116	2,915	0	-2,902	0	-8,081	-2,226	0	1,529
4.0 defaults used for all response curves																				
Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)																				

Table 28

Sacramento River SAM Analysis Reach

ARS_DEFG

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
0	0		0	0		0		0	0		0		0	0		0		0	0	
1	-1,101		-400	-2,119		-892		97	-3,451		-946		193	-3,484		-2,136		-460	-3,759	
2	-1,075		-427	-2,526		-415		571	-1,306		-453		900	-1,147		-1,776		-468	-3,638	
3	-1,058		-434	-2,738		-121		836	15		-141		1,302	289		-1,525		-462	-3,479	
4	-1,125		-459	-2,923		-16		940	430		-23		1,470	753		-1,514		-483	-3,555	
5	-1,197		-498	-3,127		44		1,046	642		47		1,638	990		-1,604		-526	-3,809	
6	-1,266		-532	-3,373		110		1,183	999		124		1,847	1,366		-1,659		-559	-4,037	
7	-1,342		-551	-3,601		160		1,296	1,340		187		2,017	1,726		-1,679		-575	-4,171	
8	-1,381		-558	-3,738		200		1,390	1,645		241		2,159	2,045		-1,676		-578	-4,237	
9	-1,394		-555	-3,815		233		1,472	1,926		289		2,282	2,337		-1,656		-573	-4,258	
10	-1,385		-544	-3,845		261		1,545	2,187		333		2,393	2,608		-1,621		-561	-4,244	
11	-1,357		-527	-3,838		286		1,611	2,421		374		2,490	2,847		-1,571		-542	-4,201	
12	-1,311		-504	-3,806		308		1,668	2,621		411		2,574	3,047		-1,507		-518	-4,138	
13	-1,252		-478	-3,752		329		1,719	2,797		446		2,648	3,218		-1,433		-490	-4,059	
14	-1,183		-448	-3,683		348		1,765	2,952		480		2,714	3,366		-1,351		-459	-3,968	
15	-1,105		-415	-3,602		366		1,807	3,091		512		2,774	3,495		-1,263		-426	-3,867	
25	-396		-144	-2,879		497		2,094	3,968		731		3,136	4,242		-491		-150	-3,038	
50	298		94	-2,269		631		2,366	4,728		914		3,419	4,810		251		91	-2,349	
Fall-run Chinook																				
0	0		0	0		0		0	0				0	0		0		0	0	
1	-1,101		-400	-2,119		-892		97	-3,451				193	-3,484		-2,136		-460	-3,759	
2	-1,075		-427	-2,526		-415		571	-1,306				900	-1,147		-1,776		-468	-3,638	
3	-1,058		-434	-2,738		-121		836	15				1,302	289		-1,525		-462	-3,479	
4	-1,125		-459	-2,923		-16		940	430				1,470	753		-1,514		-483	-3,555	
5	-1,197		-498	-3,127		44		1,046	642				1,638	990		-1,604		-526	-3,809	
6	-1,266		-532	-3,373		110		1,183	999				1,847	1,366		-1,659		-559	-4,037	
7	-1,342		-551	-3,601		160		1,296	1,340				2,017	1,726		-1,679		-575	-4,171	
8	-1,381		-558	-3,738		200		1,390	1,645				2,159	2,045		-1,676		-578	-4,237	
9	-1,394		-555	-3,815		233		1,472	1,926				2,282	2,337		-1,656		-573	-4,258	
10	-1,385		-544	-3,845		261		1,545	2,187				2,393	2,608		-1,621		-561	-4,244	
11	-1,357		-527	-3,838		286		1,611	2,421				2,490	2,847		-1,571		-542	-4,201	
12	-1,311		-504	-3,806		308		1,668	2,621				2,574	3,047		-1,507		-518	-4,138	
13	-1,252		-478	-3,752		329		1,719	2,797				2,648	3,218		-1,433		-490	-4,059	
14	-1,183		-448	-3,683		348		1,765	2,952				2,714	3,366		-1,351		-459	-3,968	
15	-1,105		-415	-3,602		366		1,807	3,091				2,774	3,495		-1,263		-426	-3,867	
25	-396		-144	-2,879		497		2,094	3,968				3,136	4,242		-491		-150	-3,038	
50	298		94	-2,269		631		2,366	4,728				3,419	4,810		251		91	-2,349	

4.0 defaults used for all response curves

Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 28 (cont.)

Sacramento River SAM Analysis Reach

ARS_DEFG

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Late-fall-run Chinook																				
0	0		0	0		0		0	0		0		0					0		
1	-1,101		-400	-2,119		-892		97	-3,451		-946		193					-460		
2	-1,075		-427	-2,526		-415		571	-1,306		-453		900					-468		
3	-1,058		-434	-2,738		-121		836	15		-141		1,302					-462		
4	-1,125		-459	-2,923		-16		940	430		-23		1,470					-483		
5	-1,197		-498	-3,127		44		1,046	642		47		1,638					-526		
6	-1,266		-532	-3,373		110		1,183	999		124		1,847					-559		
7	-1,342		-551	-3,601		160		1,296	1,340		187		2,017					-575		
8	-1,381		-558	-3,738		200		1,390	1,645		241		2,159					-578		
9	-1,394		-555	-3,815		233		1,472	1,926		289		2,282					-573		
10	-1,385		-544	-3,845		261		1,545	2,187		333		2,393					-561		
11	-1,357		-527	-3,838		286		1,611	2,421		374		2,490					-542		
12	-1,311		-504	-3,806		308		1,668	2,621		411		2,574					-518		
13	-1,252		-478	-3,752		329		1,719	2,797		446		2,648					-490		
14	-1,183		-448	-3,683		348		1,765	2,952		480		2,714					-459		
15	-1,105		-415	-3,602		366		1,807	3,091		512		2,774					-426		
25	-396		-144	-2,879		497		2,094	3,968		731		3,136					-150		
50	298		94	-2,269		631		2,366	4,728		914		3,419					91		
Winter-run Chinook																				
0	0		0	0		0		0	0		0		0	0		0		0		
1	-1,101		-400	-2,119		-892		97	-3,451		-946		193	-3,484		-2,136		-460		
2	-1,075		-427	-2,526		-415		571	-1,306		-453		900	-1,147		-1,776		-468		
3	-1,058		-434	-2,738		-121		836	15		-141		1,302	289		-1,525		-462		
4	-1,125		-459	-2,923		-16		940	430		-23		1,470	753		-1,514		-483		
5	-1,197		-498	-3,127		44		1,046	642		47		1,638	990		-1,604		-526		
6	-1,266		-532	-3,373		110		1,183	999		124		1,847	1,366		-1,659		-559		
7	-1,342		-551	-3,601		160		1,296	1,340		187		2,017	1,726		-1,679		-575		
8	-1,381		-558	-3,738		200		1,390	1,645		241		2,159	2,045		-1,676		-578		
9	-1,394		-555	-3,815		233		1,472	1,926		289		2,282	2,337		-1,656		-573		
10	-1,385		-544	-3,845		261		1,545	2,187		333		2,393	2,608		-1,621		-561		
11	-1,357		-527	-3,838		286		1,611	2,421		374		2,490	2,847		-1,571		-542		
12	-1,311		-504	-3,806		308		1,668	2,621		411		2,574	3,047		-1,507		-518		
13	-1,252		-478	-3,752		329		1,719	2,797		446		2,648	3,218		-1,433		-490		
14	-1,183		-448	-3,683		348		1,765	2,952		480		2,714	3,366		-1,351		-459		
15	-1,105		-415	-3,602		366		1,807	3,091		512		2,774	3,495		-1,263		-426		
25	-396		-144	-2,879		497		2,094	3,968		731		3,136	4,242		-491		-150		
50	298		94	-2,269		631		2,366	4,728		914		3,419	4,810		251		91		

4.0 defaults used for all response curves

Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 28 (cont.)

Sacramento River SAM Analysis Reach

ARS_DEFG

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Steelhead																				
0	0		0	0	0	0		0	0	0	0		0	0	0	0		0		0
1	-1,747		-820	-2,239	-1,747	-1,747		-77	-3,044	-1,747	-1,801		-36	-3,082	-1,801	-3,793		-964		-3,793
2	-1,656		-871	-2,645	-1,656	-772		649	-1,266	-772	-774		946	-1,173	-774	-3,047		-970		-3,047
3	-1,609		-887	-2,848	-1,609	-170		1,060	-188	-170	-132		1,508	-16	-132	-2,536		-952		-2,536
4	-1,702		-938	-3,038	-1,702	56		1,206	116	56	119		1,722	324	119	-2,465		-998		-2,465
5	-1,780		-1,021	-3,256	-1,780	195		1,339	234	195	280		1,917	463	280	-2,574		-1,089		-2,574
6	-1,865		-1,094	-3,513	-1,865	345		1,525	482	345	450		2,177	731	450	-2,634		-1,161		-2,634
7	-1,984		-1,139	-3,749	-1,984	457		1,684	735	457	581		2,397	1,002	581	-2,644		-1,196		-2,644
8	-2,040		-1,156	-3,887	-2,040	545		1,818	961	545	688		2,583	1,244	688	-2,617		-1,206		-2,617
9	-2,053		-1,154	-3,961	-2,053	617		1,936	1,170	617	779		2,747	1,467	779	-2,566		-1,199		-2,566
10	-2,030		-1,137	-3,985	-2,030	678		2,042	1,367	678	858		2,896	1,675	858	-2,492		-1,177		-2,492
11	-1,974		-1,106	-3,971	-1,974	732		2,137	1,544	732	928		3,027	1,861	928	-2,394		-1,143		-2,394
12	-1,890		-1,065	-3,929	-1,890	780		2,220	1,696	780	991		3,141	2,017	991	-2,274		-1,098		-2,274
13	-1,784		-1,016	-3,866	-1,784	824		2,293	1,828	824	1,048		3,240	2,152	1,048	-2,139		-1,047		-2,139
14	-1,661		-960	-3,786	-1,661	864		2,359	1,946	864	1,101		3,329	2,269	1,101	-1,990		-989		-1,990
15	-1,524		-900	-3,692	-1,524	901		2,420	2,051	901	1,151		3,409	2,372	1,151	-1,832		-926		-1,832
25	-343		-391	-2,871	-343	1,167		2,823	2,718	1,167	1,472		3,899	2,973	1,472	-528		-407		-528
50	734		58	-2,166	734	1,431		3,200	3,301	1,431	1,733		4,282	3,433	1,733	641		50		641
Green Sturgeon																				
0			0	0		0		0		0	0		0	0	0	0		0	0	0
1			-708	0		0		-4,397		-1,551	0		-4,397	0	-1,551	0		-5,009	0	-1,298
2			-1,391	0		0		-3,248		-1,199	0		-3,248	0	-1,199	0		-4,297	0	-765
3			-1,830	0		0		-2,485		-966	0		-2,485	0	-966	0		-3,767	0	-436
4			-2,032	0		0		-2,310		-923	0		-2,310	0	-923	0		-3,709	0	-344
5			-2,076	0		0		-2,380		-1,146	0		-2,380	0	-1,146	0		-3,899	0	-323
6			-2,305	0		0		-2,394		-1,476	0		-2,394	0	-1,476	0		-4,077	0	-288
7			-2,685	0		0		-2,368		-1,731	0		-2,368	0	-1,731	0		-4,203	0	-264
8			-2,970	0		0		-2,348		-1,923	0		-2,348	0	-1,923	0		-4,298	0	-245
9			-3,191	0		0		-2,333		-2,072	0		-2,333	0	-2,072	0		-4,372	0	-231
10			-3,369	0		0		-2,321		-2,191	0		-2,321	0	-2,191	0		-4,431	0	-220
11			-3,514	0		0		-2,311		-2,288	0		-2,311	0	-2,288	0		-4,480	0	-210
12			-3,634	0		0		-2,302		-2,369	0		-2,302	0	-2,369	0		-4,520	0	-203
13			-3,737	0		0		-2,295		-2,438	0		-2,295	0	-2,438	0		-4,554	0	-196
14			-3,824	0		0		-2,289		-2,497	0		-2,289	0	-2,497	0		-4,583	0	-190
15			-3,900	0		0		-2,284		-2,548	0		-2,284	0	-2,548	0		-4,609	0	-185
25			-4,326	0		0		-2,255		-2,834	0		-2,255	0	-2,834	0		-4,751	0	-158
50			-4,645	0		0		-2,233		-3,048	0		-2,233	0	-3,048	0		-4,857	0	-138

4.0 defaults used for all response curves

Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 29

Sacramento Bypass Levee and Weir SAM Analysis Reach

SBP Weir and Levee

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
0	0		0	0		0		0	0		0		0	0		0		0	0	
1	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
2	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
3	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
4	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
5	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
6	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
7	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
8	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
9	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
10	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
11	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
12	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
13	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
14	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
15	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
25	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
50	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Fall-run Chinook																				
0	0		0			0		0	0				0			0		0		
1	-60		-4			-21		-9	-146				-21			-60		-4		
2	-60		-4			-21		-9	-146				-21			-60		-4		
3	-60		-4			-21		-9	-146				-21			-60		-4		
4	-60		-4			-21		-9	-146				-21			-60		-4		
5	-60		-4			-21		-9	-146				-21			-60		-4		
6	-60		-4			-21		-9	-146				-21			-60		-4		
7	-60		-4			-21		-9	-146				-21			-60		-4		
8	-60		-4			-21		-9	-146				-21			-60		-4		
9	-60		-4			-21		-9	-146				-21			-60		-4		
10	-60		-4			-21		-9	-146				-21			-60		-4		
11	-60		-4			-21		-9	-146				-21			-60		-4		
12	-60		-4			-21		-9	-146				-21			-60		-4		
13	-60		-4			-21		-9	-146				-21			-60		-4		
14	-60		-4			-21		-9	-146				-21			-60		-4		
15	-60		-4			-21		-9	-146				-21			-60		-4		
25	-60		-4			-21		-9	-146				-21			-60		-4		
50	-60		-4			-21		-9	-146				-21			-60		-4		

4.0 defaults used for all response curves

4.0 defaults used for all timing tables

Table 29 (cont.)

Sacramento Bypass Levee and Weir SAM Analysis Reach

SBP Weir and Levee

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Late-fall-run Chinook																				
0	0		0	0		0		0	0		0		0					0		
1	-60		-4	-26		-21		-9	-146		-51		-21					-4		
2	-60		-4	-26		-21		-9	-146		-51		-21					-4		
3	-60		-4	-26		-21		-9	-146		-51		-21					-4		
4	-60		-4	-26		-21		-9	-146		-51		-21					-4		
5	-60		-4	-26		-21		-9	-146		-51		-21					-4		
6	-60		-4	-26		-21		-9	-146		-51		-21					-4		
7	-60		-4	-26		-21		-9	-146		-51		-21					-4		
8	-60		-4	-26		-21		-9	-146		-51		-21					-4		
9	-60		-4	-26		-21		-9	-146		-51		-21					-4		
10	-60		-4	-26		-21		-9	-146		-51		-21					-4		
11	-60		-4	-26		-21		-9	-146		-51		-21					-4		
12	-60		-4	-26		-21		-9	-146		-51		-21					-4		
13	-60		-4	-26		-21		-9	-146		-51		-21					-4		
14	-60		-4	-26		-21		-9	-146		-51		-21					-4		
15	-60		-4	-26		-21		-9	-146		-51		-21					-4		
25	-60		-4	-26		-21		-9	-146		-51		-21					-4		
50	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Winter-run Chinook																				
0	0		0	0		0		0	0		0		0	0		0		0		
1	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
2	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
3	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
4	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
5	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
6	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
7	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
8	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
9	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
10	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
11	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
12	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
13	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
14	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
15	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
25	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
50	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		

4.0 defaults used for all response curves

4.0 defaults used for all timing tables

Table 29 (cont.)

Sacramento Bypass Levee and Weir SAM Analysis Reach

SBP Weir and Levee

Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Steelhead																				
0	0		0	0	0	0		0	0	0	0		0	0	0	0		0		0
1	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
2	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
3	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
4	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
5	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
6	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
7	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
8	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
9	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
10	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
11	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
12	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
13	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
14	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
15	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
25	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
50	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Green Sturgeon																				
0			0	0		0		0		0	0	0	0	0	0	0	0	0	0	0
1			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
2			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
3			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
4			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
5			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
6			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
7			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
8			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
9			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
10			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
11			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
12			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
13			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
14			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
15			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
25			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
50			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8

4.0 defaults used for all response curves

4.0 defaults used for all timing tables

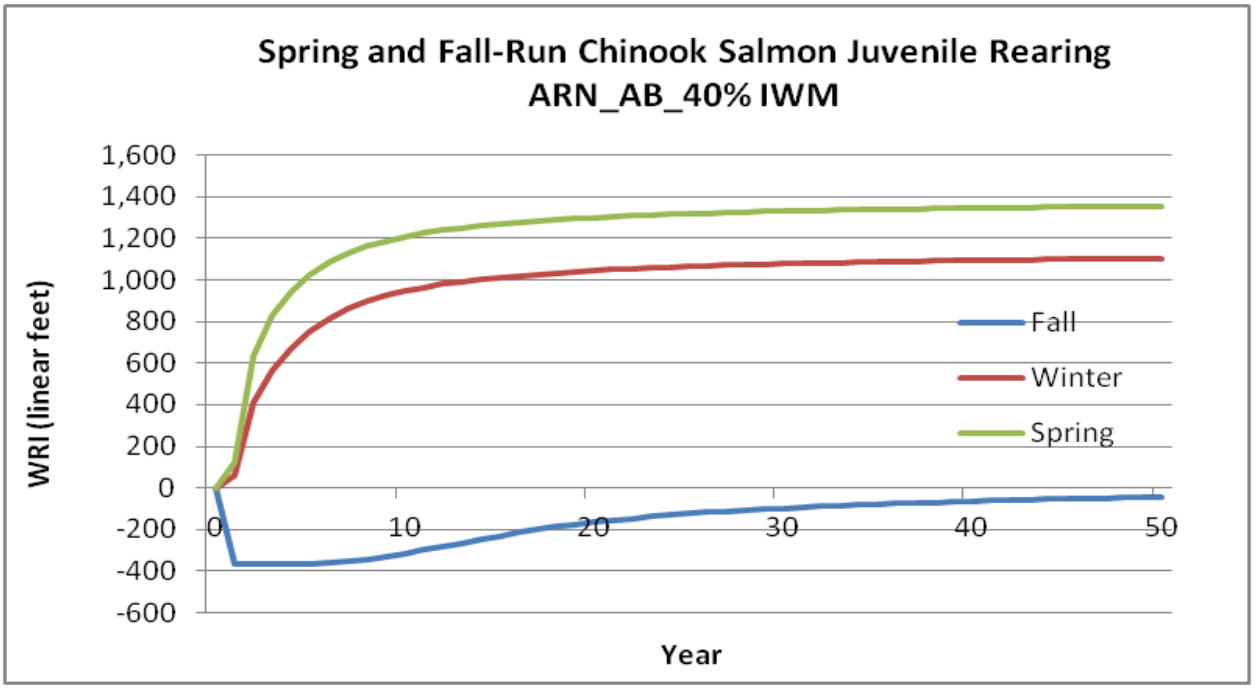


Figure 2. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for spring and fall-run Chinook salmon juvenile rearing.

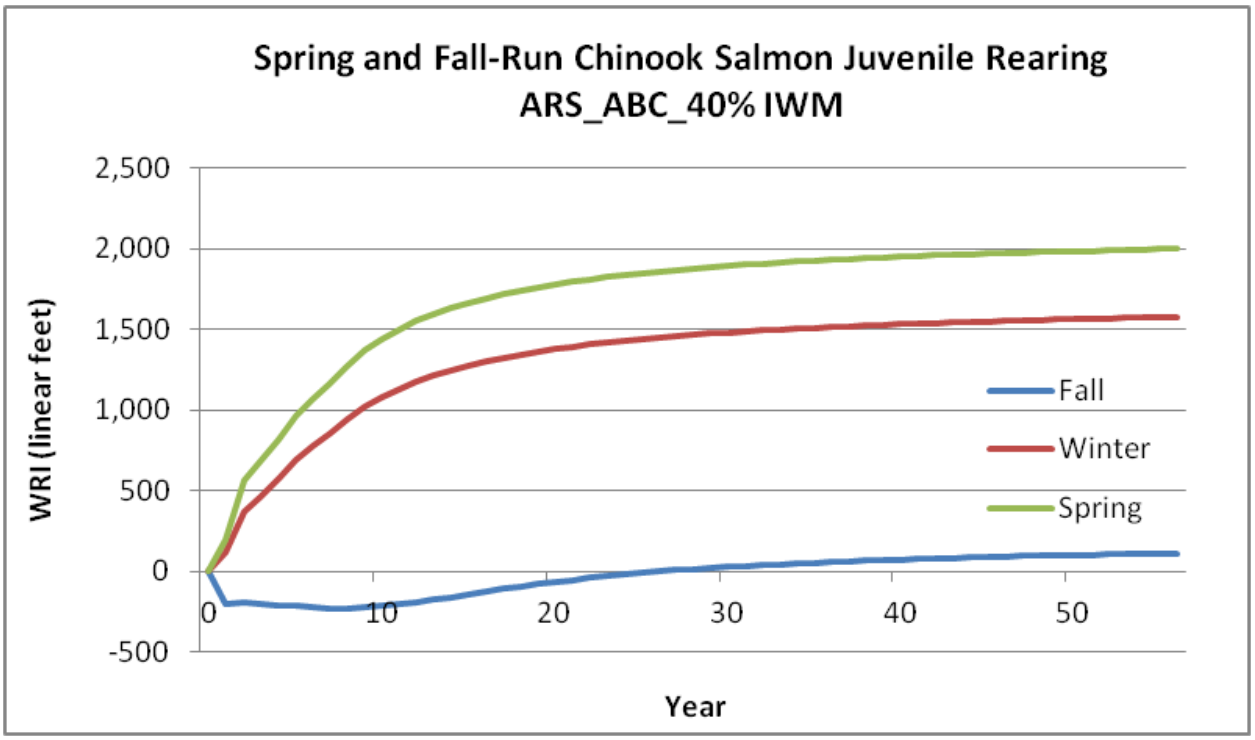


Figure 3. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for spring and fall-run Chinook salmon juvenile rearing.

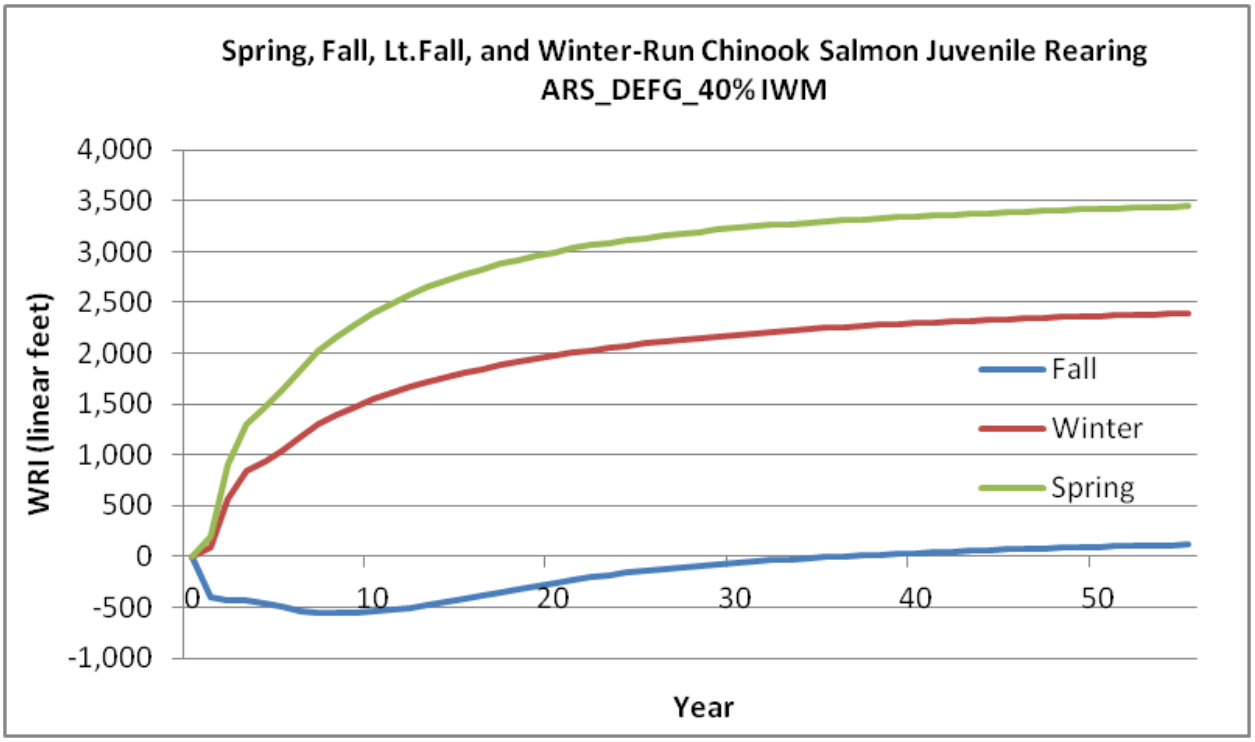


Figure 4. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for Chinook salmon juvenile rearing.

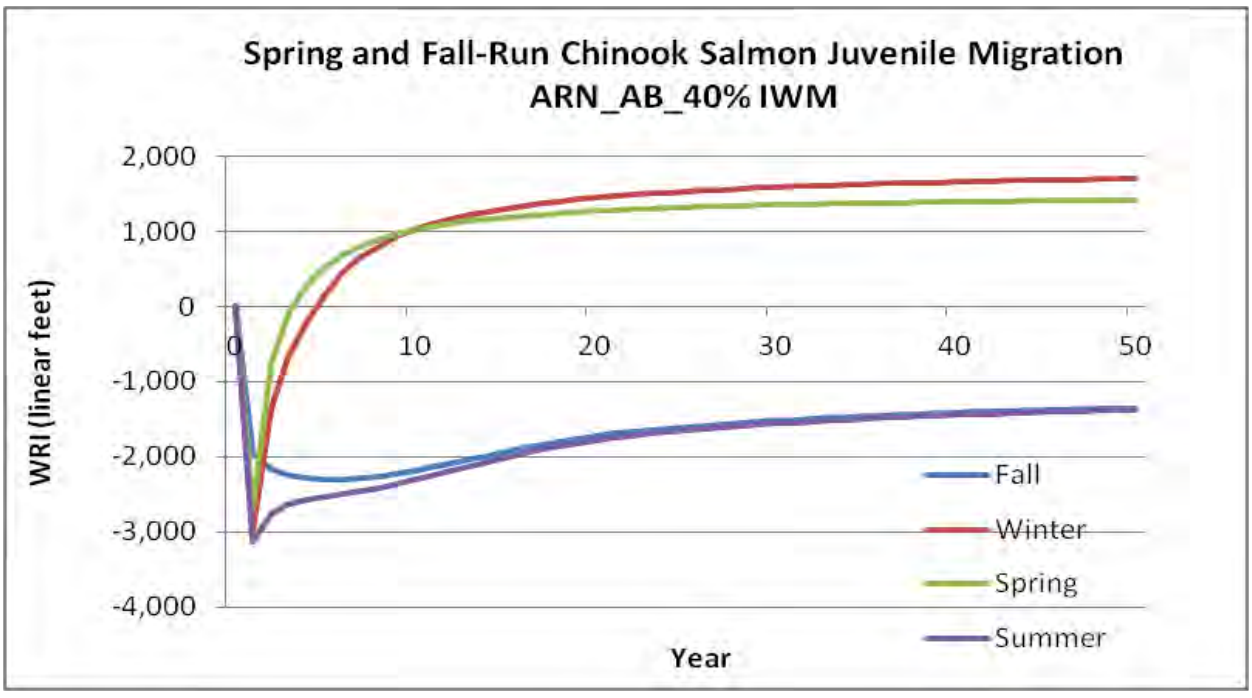


Figure 5. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for spring and fall-run Chinook salmon juvenile migration.

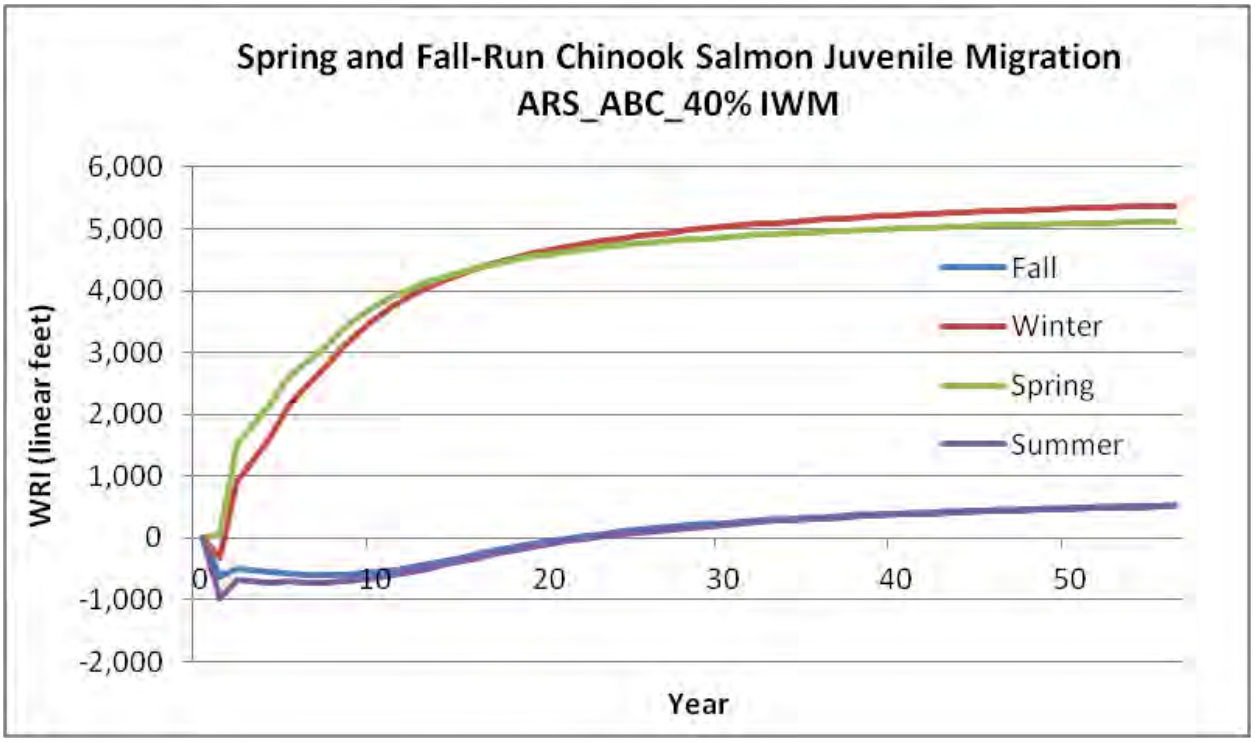


Figure 6. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for spring and fall-run Chinook salmon juvenile migration.

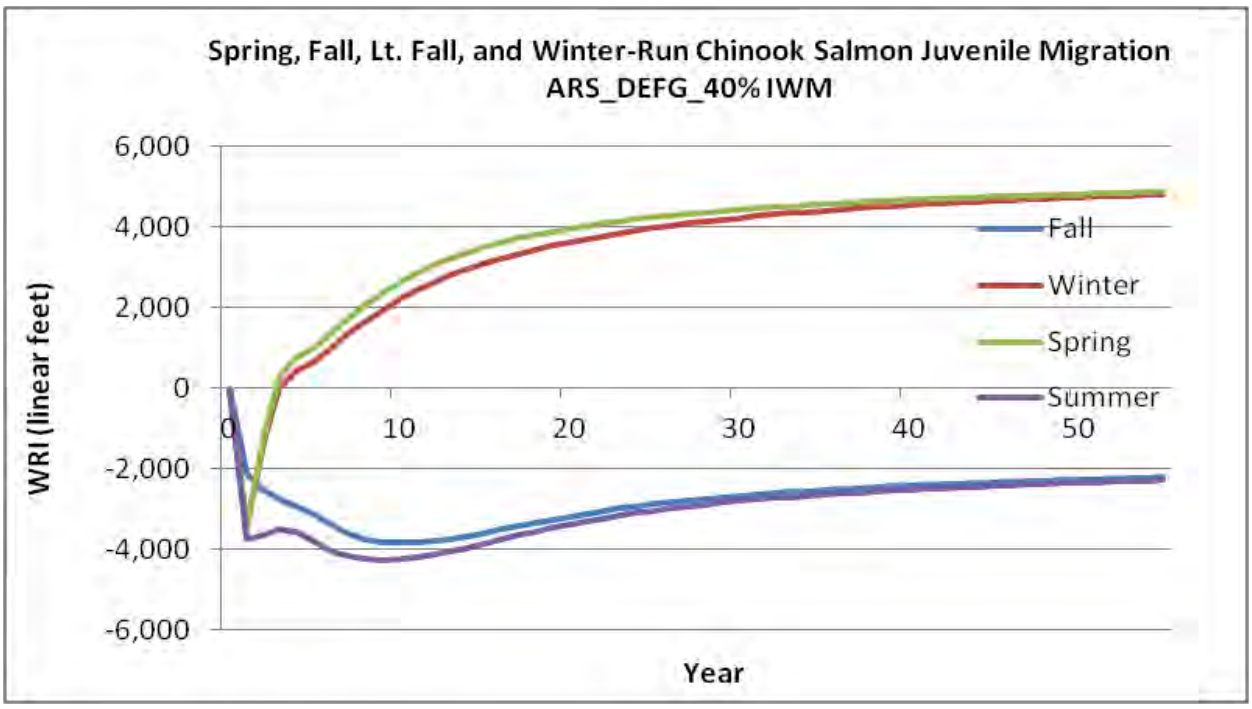


Figure 7. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for Chinook salmon juvenile migration.

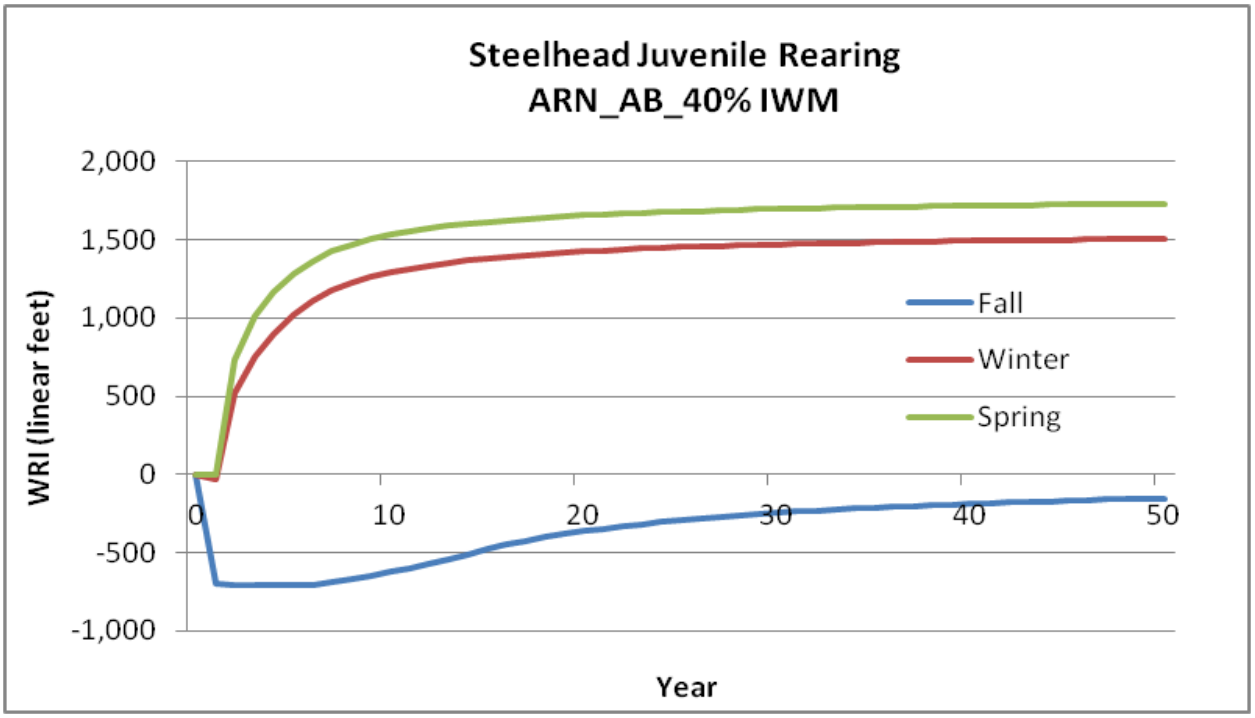


Figure 8. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for steelhead juvenile rearing.

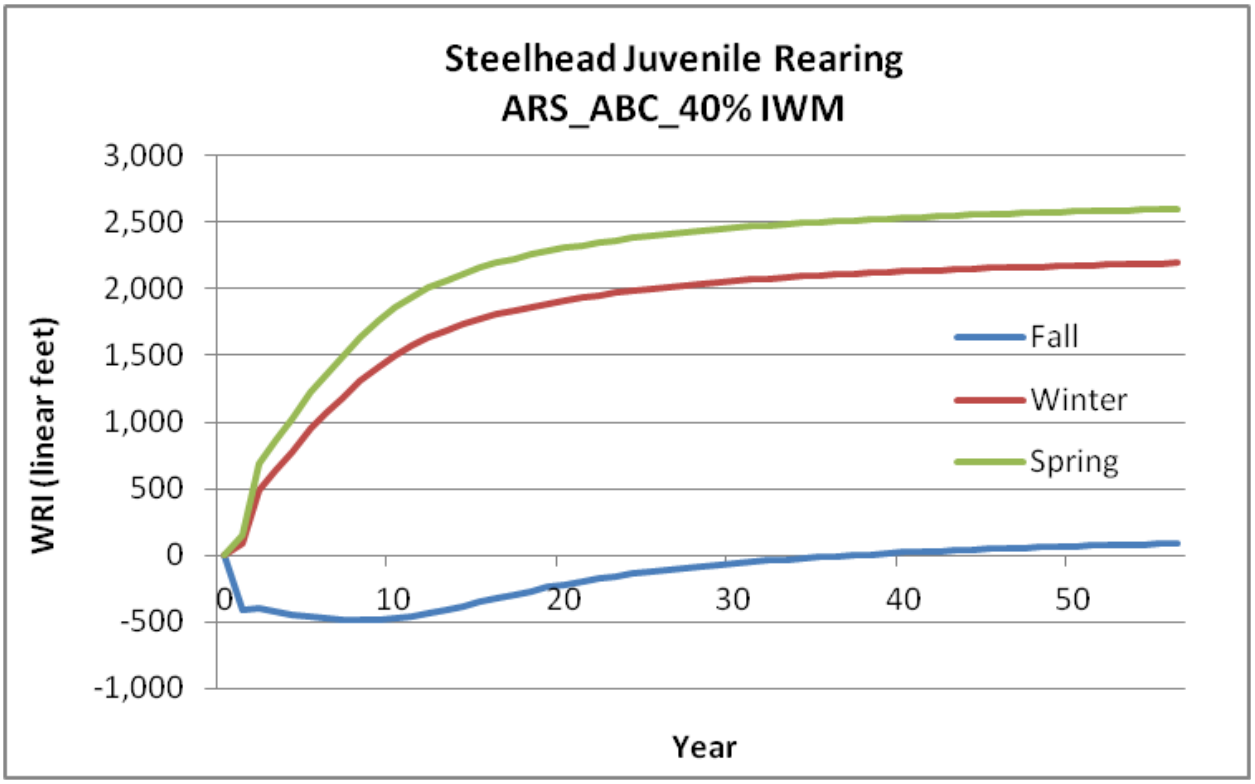


Figure 9. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for steelhead juvenile rearing.

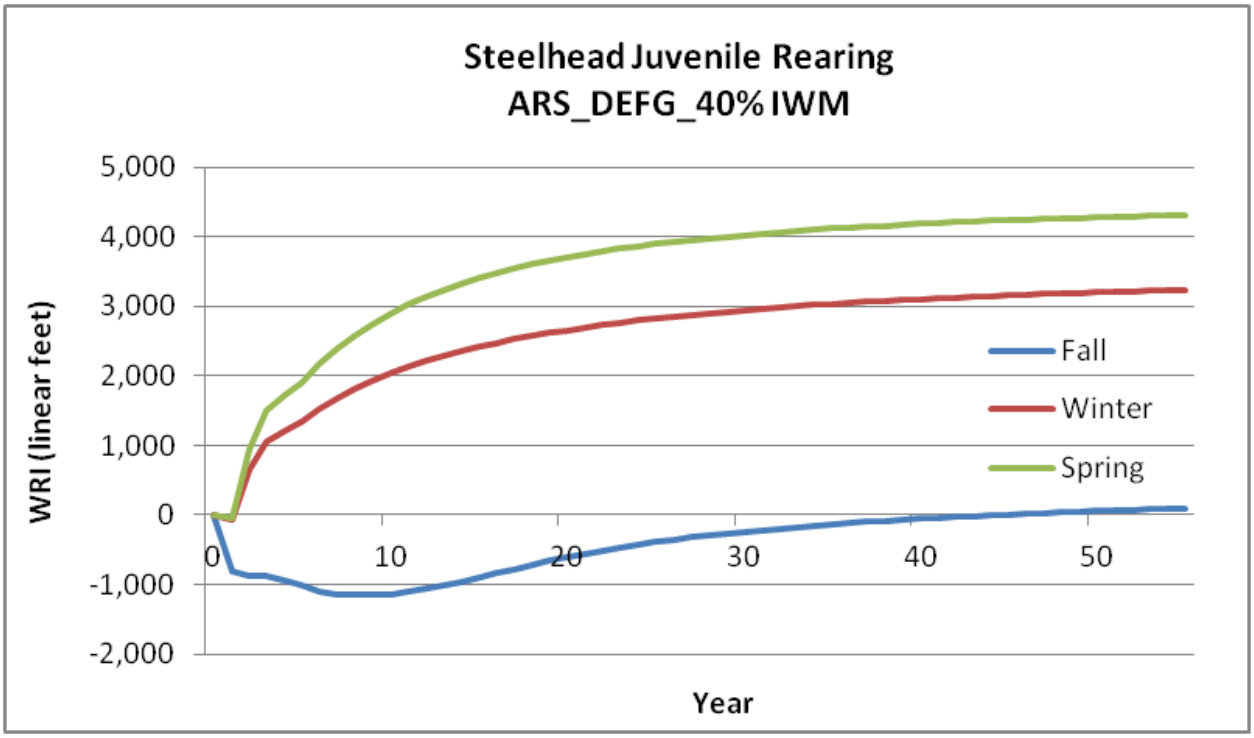


Figure 10. Weighted response indices at 40% IWM placement on the American River (ARS_DEFG) for steelhead juvenile rearing.

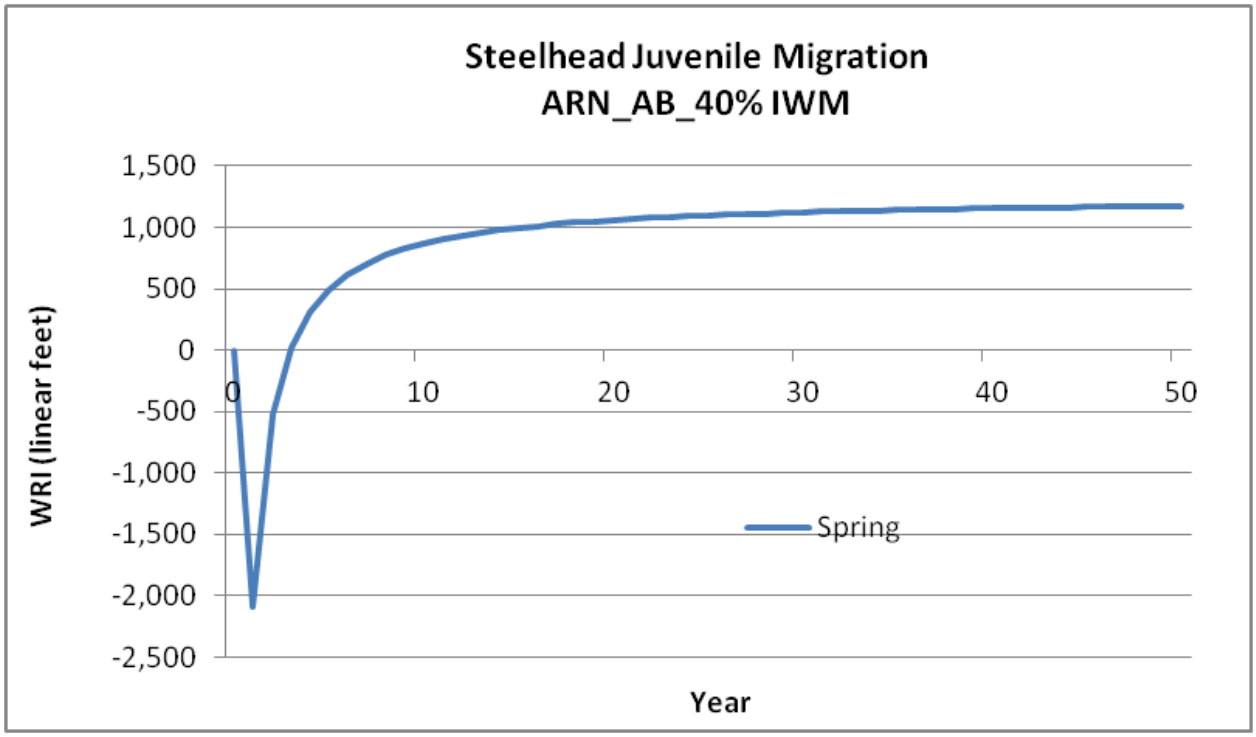


Figure 11. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for steelhead juvenile migration.

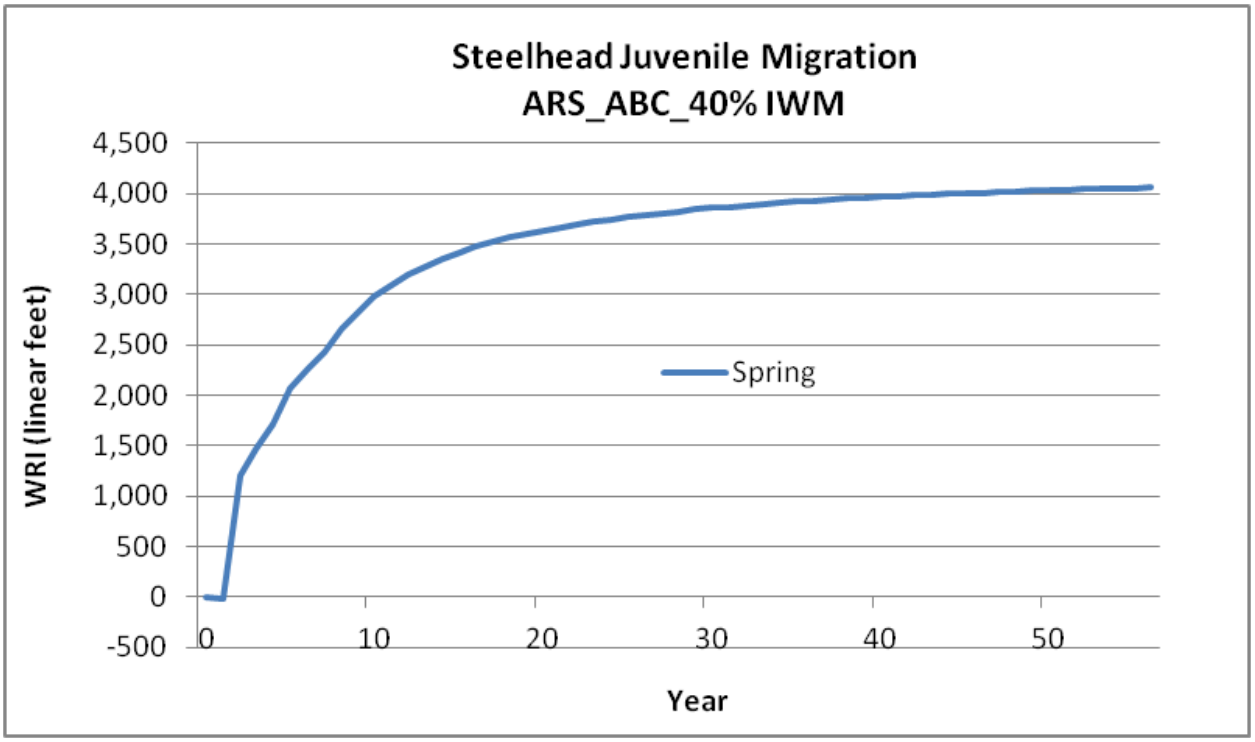


Figure 12. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for steelhead juvenile migration.

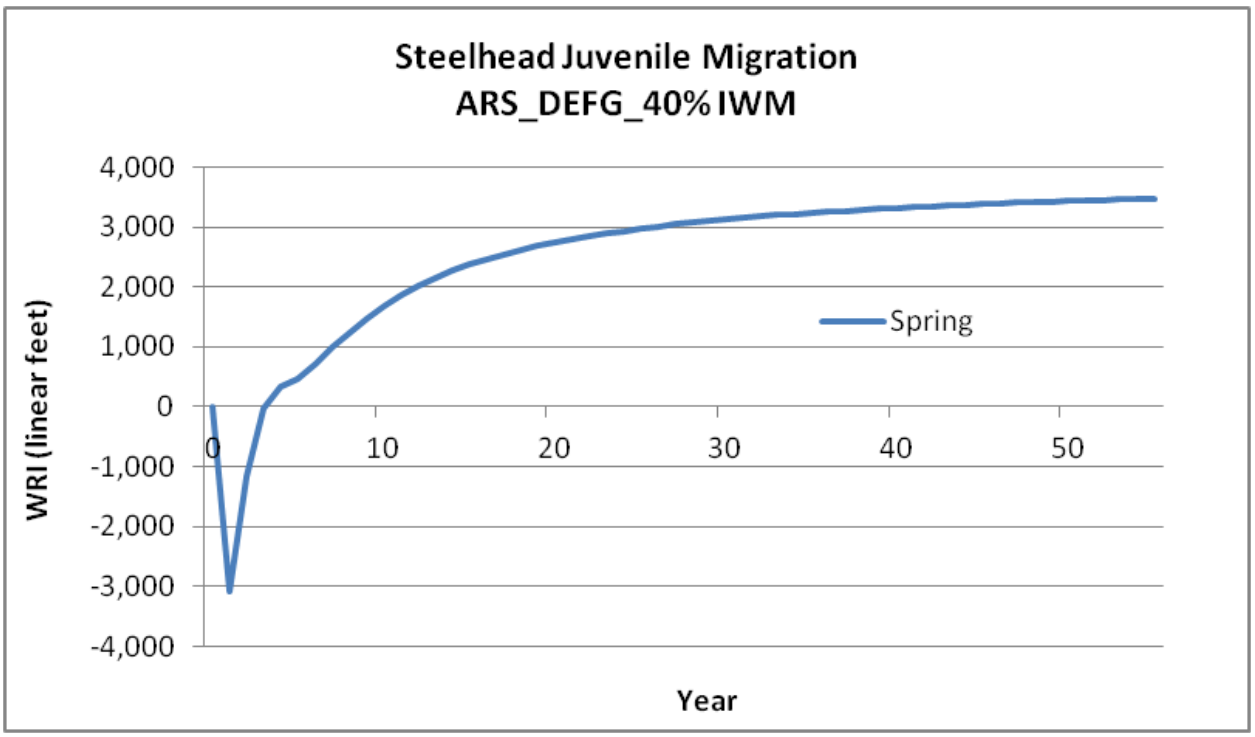


Figure 13. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for steelhead juvenile migration.

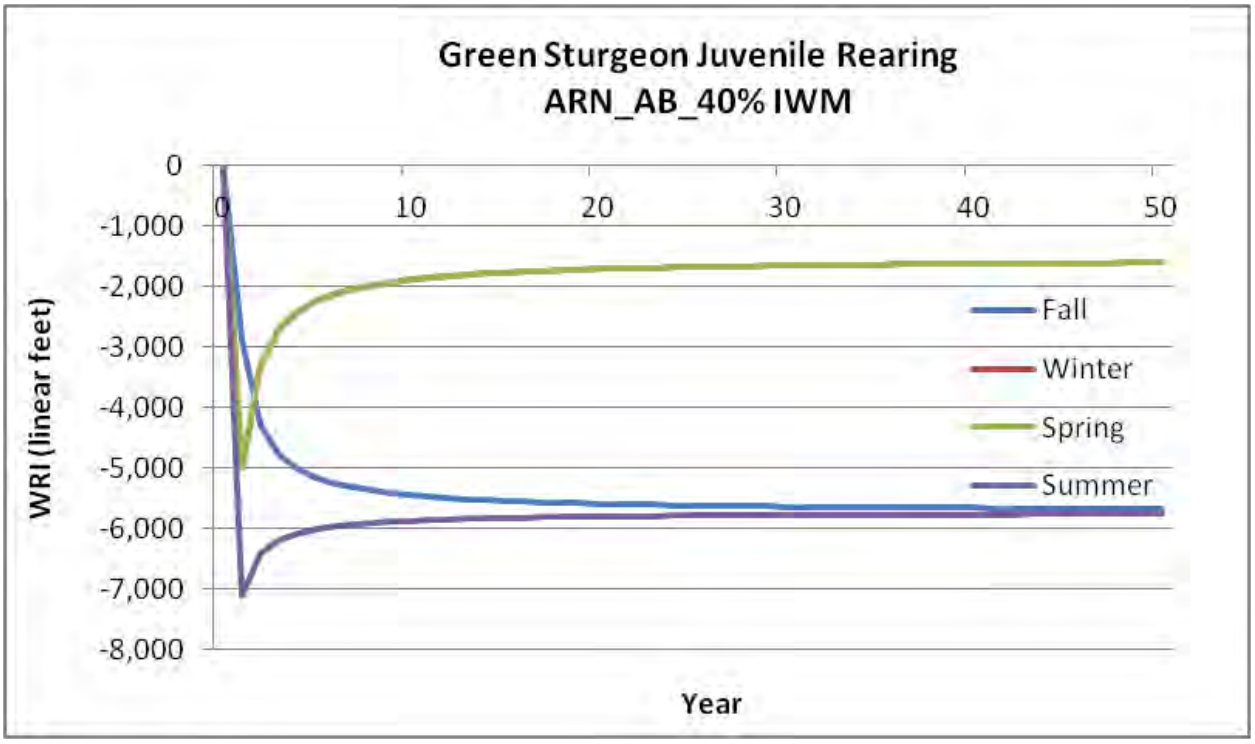


Figure 14. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for green sturgeon juvenile rearing.

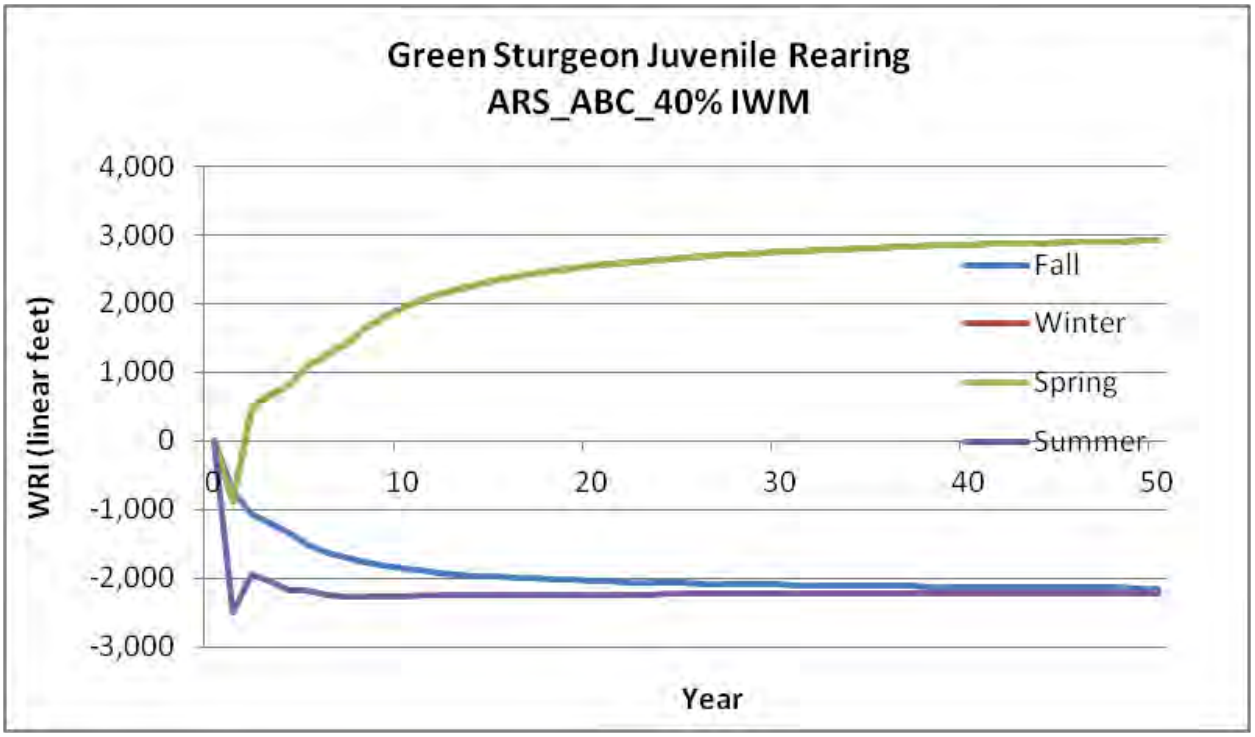


Figure 15. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for green sturgeon juvenile rearing.

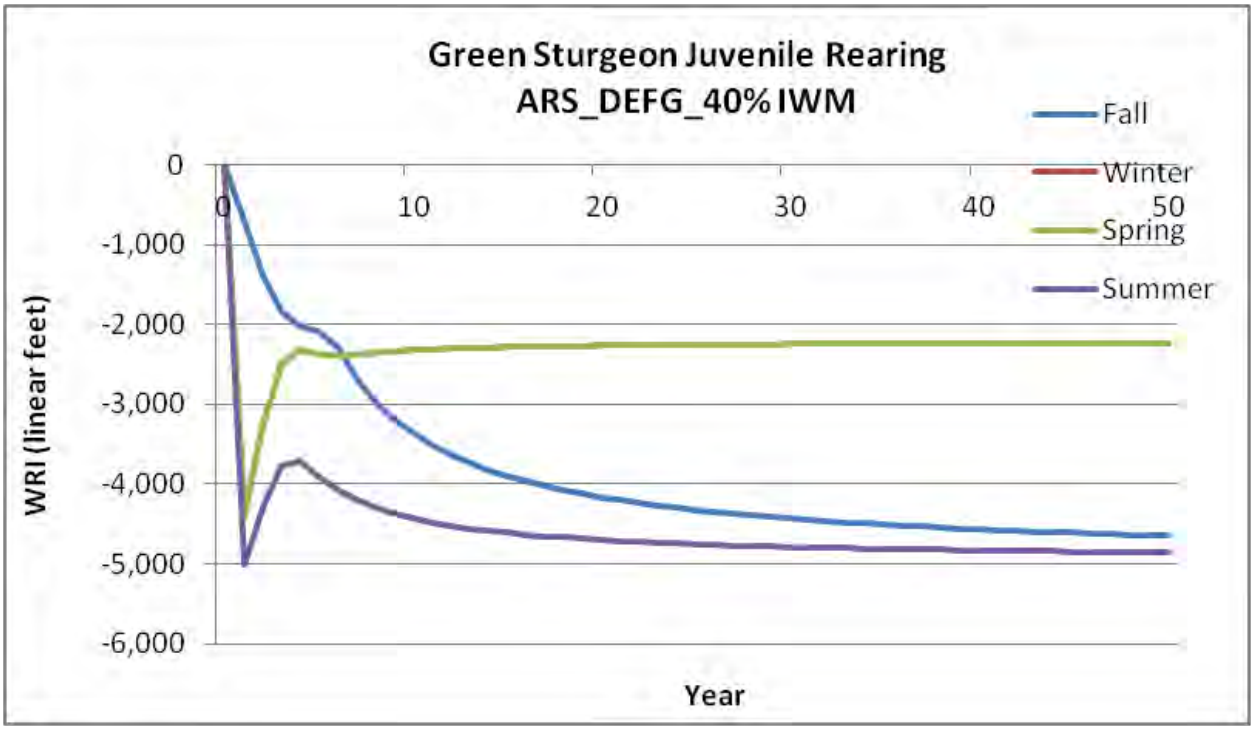


Figure 16. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for green sturgeon juvenile rearing.

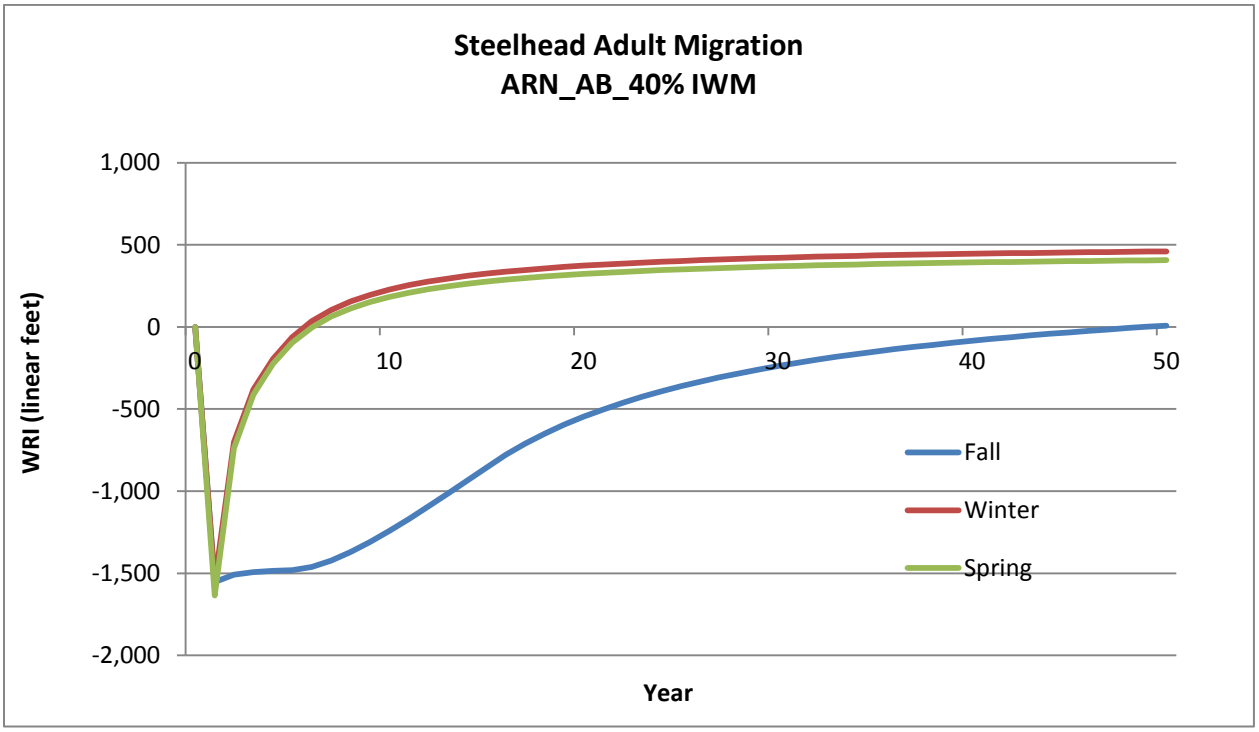


Figure 17. Weighted response indices at 40% IWM placement on the Sacramento River (ARN_AB) for steelhead adult migration.

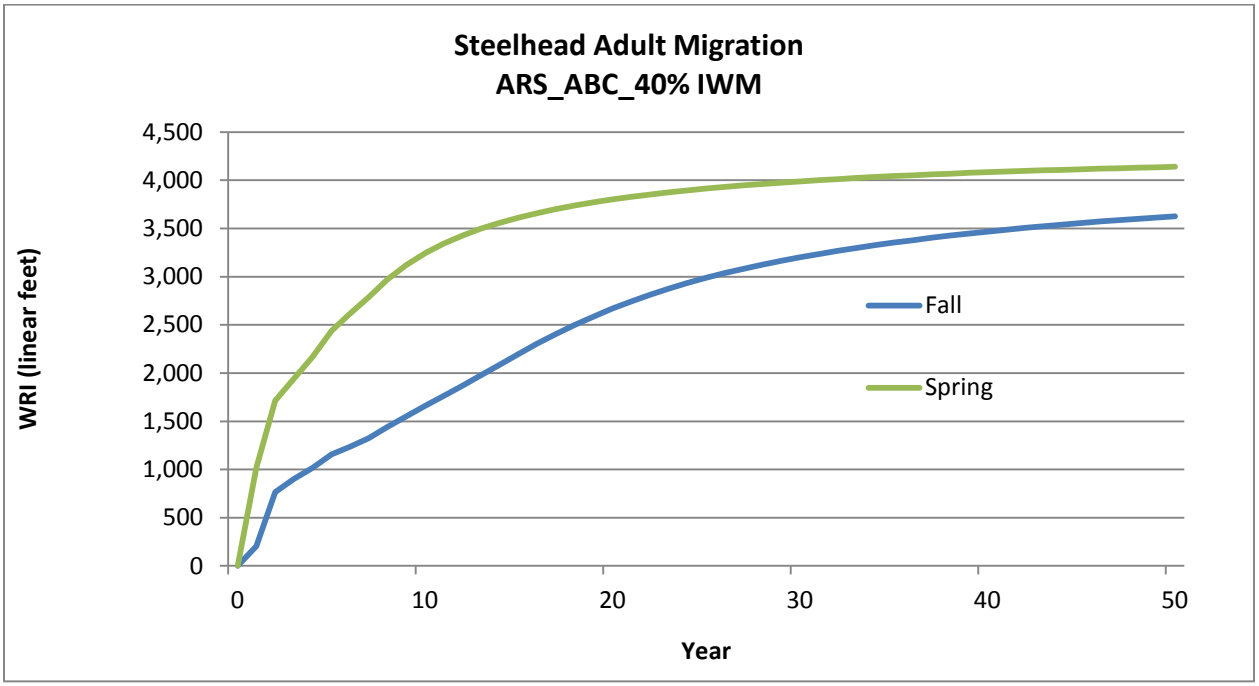


Figure 18. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_ABC) for steelhead adult migration.

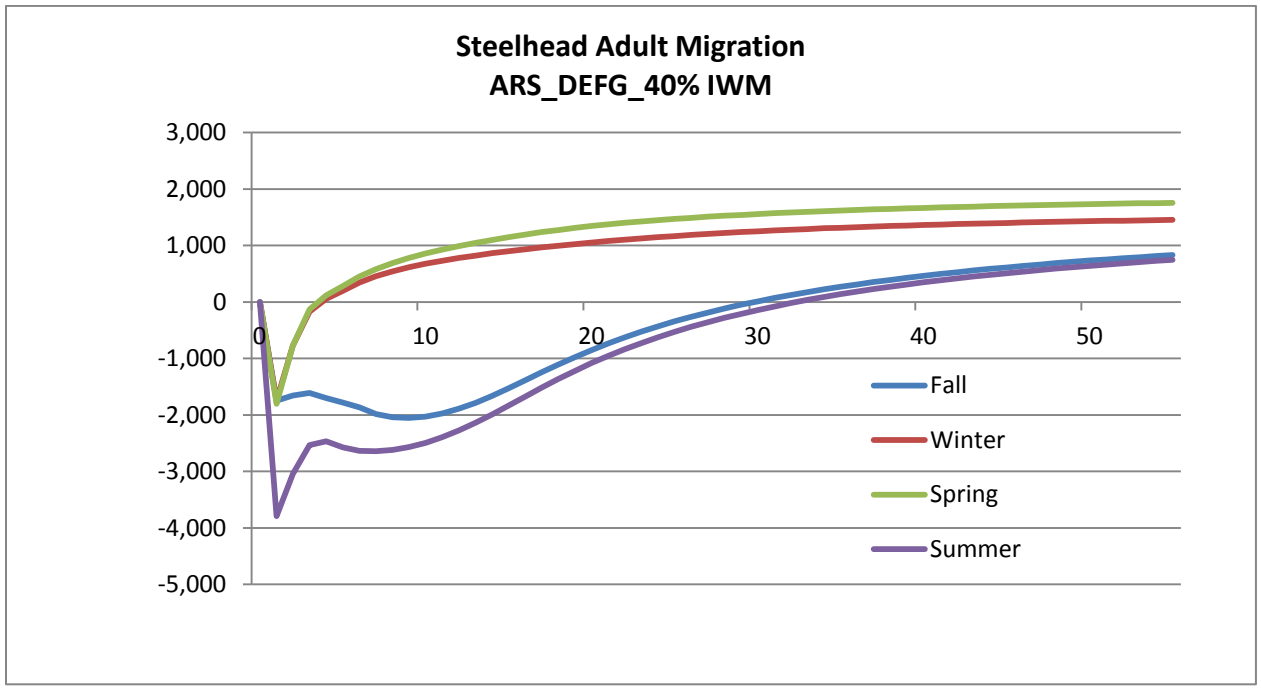


Figure 19. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for steelhead adult migration.

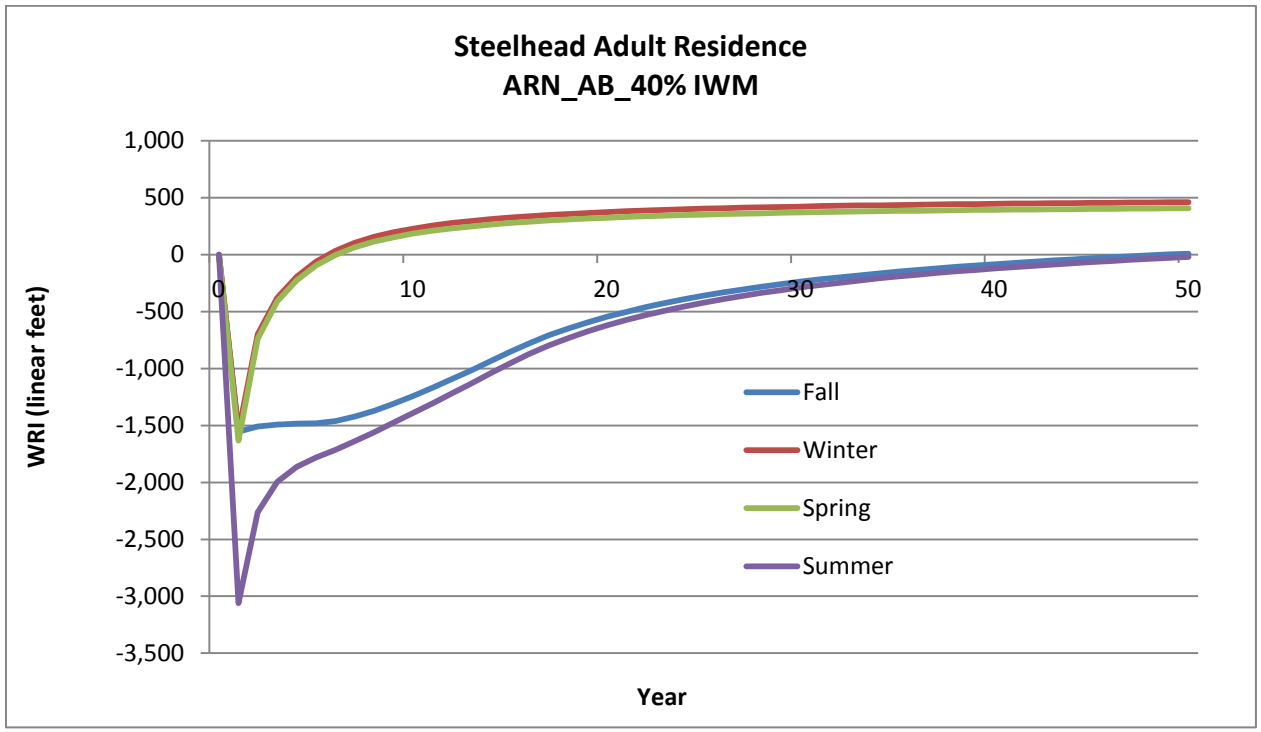


Figure 20. Weighted response indices at 40% IWM placement on the Sacramento River (ARN_AB) for steelhead adult residence.

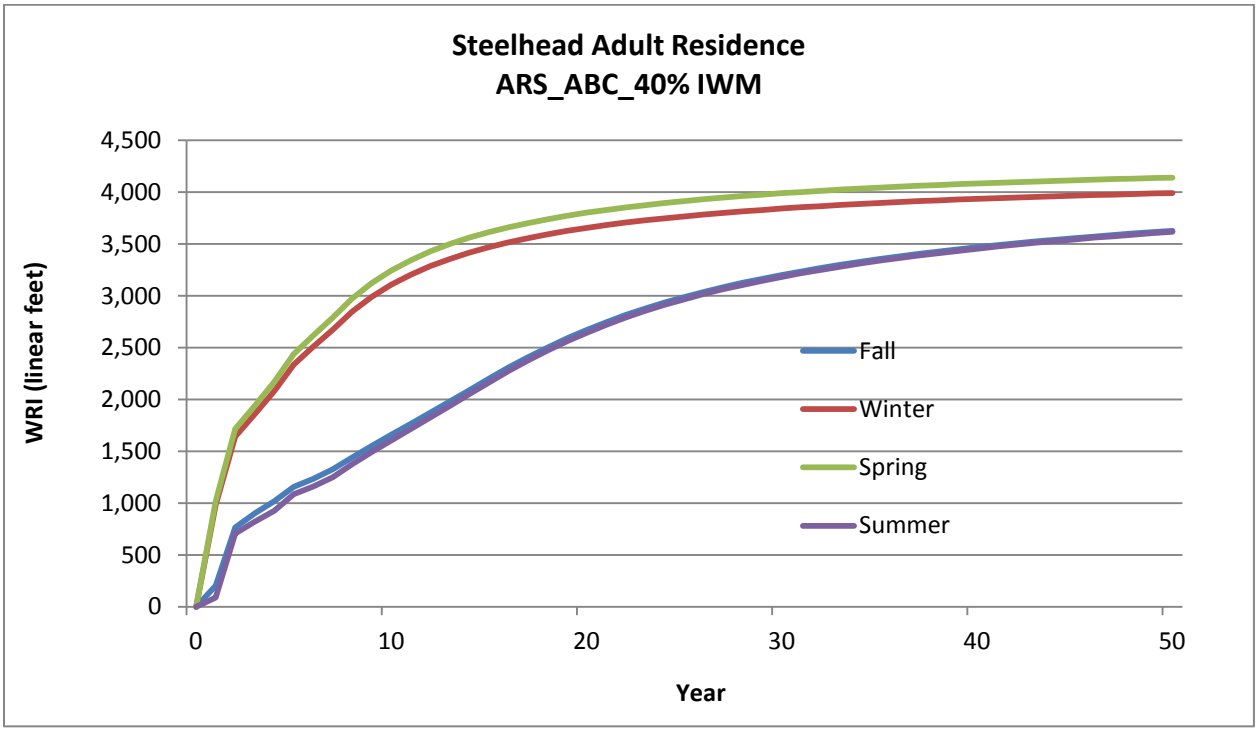


Figure 21. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_ABC) for steelhead adult residence.

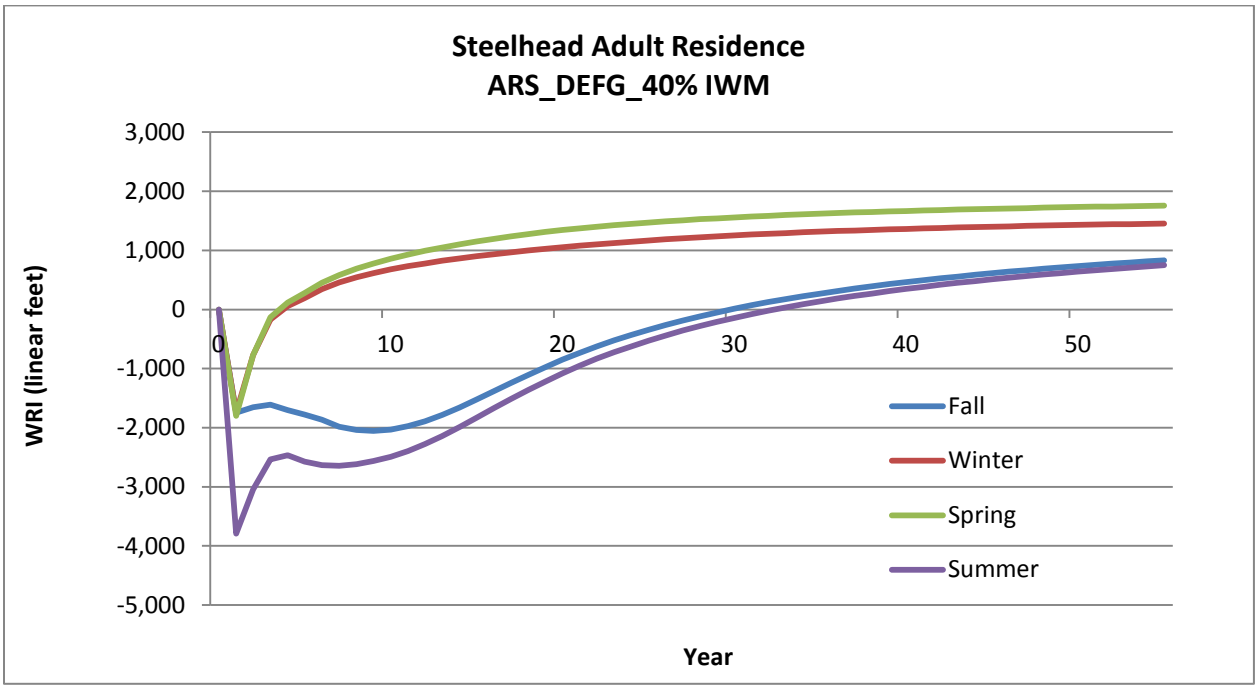


Figure 22. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for steelhead adult residence.

Table 30

ARN_AB_40% IWM

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-366	50	0
	Juvenile Migration	-2,303	50	0
Winter	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,102
	Juvenile Migration	-3,002	2	1,699
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,354
	Juvenile Migration	-2,681	4	1,699
Summer	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-421	50	0
	Juvenile Migration	-3,129	50	0
Fall-Run Chinook Salmon				
Fall	Adult Migration	-877	39	59
	Fry and Juvenile Rearing	-366	50	0
	Juvenile Migration	-2,303	50	0
Winter	Adult Migration	-759	5	245
	Fry and Juvenile Rearing	0	0	1,102
	Juvenile Migration	-3,002	4	1,699
Spring	Adult Migration	**	**	**
	Fry and Juvenile Rearing	0	0	1,354
	Juvenile Migration	-2,681	3	1,418
Summer	Adult Migration	**	**	**
	Fry and Juvenile Rearing	-421	50	0
	Juvenile Migration	-3,129	50	0
Steelhead				
Fall	Adult Migration	-1,554	48	8
	Fry and Juvenile Rearing	-712	50	0
	Juvenile Migration	***	***	***
	Adult Residence	-1,554	48	8
Winter	Adult Migration	-1,558	5	460

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Fry and Juvenile Rearing	-36	1	1,507
	Juvenile Migration	***	***	***
	Adult Residence	-1,558	5	460
Spring	Adult Migration	-1,635	6	407
	Fry and Juvenile Rearing	-1	1	1,731
	Juvenile Migration	-2,096	2	1,173
	Adult Residence	-1,635	6	407
Summer	Fry and Juvenile Rearing	-833	50	0
	Juvenile Migration	-3,013	50	0
	Adult Residence	-3,061	50	0
Green Sturgeon				
Fall	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-5,677	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-21	50	0
Winter	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-5,020	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-3,621	50	0
Spring	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-5,020	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-3,621	50	0
Summer	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-7,118	0	0
	Juvenile Migration	0	0	0
	Adult Residence	-942	50	0

* Not applicable, adult spring-run Chinook salmon are not present on the American River

** Not applicable, adult migration of fall-run Chinook begins in early fall.

*** Not applicable, historically juvenile steelhead migration occurs in spring and summer.

Table 31

ARS_ABC_40% IWM

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-229	26	112
	Juvenile Migration	-620	21	526
Winter	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,578
	Juvenile Migration	-333	1	5,377
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	2,001
	Juvenile Migration	0	0	5,123
Summer	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-239	26	111
	Juvenile Migration	-967	22	510
Fall-Run Chinook Salmon				
Fall	Adult Migration	0	0	1,860
	Fry and Juvenile Rearing	-229	26	112
	Juvenile Migration	-620	21	526
Winter	Adult Migration	0	0	1,937
	Fry and Juvenile Rearing	0	0	1,578
	Juvenile Migration	-333	1	5,377
Spring	Adult Migration	**	**	**
	Fry and Juvenile Rearing	0	0	965
	Juvenile Migration	0	0	5,123
Summer	Adult Migration	**	**	**
	Fry and Juvenile Rearing	-239	26	111
	Juvenile Migration	-967	22	510
Steelhead				
Fall	Adult Migration	0	0	3,696
	Fry and Juvenile Rearing	-489	36	88
	Juvenile Migration	***	***	***
	Adult Residence	0	0	3,696
Winter	Adult Migration	0	0	4,015

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Fry and Juvenile Rearing	0	0	2,194
	Juvenile Migration	***	***	***
	Adult Residence	0	0	4,015
Spring	Adult Migration	0	0	4,164
	Fry and Juvenile Rearing	0	0	2,601
	Juvenile Migration	0	0	4,061
	Adult Residence	0	0	4,164
Green Sturgeon				
Fall	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-2,154	50	0
	Juvenile Migration	0	0	0
	Adult Residence	0	0	1,548
Winter	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-876	1	2,941
	Juvenile Migration	0	0	0
	Adult Residence	-2,917	50	0
Spring	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-876	1	2,941
	Juvenile Migration	0	0	0
	Adult Residence	-2,917	50	0
Summer	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-2,496	50	0
	Juvenile Migration	0	0	0
	Adult Residence	0	0	1,537

* Not applicable, adult spring-run Chinook salmon are not present on the American River

** Not applicable, adult migration of fall-run Chinook begins in early fall.

*** Not applicable, historically juvenile steelhead migration occurs in spring and summer.

Table 32

ARS_DEFG_40% IWM

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Adult Migration	-2,136	37	319
	Fry and Juvenile Rearing	-578	36	113
	Juvenile Migration	-4,258	50	0
Fall-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Fry and Juvenile Rearing	-578	36	113
	Juvenile Migration	-4,258	50	0
Late-Fall-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931
	Fry and Juvenile Rearing	0	0	3,445
Summer	Fry and Juvenile Rearing	-578	36	113
Winter-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Adult Migration	-2,136	37	319
	Fry and Juvenile Rearing	-578	36	113
Steelhead				
Fall	Adult Migration	-2,053	29	832
	Fry and Juvenile Rearing	-1,156	44	99
	Juvenile Migration	-3,985	50	0
	Adult Residence	-2,053	29	832
Winter	Adult Migration	-1,747	3	1,455
	Fry and Juvenile Rearing	-77	1	3,234
	Juvenile Migration	-3,044	3	3,355
	Adult Residence	-1,747	3	1,455
Spring	Adult Migration	-1,801	3	1,757
	Fry and Juvenile Rearing	-36	1	4,317
	Juvenile Migration	-3,082	3	3,474
	Adult Residence	-1,801	3	1,757
Summer	Adult Migration	-3,793	32	748
	Fry and Juvenile Rearing	-1,206	45	92

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Adult Residence	-3,793	32	748
sDPS Green Sturgeon				
Fall	Fry and Juvenile Rearing	-4,674	50	0
	Juvenile Migration	0	0	0
Winter	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-4,397	50	0
	Adult Residence	-3,068	50	0
Spring	Fry and Juvenile Rearing	-4,397	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-3,068	50	0
	Adult Migration	0	0	0
Summer	Fry and Juvenile Rearing	-5,009	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-1,298	50	0

* Not applicable because adult fall-run Chinook salmon migrate in early fall.

Table 33

SBP

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-4	50	0
	Juvenile Migration	-26	50	0
Winter	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-9	50	0
	Juvenile Migration	-146	50	0
Spring	Adult Migration	-51	50	0
	Fry and Juvenile Rearing	-21	50	0
	Juvenile Migration	-188	50	0
Winter-Run Chinook Salmon				
Fall	Adult Migration	**	**	**
	Fry and Juvenile Rearing	-4	50	0
	Juvenile Migration	-26	50	0
Winter	Adult Migration	-21	50	0
	Fry and Juvenile Rearing	-9	50	0
	Juvenile Migration	-146	50	0
Spring	Adult Migration	-51	50	0
	Fry and Juvenile Rearing	-21	50	0
	Juvenile Migration	-188	50	0
Fall-Run Chinook Salmon				
Fall	Adult Migration	-60	50	0
	Fry and Juvenile Rearing	-4	50	0
	Juvenile Migration	-26	50	0
Winter	Adult Migration	-21	50	0
	Fry and Juvenile Rearing	-9	50	0
	Juvenile Migration	-146	50	0
Spring	Adult Migration	***	***	***
	Fry and Juvenile Rearing	-21	50	0
	Juvenile Migration	-188	50	0
Late-Fall-Run Chinook Salmon				
Fall	Adult Migration	-60	50	0

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Fry and Juvenile Rearing	-4	50	0
	Juvenile Migration	-26	50	0
Winter	Adult Migration	-21	50	0
	Fry and Juvenile Rearing	-9	50	0
	Juvenile Migration	-146	50	0
Spring	Adult Migration	****	****	****
	Fry and Juvenile Rearing	-21	50	0
	Juvenile Migration	-188	50	0
Steelhead				
Fall	Adult Migration	-100	50	0
	Fry and Juvenile Rearing	-17	50	0
	Juvenile Migration	-35	50	0
Winter	Adult Migration	-40	50	0
	Fry and Juvenile Rearing	-29	50	0
	Juvenile Migration	-127	50	0
Spring	Adult Migration	-87	50	0
	Fry and Juvenile Rearing	-55	50	0
	Juvenile Migration	-174	50	0
sDPS Green Sturgeon				
Fall	Fry and Juvenile Rearing	0	0	115
	Juvenile Migration	0	0	0
Winter	Adult Migration	0	0	0
	Fry and Juvenile Rearing	0	0	115
Spring	Adult Migration	0	0	0
	Fry and Juvenile Rearing	0	0	115
	Juvenile Migration	0	0	0

* Not applicable, adult spring-run Chinook salmon migrate upstream in the spring

** Not applicable, adult winter-run Chinook salmon migrate upstream in the winter

*** Not applicable, adult fall-run Chinook salmon migrate upstream in the fall

**** Not applicable, adult lt.fall-run Chinook salmon migrate upstream in the late fall and winter

7.0 References

USACE (U. S. Army Corps of Engineers). 2008. Standard assessment methodology (SAM) analysis of 29 constructed bank repair sites for the Sacramento River Bank Protection Project. Final. Contract No. W91238-07-C-0002. Prepared by Stillwater Sciences, Berkeley, California for USACE, Sacramento District, Sacramento, California. July.

USACE (U. S. Army Corps of Engineers). 2012. Standard Assessment Methodology for the Sacramento River Bank Protection Project, 2010–2012 Certification Update, Final. Prepared for U.S. Army Corps of Engineers, Sacramento District by Stillwater Sciences, Berkeley, California. Contract W91238-09-P-0249 Task Order 3.

USACE (U. S. Army Corps of Engineers). 2013. Standard Assessment Methodology (SAM) for the Sacramento River Bank Protection Project (SRBPP), Cumulative Analysis of 22 Sites. Final June 2013.

Appendix C

Delta Smelt Shallow Water Habitat Analysis

SACRAMENTO RIVER D/S OF AMERICAN RIVER

RIVER STATION	AVG. WS ELEV (NAVD88)			SHA DEPTH
(mi)	MHHW	SHALLOW END	SUMMER	(ft)
60.39	8.76	-2.22	10.7	10.98
60.39	8.76	-2.22	10.7	10.98
60.25	8.73	-2.22	10.6	10.95
60.00	8.64	-2.25	10.6	10.89
59.75	8.59	-2.25	10.5	10.84
59.70	8.59	-2.25	10.5	10.84
59.69	8.59	-2.25	10.5	10.84
59.69	8.59	-2.25	10.5	10.84
59.68	8.59	-2.25	10.5	10.84
59.68	8.59	-2.25	10.5	10.84
59.68	8.59	-2.25	10.5	10.84
59.50	8.56	-2.25	10.5	10.81
59.29	8.55	-2.25	10.5	10.80
59.29	8.55	-2.25	10.5	10.80
59.27	8.55	-2.25	10.5	10.80
59.27	8.55	-2.25	10.5	10.80
59.25	8.55	-2.25	10.5	10.80
59.00	8.49	-2.26	10.5	10.75
58.75	8.42	-2.28	10.4	10.70
58.52	8.36	-2.29	10.4	10.65
58.52	8.36	-2.29	10.4	10.65
58.51	8.36	-2.29	10.3	10.65
58.50	8.36	-2.29	10.3	10.65
58.50	8.36	-2.29	10.3	10.65
58.50	8.36	-2.29	10.3	10.65
58.49	8.35	-2.29	10.3	10.64
58.49	8.35	-2.29	10.3	10.64
58.25	8.30	-2.30	10.3	10.60
58.00	8.25	-2.30	10.2	10.55
57.85	8.23	-2.30	10.2	10.53
57.64	8.19	-2.30	10.1	10.49
57.50	8.18	-2.30	10.1	10.48
57.25	8.13	-2.31	10.1	10.44
57.00	8.09	-2.31	10.0	10.40
56.75	8.05	-2.31	10.0	10.36
56.50	8.02	-2.31	10.0	10.33
56.25	7.98	-2.31	10.0	10.29
56.00	7.95	-2.32	9.9	10.27
55.75	7.93	-2.32	9.9	10.25
55.49	7.89	-2.32	9.9	10.21
55.25	7.87	-2.32	9.9	10.19
55.00	7.87	-2.32	9.9	10.19
54.75	7.84	-2.32	9.9	10.16

54.50	7.79	-2.32	9.8	10.11
54.25	7.76	-2.32	9.8	10.08
54.00	7.73	-2.32	9.8	10.05
53.75	7.69	-2.33	9.7	10.02
53.50	7.64	-2.33	9.7	9.97
53.25	7.61	-2.33	9.7	9.94
53.00	7.57	-2.33	9.7	9.90
52.75	7.50	-2.35	9.6	9.85
52.50	7.44	-2.36	9.6	9.80
52.25	7.39	-2.36	9.6	9.75
52.00	7.37	-2.36	9.5	9.73
51.75	7.33	-2.36	9.5	9.69
51.50	7.29	-2.37	9.5	9.66
51.25	7.21	-2.37	9.4	9.58
51.00	7.19	-2.37	9.4	9.56
50.75	7.16	-2.37	9.4	9.53
50.50	7.12	-2.38	9.4	9.50
50.25	7.08	-2.38	9.4	9.46
50.00	7.05	-2.38	9.3	9.43
49.75	7.00	-2.38	9.3	9.38
49.50	6.96	-2.39	9.3	9.35
49.25	6.91	-2.39	9.2	9.30
49.00	6.87	-2.39	9.2	9.26
48.75	6.84	-2.39	9.2	9.23
48.50	6.79	-2.39	9.2	9.18
48.25	6.75	-2.40	9.1	9.15
48.00	6.69	-2.41	9.1	9.10
47.75	6.62	-2.42	9.1	9.04
47.50	6.57	-2.42	9.0	8.99
47.25	6.53	-2.42	9.0	8.95
47.00	6.51	-2.42	9.0	8.93
46.75	6.49	-2.42	9.0	8.91
46.50	6.48	-2.42	9.0	8.90
46.43	6.47	-2.42	9.0	8.89
46.42	6.47	-2.42	9.0	8.89
46.42	6.47	-2.42	9.0	8.89
46.42	6.47	-2.42	9.0	8.89
46.25	6.44	-2.42	9.0	8.86
46.00	6.42	-2.42	9.0	8.84
45.75	6.39	-2.43	8.9	8.82
45.50	6.37	-2.43	8.9	8.80
45.25	6.34	-2.43	8.9	8.77
45.00	6.31	-2.43	8.9	8.74

SHADED HABITAT AREA

SECTIONS ANALYZED

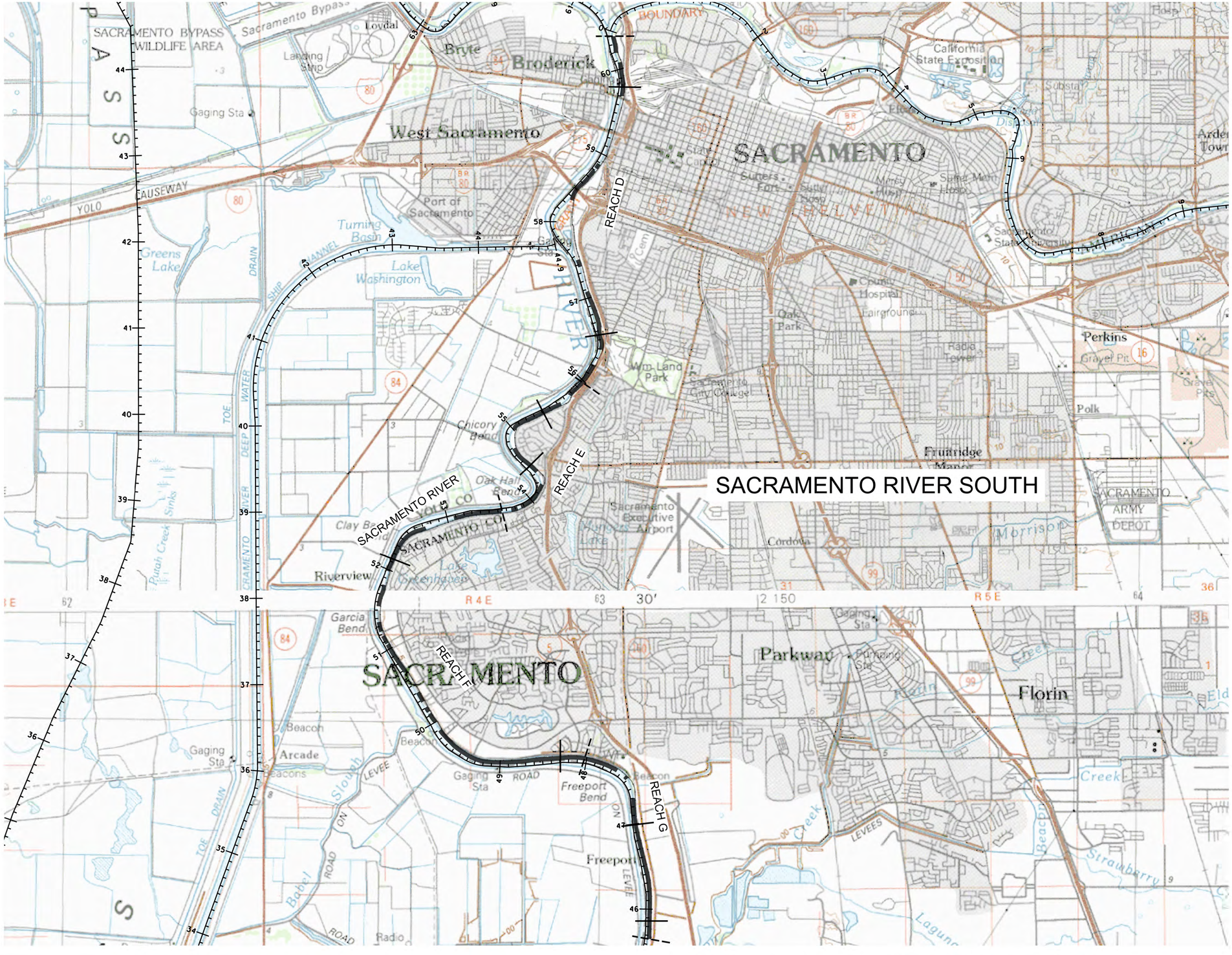
REACH	RM	STA	WATER SURFACE		
			MHHW	SHALLOW END	SUMMER
D	59.80	32+00	8.6	-2.3	10.5
D	56.55	195+00	8.0	-2.3	10.0
E	55.41	260+00	7.9	-2.3	9.9
E	54.40	305+00	7.8	-2.3	9.8
F	52.13	430+00	7.4	-2.4	9.5
F	48.30	625+00	6.8	-2.4	9.1
G	46.99	700+00	6.5	-2.4	9.0
G	45.87	760+00	6.4	-2.4	8.9

IMPACTED SHADED HABITAT AREA

REACH	FEATURE LENGTH	SHA SWATH (ft)		DIFFERENCE	IMPACTED AREAS		WORST CASE
	(ft)	EXISTING	W/PROJECT		SF	AC	
D	9,200	23.93	26.54	2.61	24,000	0.55	
D	9,200	53.17	26.33	-26.84	-246,900	-5.67	-5.67
E	8,850	22.84	27.97	5.13	45,400	1.04	
E	8,850	48.73	26.87	-21.86	-193,500	-4.44	-4.44
F	21,100	35.94	27.92	-8.02	-169,200	-3.88	-3.88
F	21,100	19.02	26.67	7.65	161,400	3.71	
G	11,150	29.55	26.17	-3.38	-37,700	-0.87	-0.87
G	11,150	21.05	26.07	5.02	56,000	1.29	

IMPACTED SPAWNING AREAS				
REACH	FEATURE LENGTH (ft)	EXISTING (ft)	SF	AC
D	9200	53.17	489164	11.23
E	8850	48.73	431261	9.90
F	21100	35.94	758334	17.41
G	11150	29.55	329483	7.56
				46.10

SACRAMENTO RIVER SOUTH



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SHA ANALYSIS OVERVIEW

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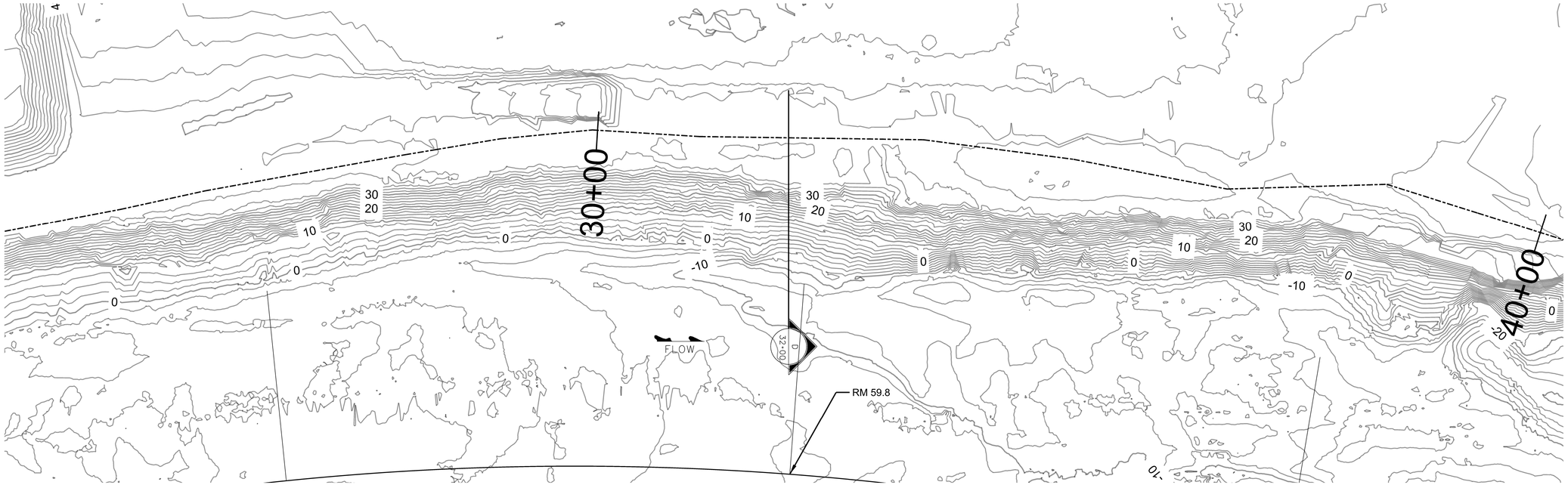

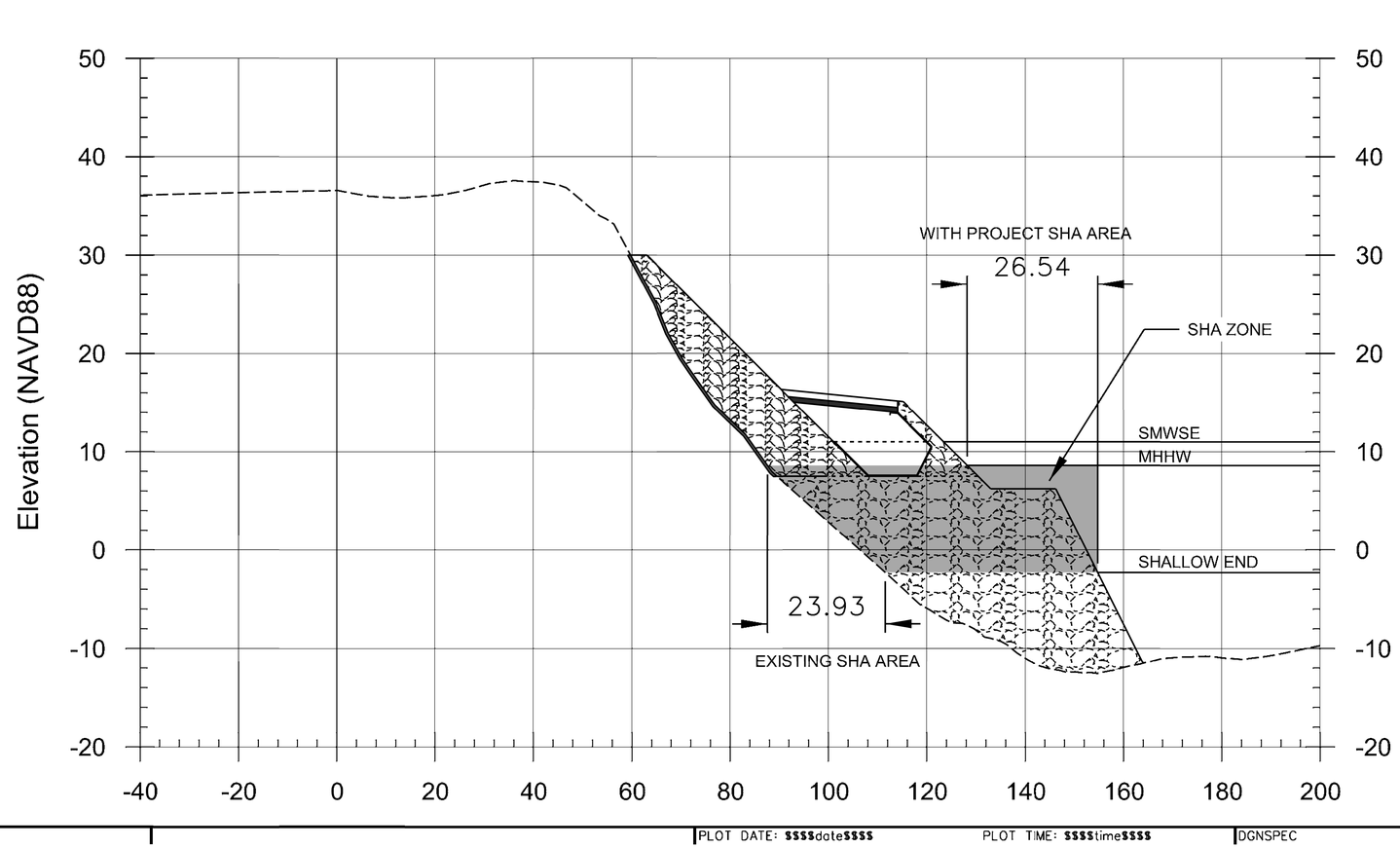

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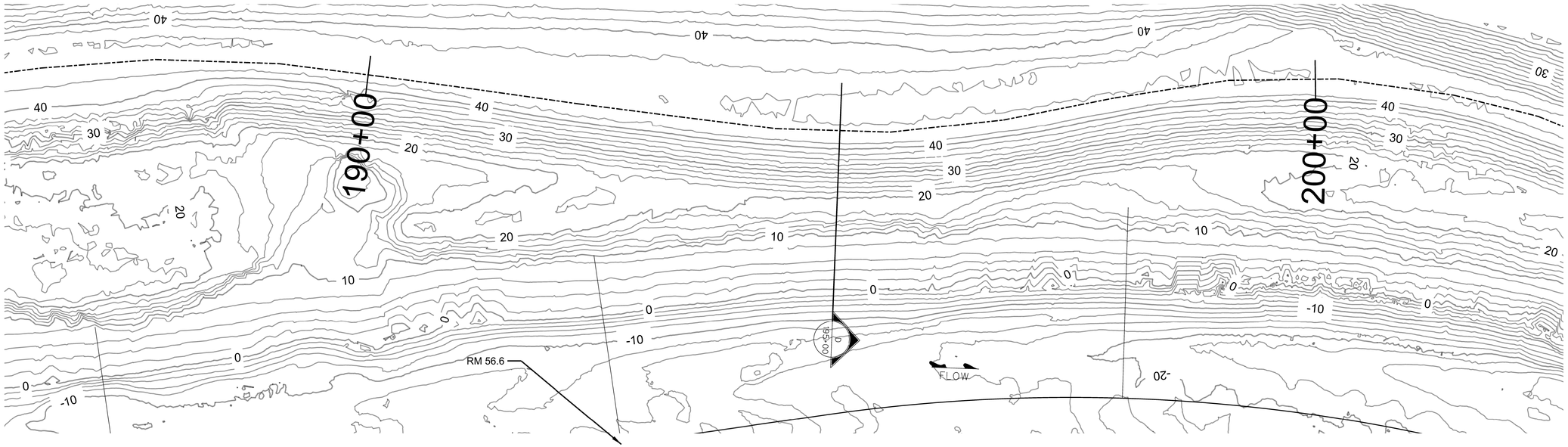

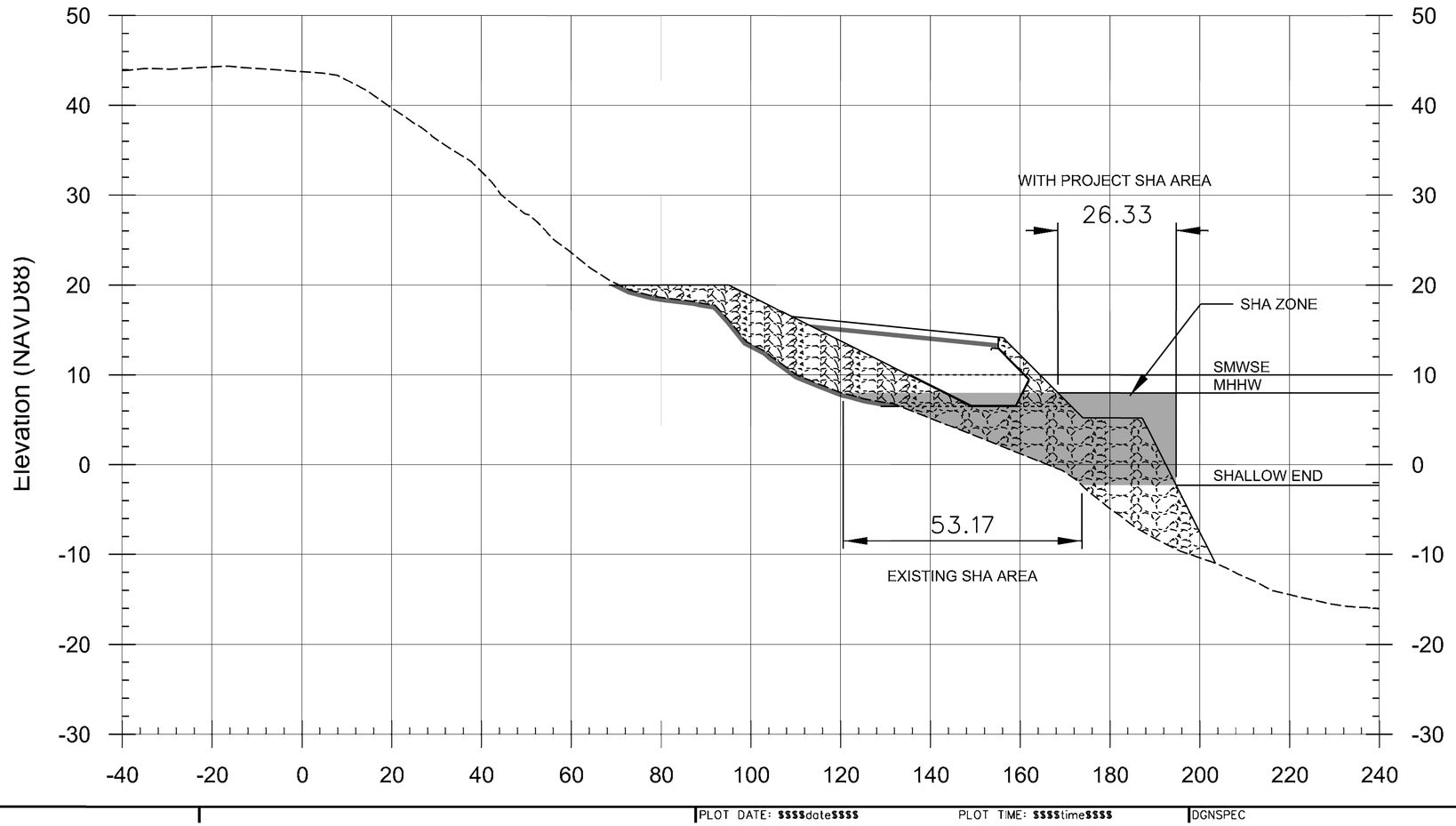

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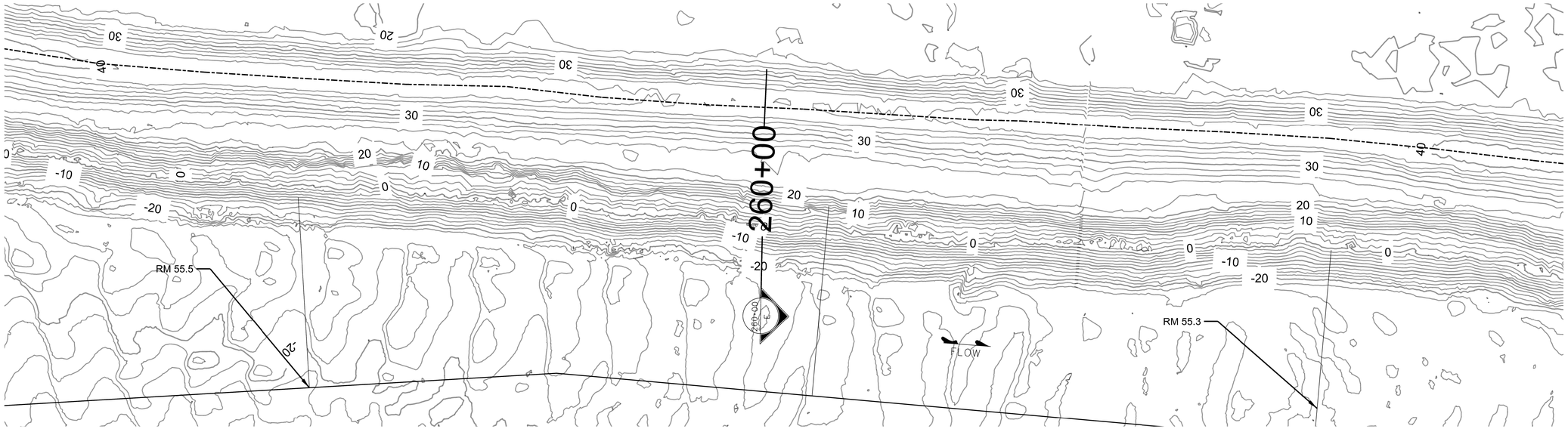

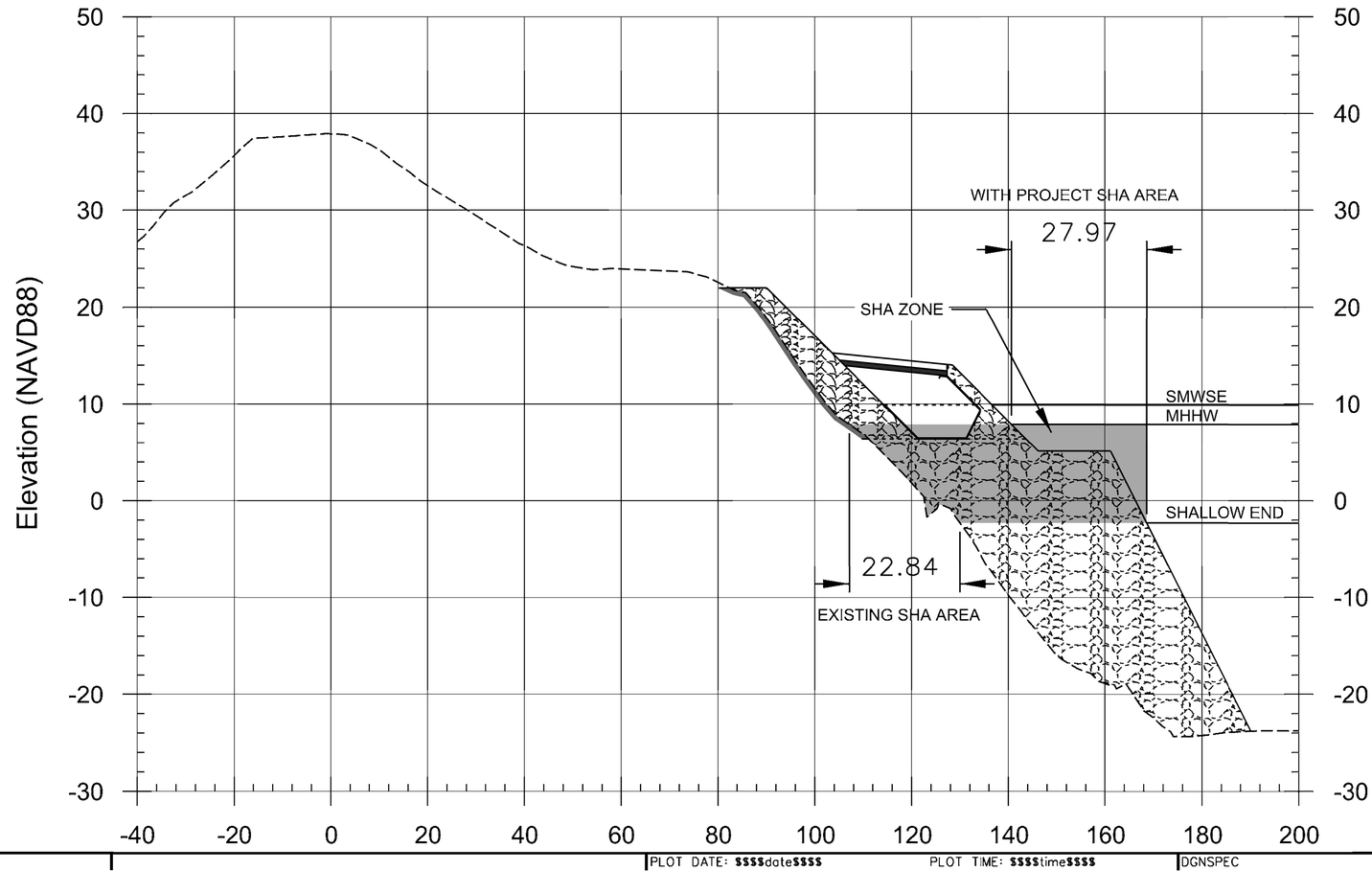

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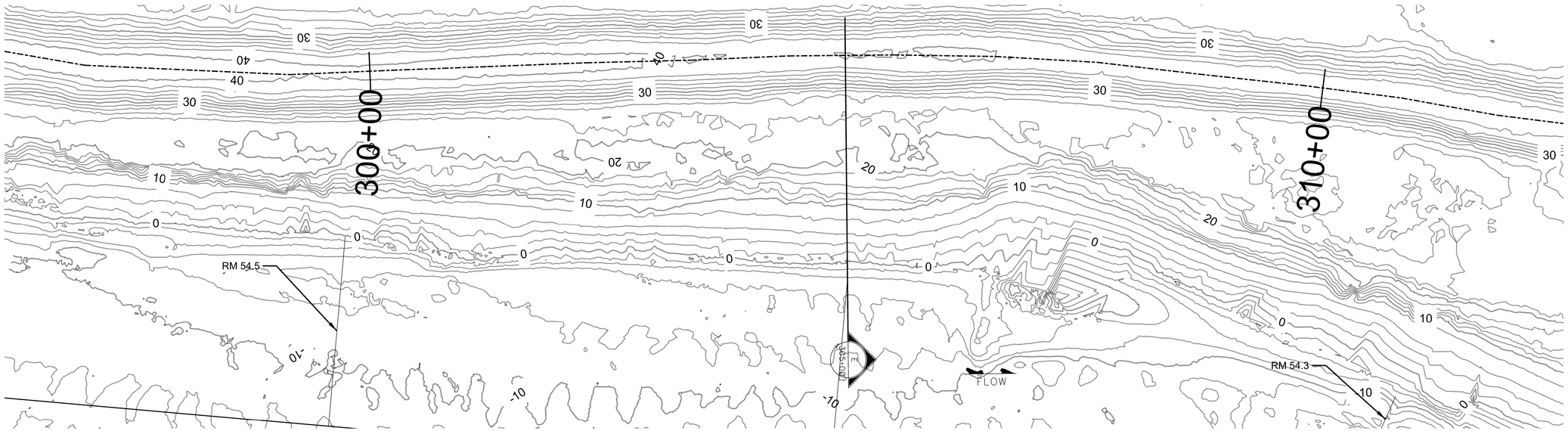

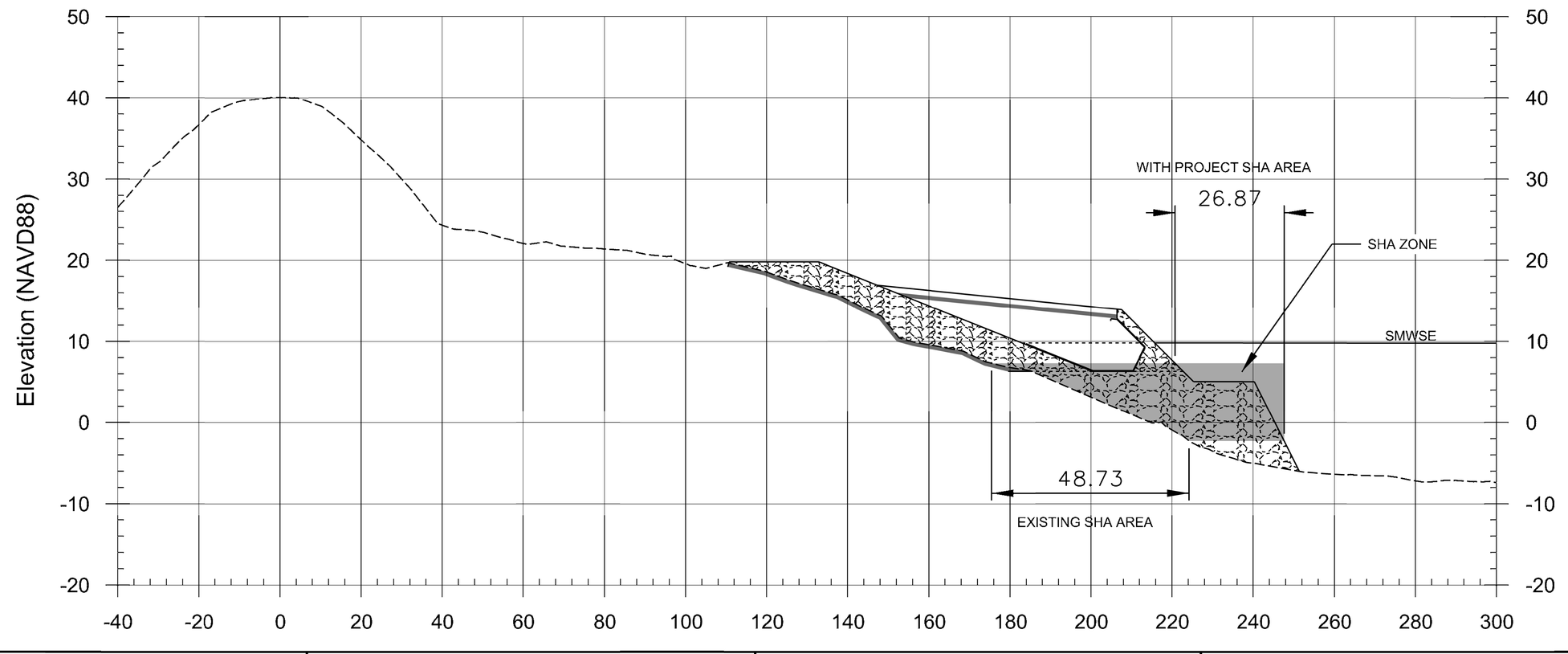

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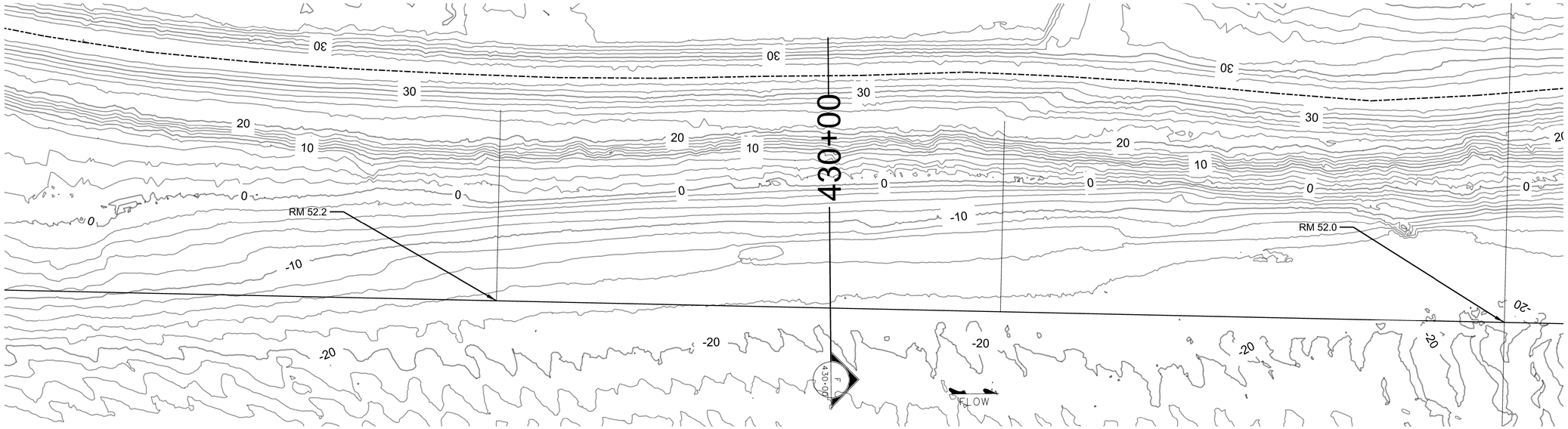

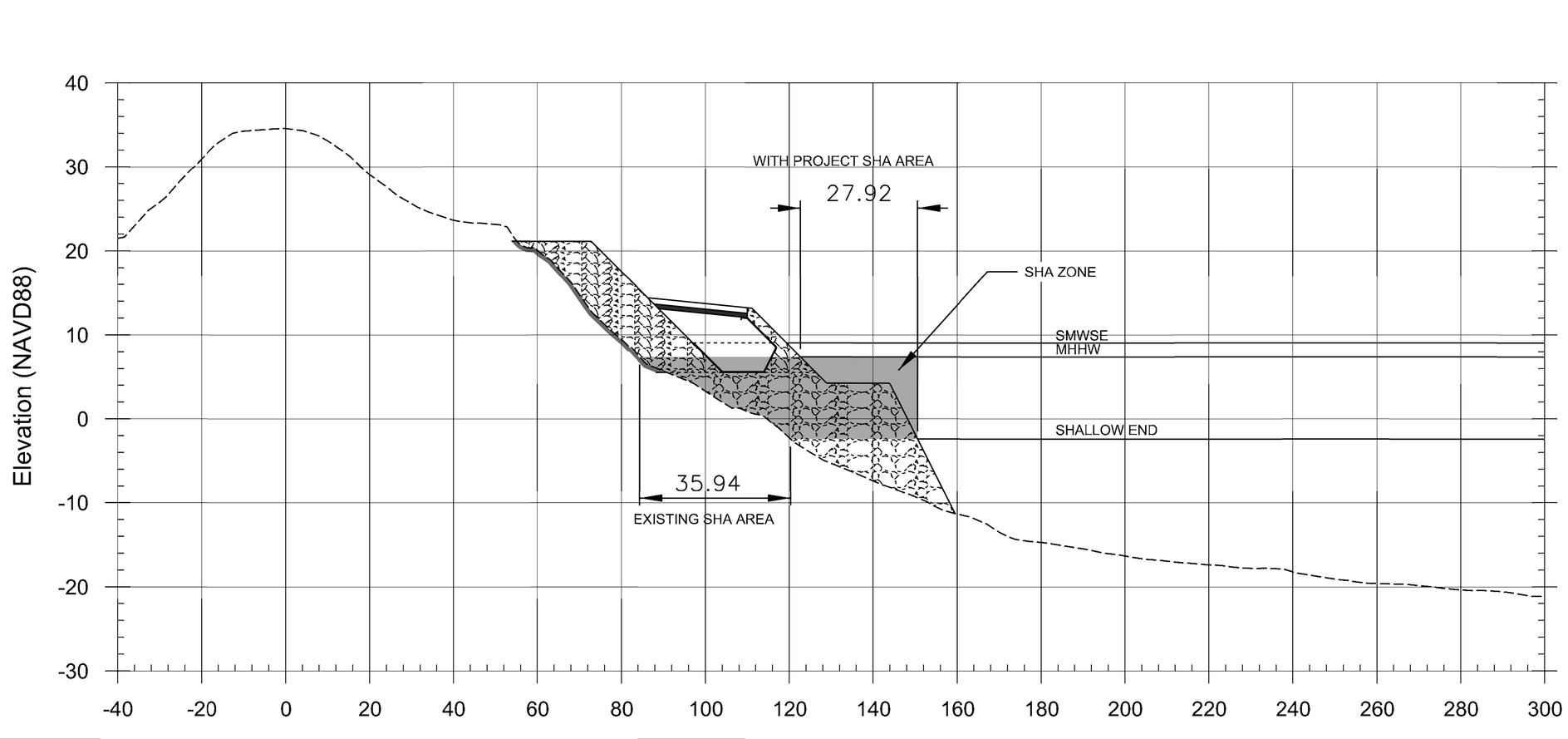

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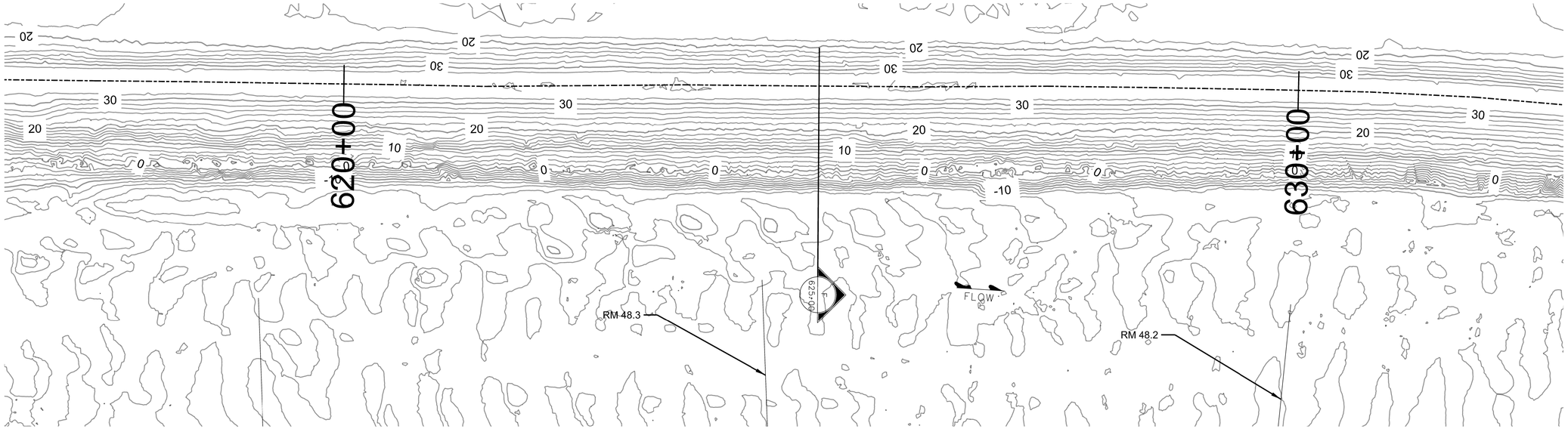

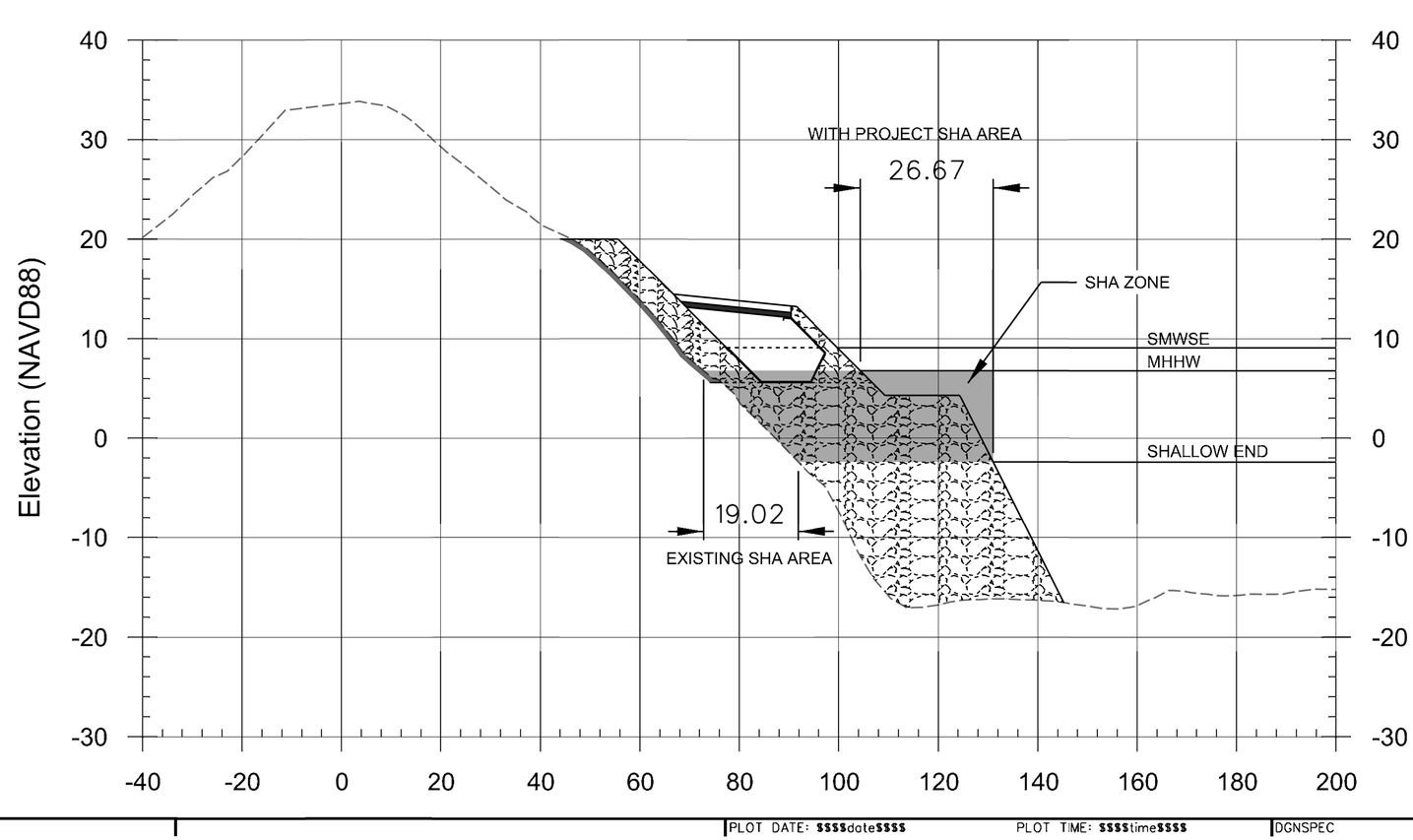

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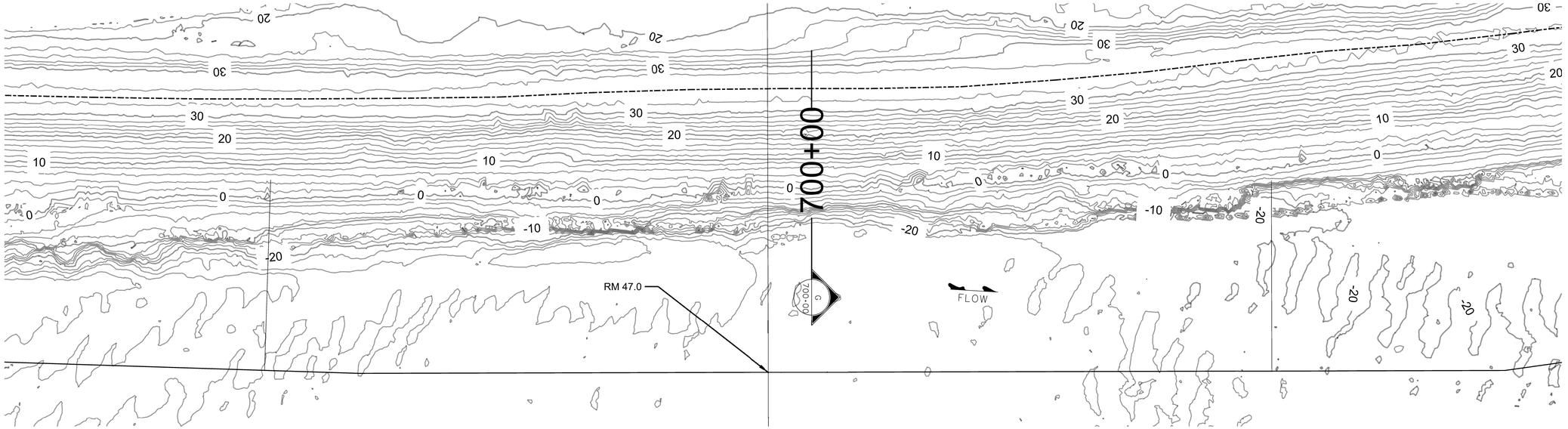

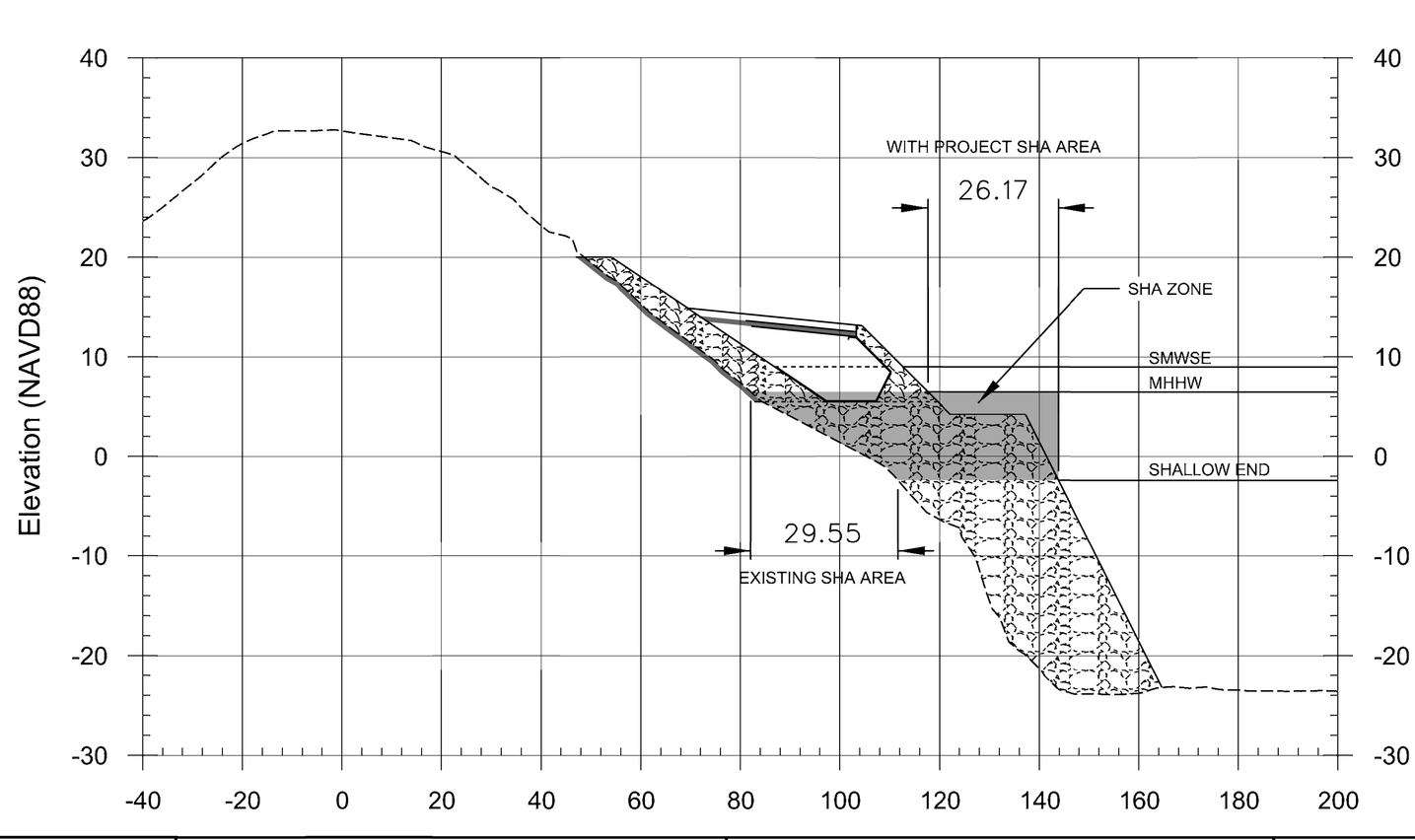

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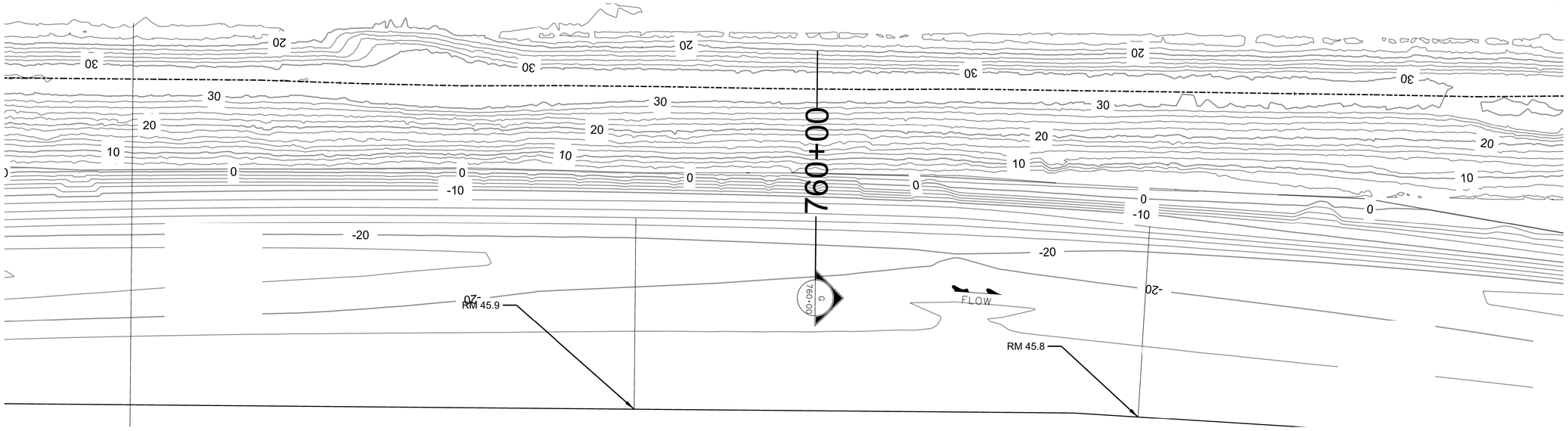

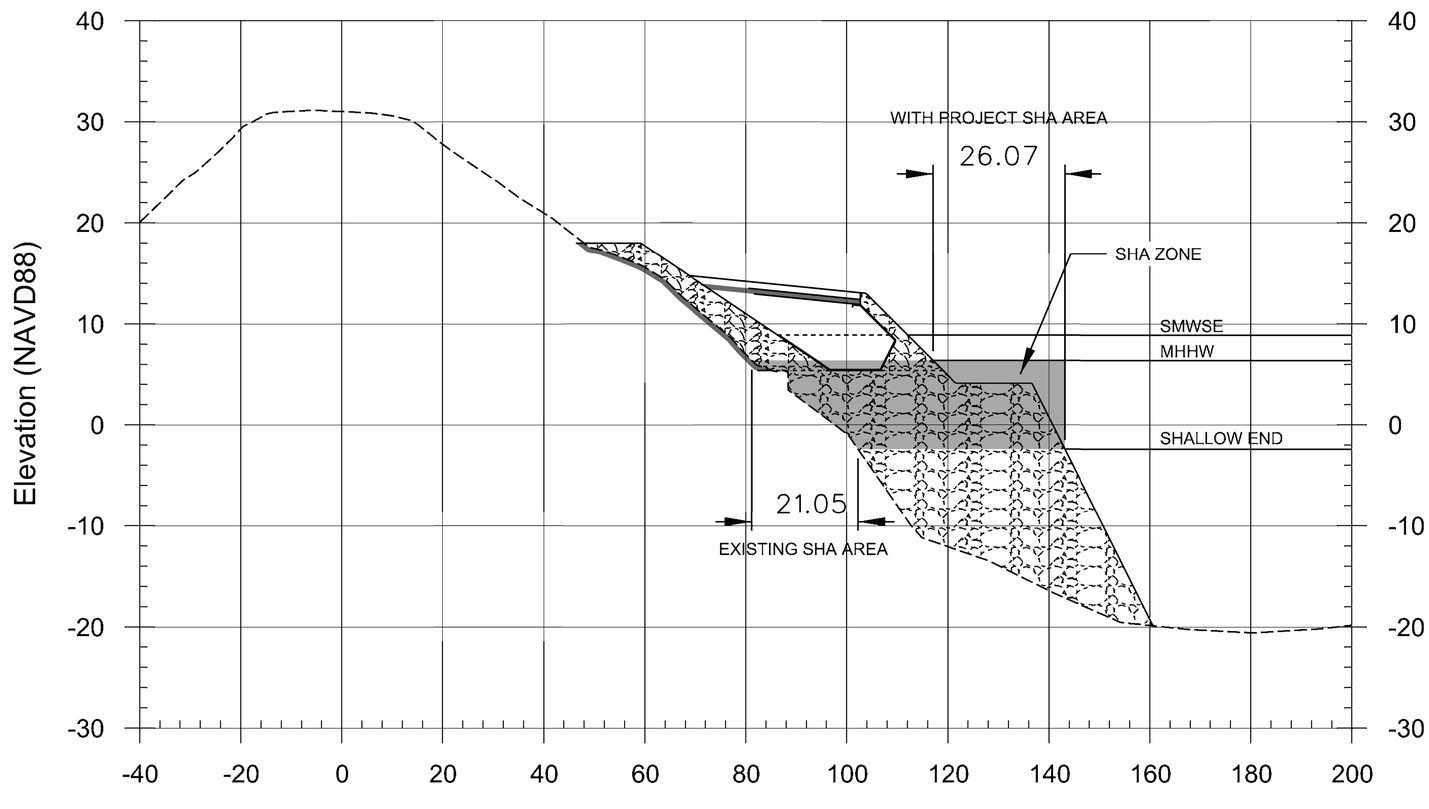

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Appendix D

North Sacramento Streams Levee Improvement Project

Preliminary Biological Evaluation

Preliminary Biological Evaluation

North Sacramento Streams Levee Improvements Project

Prepared for:

Sacramento Area Flood Control Agency

Prepared for submittal to:

U.S. Army Corps of Engineers
CESPK-PD
1325 J Street
Sacramento, CA 95814

Attn: Anne Baker

February 2015

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Appendix A – Exhibits

1.0 INTRODUCTION

The purpose of this preliminary biological evaluation is to support the preparation of a forthcoming biological assessment (BA). The BA would analyze the North Sacramento Streams (NSS) component of the Sacramento Area Flood Control Agency's (SAFCA) proposed Levee Accreditation Project (NSS Levee Improvements Project) in sufficient detail to determine the extent to which the proposed action may affect any of the federally listed species described below under "Species Considered."

A BA is prepared in accordance with requirements set forth under Section 7 of the Federal Endangered Species Act (ESA) (16 United States Code [USC] 1536[c]). It serves to initiate consultation with the U.S. Fish and Wildlife Service (USFWS) and consultation with the National Marine Fisheries Service (NMFS) on effects of the NSS Levee Improvements Project on federally listed species. A BA also serves to initiate consultation with NMFS on essential fish habitat (EFH) conservation recommendations for Pacific salmon (*Oncorhynchus* spp.), as required by the Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 USC 1801). (See the "Essential Fish Habitat Assessment" section below.)

Section 7(a)(2) of the ESA directs federal agencies to ensure that their activities are not likely to jeopardize the continued existence of any listed species, or to result in the destruction or adverse modification of designated critical habitat. This section of the ESA also requires agencies with regulatory authority over listed species to issue biological opinions evaluating the direct and indirect effects of federal actions, and actions that are interrelated or interdependent with the federal action. The biological opinions must determine whether the actions being evaluated may appreciably reduce the listed species' likelihood of surviving or recovering in the wild by reducing their productivity, numbers, or distribution.

To implement the NSS Levee Improvements Project, SAFCA would request permission from the U.S. Army Corps of Engineers (USACE) for:

- alteration of federal project levees, pursuant to Section 14 of the Rivers and Harbors Act of 1899 (33 USC 408, referred to in this preliminary biological evaluation as "Section 408"); and
- placement of fill in jurisdictional waters of the United States, pursuant to Section 404 of the Clean Water Act (33 USC 1344, referred to in this preliminary biological evaluation as "Section 404").

These activities are described in more detail under "Description of the Proposed Action." Similar to a BA, this preliminary biological evaluation analyzes direct, indirect, interrelated/interdependent, and cumulative effects of the proposed action on federally listed species.

The proposed action described herein is also part of a larger, joint project with USACE and the State of California called the American River Common Features (ARCF) Project. The ARCF Project is currently in the planning phase and therefore detailed design information is not available. Therefore, USACE is consulting with NMFS and USFWS on the ARCF Project using a worst-case approach. Since the NSS Levee Improvements Project is a subset of the ARCF Project, and because detailed design information for SAFCA's NSS Levee Improvements Project is available, consultation for the two projects is being combined. It should be noted that because design for the NSS Levee Improvements Project has progressed further than that for the ARCF Project, some areas (e.g., borrow sites) not identified by USACE are being identified below. SAFCA also anticipates future consultation as part of the ARCF Project consultation for work along the Sacramento River, although this effort is still in the planning phase by SAFCA.

2.0 SPECIES CONSIDERED

This document considers species or designated critical habitat that have been termed "threatened" or "endangered" under the jurisdiction of USFWS and NMFS. On February 22, 2015, biologists consulted the online database maintained by USFWS's Sacramento Office to conduct a query of the Rio Linda (512B) and Sacramento East (512C) 7.5-minute quadrangles (USFWS 2015). Using the California Department of Fish and Wildlife's (CDFW's) California Natural Diversity Database (CNDDB) (2015) and the California Native Plant Society's database of rare and endangered plant species (CNPS 2014), biologists also conducted a query of the topographic quadrangles in which the action area occurs and the surrounding quadrangles; these database queries were conducted on February 27, 2014, and March 3, 2014, respectively. This query identified all listed species in the area surrounding the action area, which is defined here in accordance with ESA guidelines as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 Code of Federal Regulations [CFR] 402.02).

On June 18, 20, 23, 24, and 25, 2014, AECOM biologists conducted field surveys of Arcade Creek. NEMDC/Steelhead Creek was surveyed by AECOM biologists on September 3 and 8, 2014. A qualitative survey of additional areas where other proposed project elements would occur, including Robla Creek, was conducted by AECOM biologists through interpretation of aerial imagery. The purpose of these surveys was to characterize general biological resources, map vegetation and land covers within the footprints of the various project elements (i.e., levee improvements, encroachment removal, vegetation management, and Conservation Strategy), and assess the potential for the project study area to support special-status species and other sensitive biological resources. Locations of elderberry shrubs within the project study area (including a 100-foot buffer area around the various levee improvement footprints) were mapped, but no protocol-level plant or wildlife surveys were conducted. Tree survey data collected along the project study area levees by MBK Engineers (2014) was reviewed in the field. Vegetation and land cover were mapped onto aerial photographs during field surveys. The polygons were later digitized into a GIS overlay and used to create maps depicting the location and extent of each cover type present in the project study area.

Based on these database queries, field surveys, and the biologists' familiarity with local flora and fauna, 15 plant and wildlife species that are federally listed as endangered or threatened, or are federally proposed for listing, were considered as part of this assessment (**Table 1**).

Table 1
Fish and Wildlife Species Federally Listed or Proposed for Listing that Were Considered in the Evaluation of the North Sacramento Streams Levee Improvements Project

Species	Status	Habitat	Potential to Occur[1] in the Action Area[2]
Plants			
Slender Orcutt grass *Orcuttia tenuis*	Threatened	Vernal pools, often in gravelly soils; from 114 to 5,774 feet in elevation. Blooms May–October.	No potential to occur. No suitable habitat is present within the action area.[2]
Sacramento Orcutt grass *Orcuttia viscida*	Endangered	Vernal pools; from 98 to 328 feet in elevation. Blooms April–September.	No potential to occur. No suitable habitat is present within the action area.[2]
Invertebrates			
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	Threatened	Closely associated with blue elderberry (*Sambucus* sp.), which is an obligate host for the beetle larvae; CNDDB (2014) occurrences along the Sacramento	Could occur; elderberry shrubs present occasionally along the Arcade Creek; however, no shrubs were observed in NSS Levee Improvements Project area.

Table 1
Fish and Wildlife Species Federally Listed or Proposed for Listing that Were Considered in the Evaluation of the North Sacramento Streams Levee Improvements Project

Species	Status	Habitat	Potential to Occur[1] in the Action Area[2]
		and American Rivers.	
Vernal pool fairy shrimp *Branchinecta lynchii*	Threatened	Vernal pools and other seasonal wetlands, typically small but including a wide range of sizes; scattered CNDDB (2014) occurrences in vicinity of Dry Creek.	Could occur. Potentially suitable habitat is present within the action area.[2]
Vernal pool tadpole shrimp *Lepidurus packardi*	Endangered	Vernal pools and other seasonal wetlands, typically medium to large but including a wide range of sizes with relatively long inundation period; scattered CNDDB (2014) occurrences in vicinity of Dry Creek.	Could occur. Potentially suitable habitat is present within the action area.[2]
Fish			
Central Valley steelhead *Oncorhynchus mykiss*	Threatened	Anadromous. Requires cold freshwater streams with suitable gravel for spawning; rears seasonally in inundated floodplains, rivers, tributaries, and the Delta. Adult migration to upstream spawning areas occurs July–March (Hallock 1987). Juveniles typically spend 1–3 years in fresh water before migrating to the ocean, generally in December–August (McEwan 2001).	Likely to occur. Expected to occur in the NEMDC/Steelhead Creek, either as adults migrating to their upstream spawning habitat, or as juveniles and smolts, rearing and migrating towards the ocean. High water temperatures and low flows preclude occurrence in NEMDC/Steelhead Creek in summer. Not expected to occur in Arcade or Robla Creek as these streams lack suitable water quality conditions for spawning. Designated critical habitat is in the action area[2].
Central Valley fall-/late fall-run Chinook salmon *Oncorhynchus tshawytscha*	Species of Concern[2]	Anadromous. Requires cold freshwater streams with suitable gravel for spawning; rears seasonally in inundated floodplains, rivers, tributaries, and the Delta. Fall-run adults migrate in June–December, and juveniles migrate downstream and out to the ocean soon after emerging (December–March), rearing in fresh water for only a few months, and migrating to the ocean in March–July (Yoshiyama et al. 1998). Late fall-run adults migrate in October–April, and juveniles rear in their natal stream during summer; in some streams they remain throughout the year. Smolt outmigration can occur in November–May (Yoshiyama et al. 1998).	Likely to occur. Occurs in the Sacramento and San Joaquin Rivers, tributaries, and the Delta. Fall-run could occur in the NEMDC/Steelhead Creek, either as adults migrating upstream to their spawning habitat, spawning in the lower American River, or as juveniles and smolts, rearing and migrating towards the ocean. Not expected to occur in Arcade or Robla Creeks, as these streams regularly lack suitable water quality conditions or access for spawning. Essential fish habitat is in the action area[2].
Delta smelt *Hypomesus*	Threatened	Semi-anadromous. Typically restricted to the Delta and the	Unlikely to occur. Occurs in tidally influenced segments of the Sacramento and San Joaquin

Table 1
Fish and Wildlife Species Federally Listed or Proposed for Listing that Were Considered in the Evaluation of the North Sacramento Streams Levee Improvements Project

Species	Status	Habitat	Potential to Occur[1] in the Action Area[2]
transpacificus		lower Sacramento River downstream of Isleton; juveniles move downstream with the currents (USFWS 1996; Sommer et al. 2001a; Moyle 2002).	Rivers, tributaries, and Delta. No spawning habitat is in the action area.[2]
Sacramento River winter-run Chinook salmon *Oncorhynchus tshawytscha*	Endangered	Anadromous. Requires cold freshwater streams with suitable gravel for spawning; rears seasonally in inundated floodplains, rivers, tributaries, and the Delta. Adults migrate upstream in December–July (peak in March) (Moyle 2002), and juveniles migrate downstream soon after fry emerge, typically beginning in August and peaking in September and October (Vogel and Marine 1991).	Unlikely to occur. Occurs in the Sacramento River, tributaries, and the Delta. The Sacramento River channel is the main migration route for winter-run juveniles, and smolts (Yoshiyama et al. 1998). No spawning habitat is in the action area[2].
Central Valley spring-run Chinook salmon *Oncorhynchus tshawytscha*	Threatened	Anadromous. Requires cold freshwater streams with suitable gravel for spawning; rears seasonally in inundated floodplains, rivers, tributaries, and the Delta. Adults migrate upstream in March–September, (peak May–June) (Yoshiyama et al. 1998), and juveniles and yearlings migrate downstream following the onset of the winter storm season through March (CDFG 1998; Fisher 1994; S. P. Cramer and Associates 1995; Hill and Webber 1999). Adults: July–March (Hallock 1987).	Unlikely to occur. Occurs in the Sacramento River, tributaries, and the Delta. No spawning habitat is in the action area[2].
Green sturgeon *Acipenser medirostris*	Threatened	Anadromous. Requires seasonally inundated floodplains, rivers, tributaries, and the Delta. Adults migrate upstream to their spawning habitat (between late February and late July), and juveniles are reared and migrate to the ocean (year-round).	Unlikely to occur. Occurs in the Sacramento and San Joaquin Rivers, tributaries, and the Delta. No spawning habitat is in the action area[2].
Amphibians and Reptiles			
California red-legged frog *Rana draytonii (=R. aurora draytonii)*	Threatened	Prefers semi-permanent and permanent stream pools, ponds, and creeks with emergent riparian vegetation and typically without predatory fish. Requires adequate hibernacula such as small-mammal burrows and moist leaf litter.	No potential to occur. The action area is outside of the species' extant range.

Table 1
Fish and Wildlife Species Federally Listed or Proposed for Listing that Were Considered in the Evaluation of the North Sacramento Streams Levee Improvements Project

Species	Status	Habitat	Potential to Occur[1] in the Action Area[2]
California tiger salamander *Ambystoma californiense*	Threatened	Vernal pools and other seasonal wetlands with adequate inundation period and adjacent uplands, primarily grasslands, with burrows and other refugia; no known occurrences in the project vicinity.	No potential to occur. No suitable habitat is present within the action area.[2]
Giant garter snake *Thamnophis gigas*	Threatened	Open water associated with marshes, sloughs, and irrigation/drainage ditches within the Central Valley; requires emergent herbaceous wetland vegetation for escape and foraging habitat, grassy banks and openings in waterside vegetation for basking, and higher elevation upland habitat for cover and refuge from flooding. Nearest known extant populations are located in the Natomas Basin, adjacent to and just west of NEMDC/Steelhead Creek (CDFW 2014).	Could occur. In the NSS Levee Improvements Project area, the quality of habitat for giant garter snake is better along the NEDMC/ Steelhead Creek north of Dry Creek; Arcade and Robla Creeks and the NEMDC/Steelhead Creek south of Dry Creek are less suitable for this species. Giant garter snakes are known to occur in rice fields, associated canals, and managed marshes in the Natomas Basin west of the portion of NEMDC/Steelhead Creek that is north of Dry Creek; thus, there is potential for the species to occur, at least occasionally, in this portion of NEMDC/Steelhead Creek.
Birds			
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	Threatened	Riparian forest with dense deciduous trees and shrubs; there are no recent CNDDB occurrences in the vicinity of the program area, but migrant individuals are likely to pass through the area in transit to breeding sites along the Sacramento River north of Colusa.	Unlikely to occur. Although potential dispersal and foraging habitat is in the NSS Levee Improvements Project area, the action area is outside of the species' extant range.

Notes: CNDDB = California Natural Diversity Database; Delta = Sacramento–San Joaquin Delta; NSS = North Sacramento Streams

[1] **Potential for Occurrence Definitions:**

No potential to occur: Potentially suitable habitat is not present.

Unlikely to occur: Potentially suitable habitat present but species unlikely to be present because of very restricted distribution.

Could occur: Suitable habitat is available; however, there are few or no other indicators that the species may be present.

Likely to occur: Habitat conditions, behavior of the species, known occurrences in the vicinity, or other factors indicate a relatively high likelihood that the species would occur.

Known to occur: The species, or evidence of its presence, was observed during reconnaissance-level surveys or was reported by others.

[2] Action Area: The action area is defined here in accordance with ESA guidelines as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR 402.02). The action area includes all areas that would be directly or indirectly affected by the components of the NSS Levee Improvements Project. Areas downstream of the NSS Levee Improvements Project area may also be indirectly affected by the flood risk management component of the project through improved water quality and flood risk management conditions.

Sources: CDFW 2014; CNPS 2014; data collected and compiled by AECOM in 2014 CNDDB 2014, CNPS 2014, USFWS 2014; data compiled by AECOM and Stillwater Sciences in 2014

The following federally proposed and federally listed species are known to occur or have the potential to occur in the NSS Levee Improvements Project area:

- vernal pool fairy shrimp *(Branchinecta lynchi),*
- vernal pool tadpole shrimp *(Lepidurus packardii),*
- valley elderberry longhorn beetle (VELB) (*Desmocerus californicus dimorphus*),
- Central Valley steelhead distinct population segment (DPS) (*Oncorhynchus mykiss*), and
- giant garter snake (*Thamnophis giga*).

Central Valley fall- /late fall-run Chinook salmon ESU (*O. tshawytscha*) is not federally listed; however, EFH is present in the action area.

The other federally listed species identified in **Table 1** were eliminated from further consideration because they are not likely to occur in the NSS Levee Improvements Project area because of a lack of suitable habitat, local range restrictions, regional extirpations, or lack of connectivity between areas of suitable or occupied habitat, or because the action area is located outside of the extant range of the species (see "Action Area" section below). The USFWS-regulated species with the potential to occur on-site are discussed in more detail in this preliminary biological evaluation.

2.1 SPECIES HABITAT AND POTENTIAL FOR OCCURRENCE IN THE AREA

The following is a summary of relevant habitat conditions in the action area for species that could occur, are likely to occur, or are known to occur in the NSS Levee Improvements Project area. Full species accounts for federally listed species addressed in this preliminary biological evaluation are presented in the section titled "Species Accounts."

- **Vernal pool fairy shrimp** and **vernal pool tadpole shrimp:** Seasonal wetlands, which may provide suitable habitat for vernal pool invertebrates, occur at Borrow Site 3/ Robla woodland mitigation site A. There are documented occurrences of vernal pool fairy shrimp north of Dry Creek along the landside of the NEMDC/Steelhead Creek East Levee and there are documented occurrences of vernal pool fairy shrimp and vernal pool tadpole on the former McClellan Air Force Base, northeast of Arcade Creek (CDFW 2014).

- **Valley elderberry longhorn beetle:** Elderberry shrubs were not observed along Arcade Creek or NEMDC/Steelhead Creek during field surveys. Robla Creek has not been surveyed for elderberry shrubs, the obligate host plant for the valley elderberry longhorn beetle, but shrubs may occur amongst vegetation along the creek, adjacent to Borrow Site 3 and the proposed woodland mitigation sites north of Robla Creek. While there are no documented occurrences of valley elderberry longhorn beetle in the NSS Levee Improvements Project area, this species could occur in elderberry shrubs, if present along Robla Creek.

- **Central Valley Steelhead DPS:** Adult and juvenile Central Valley steelhead could occur in the action area during migrations along the Sacramento River and its tributaries. Central Valley steelhead are expected to occur in NEMDC/Steelhead Creek as adults, migrating upstream to their spawning habitat, and as juveniles and smolts, rearing and migrating toward the ocean. Central Valley steelhead would not typically occur in Arcade Creek, as this stream regularly lacks water quality conditions for spawning. There are no known runs within Robla Creek, similar to Arcade Creek. NEMDC/Steelhead Creek includes critical habitat for Central

Valley steelhead, which uses this locations for juvenile rearing, juvenile migration, and adult migration (NMFS 2014). There is no critical fish habitat designation for Arcade and Robla Creeks.

- **Central Valley fall-/late fall-run Chinook salmon:** Adult and juvenile Central Valley fall-run Chinook salmon could occur in the action area during migrations along the Sacramento River and its tributaries. They are not expected to occur in Arcade Creek or other tributaries to NEMDC/Steelhead Creek lacking suitable water quality conditions for spawning and rearing. EFH is also present in both streams for fall-run Chinook, which use these areas for juvenile rearing, juvenile migration, and adult migration. There is no EFH for Arcade and Robla Creeks.

- **Giant garter snake:** There are numerous occurrences of giant garter snake west of NEMDC/Steelhead Creek within the Natomas Basin; these records, which are located between NEMDC/Steelhead Creek and I-5/State Route (SR) 99/70, are all located north of Elkhorn Boulevard (CDFW 2014). The channel, water primrose wetlands, and hardstem bulrush marsh in NEMDC/Steelhead Creek, particularly north of Dry Creek, provide suitable aquatic habitat for giant garter snake; suitable upland habitat for this species is present where annual (wild oats) grasslands are within 200 feet of these aquatic features. However, there are no documented occurrences of this species in NEMDC/Steelhead Creek or in any of its eastside tributaries (CDFW 2014). The historic habitat conditions of NEMDC/Steelhead Creek and particularly its eastside tributaries were likely never suitable for this species (e.g., steeper elevational slope, rapid water runoff, lack of historical marsh [E. Hansen, pers. comm., 2015; B. Halstead, pers. comm., 2015]); a recent analysis suggests that this species' distribution is limited by dispersal distances associated with historic marsh habitats (Halstead et al. 2014). However, the quality of habitat for giant garter snake is better along the NEDMC/Steelhead Creek north of Dry Creek and giant garter snakes are known to occur in rice fields, associated canals, and managed marshes in the Natomas Basin west of this portion of NEMDC/Steelhead Creek; thus, there is potential for the species to occur, at least occasionally, in this portion of NEMDC/Steelhead Creek.

2.2 CRITICAL HABITAT

"Critical habitat" is defined in Section 3(5)A of the ESA as the specific areas in the geographical area occupied by the species where physical or biological features are found that are essential to the conservation of the species and that may require special management considerations or protection. Specific areas outside of the geographical area occupied by the species may also be included in critical-habitat designations, based on a determination that such areas are essential for the conservation of the species.

The proposed action addressed in this preliminary biological evaluation falls within designated critical habitat for Central Valley steelhead DPS. Critical habitat for the Central Valley steelhead DPS was designated on August 12, 2005; a final designation was published on September 2, 2005 (70 FR 52604), with an effective date of January 2, 2006 (70 FR 52487). Critical habitat is designated to include select waters in the Sacramento and San Joaquin River basins, including the segment of the NEMDC/Steelhead Creek in the action area (see "Action Area" section below).

The action area is not within designated critical habitat for the remaining species listed in **Table 1** for which such a designation has been made: Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, VELB, Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, and California red-legged frog. Critical habitat has not been designated for Central Valley fall-/late fall–run Chinook salmon ESU, giant garter snake, or western yellow-billed cuckoo.

3.0 CONSULTATION TO DATE

[No information to input yet.]

4.0 DESCRIPTION OF THE PROPOSED ACTION

4.1 PROJECT LOCATION

The proposed project includes Levee Accreditation improvements that would be implemented in the North Sacramento Streams area. Approximately 4 miles of levee along the Natomas East Main Drainage Canal (NEMDC)/Steelhead Creek East Levee and Arcade Creek North and South Levees would be improved (**Exhibit 1**). These levee reaches require substantial work to mitigate seepage, meet embankment and foundation stability requirements, and remove high-hazard encroachments and vegetation. This work requires use of proposed borrow sites (located along either side of NEMDC/Steelhead Creek, just north of Dry Creek and along the north side of Robla Creek) and staging areas (located along the levee improvement areas).

4.2 PROJECT SCHEDULE

SAFCA's NSS Levee Improvements Project would start construction in 2016. The proposed project is anticipated to take 1 to 2 years to complete.

4.3 DESCRIPTION OF PROPOSED PROJECT ELEMENTS

The NSS Levee Improvements Project consists of four project elements: levee improvements, high-hazard levee encroachment and vegetation removal, and conservation strategy. These four project elements are summarized in **Table 2** below.

Table 2. Summary of Locations of Proposed Project Elements in NSS Levee Improvements Area

Portion of Project Study Area	Levee Improvements	Encroachment Removal	Vegetation Management	Conservation Strategy[1]
Arcade Creek Levees	X	X	X	X
NEMDC/Steelhead Creek East Levee	X	–	–	X
Robla Creek South Levee	–	X	–	X
Borrow Sites	X	–	–	X
Robla Creek Tree Mitigation Sites (A and B)	–	–	–	X

Notes: NEMDC = Natomas East Main Drainage Canal

[1] In addition to providing mitigation for levee improvements, the Conservation Strategy includes an extensive list of avoidance and minimization measures that would be implemented throughout the project study area, where applicable

Source: Data compiled by AECOM in 2014

4.3.1 NORTH SACRAMENTO STREAMS LEVEE IMPROVEMENTS

DESCRIPTION OF THE NORTH SACRAMENTO STREAMS LEVEE IMPROVEMENTS AREA

This section discusses specific levee improvements proposed for each reach along NEMDC/Steelhead Creek and Arcade Creek in the NSS Levee Improvements area. To identify and describe the levee improvements proposed for the NSS Levee Improvements area, the area has been divided into eight levee reaches (**Exhibit 1**): two along

the east side of NEMDC/Steelhead Creek and three along each side of Arcade Creek. These levee reaches and associated improvements are described below.

NEMDC A

Reach A of the NEMDC/Steelhead Creek East Levee is about 1,700 feet long and extends from Station 3028+00 to Station 3051+00. The levee height ranges from 22.7–25.7 feet, with a crown width ranging from 14–26 feet. This reach is located along the eastern boundary of the Natomas Basin, just south of the confluence with Arcade Creek. A railroad embankment that pre-dates the construction of the NEMDC/Steelhead Creek East Levee is present along the entirety of the landside embankment slope of this reach and is integral with the NEMDC/ Steelhead Creek levee.

The levee embankment consists of clay materials with a fine-grained blanket layer of clay and silt, and occasional instances of clayey sand at the ground surface. This reach contains riparian habitat, ruderal land, and stream channels within the construction footprint of the proposed improvements. Preliminary analysis indicates that this reach does not meet 100-year water surface elevation (WSE) criteria or Urban Levee Design Criteria (ULDC) for potential underseepage. The underseepage may be due to high hydraulic head in the stormwater collector channel along the landside levee toe that leads to a pump station within the reach.

Construction of a cement-bentonite (CB) slurry cutoff wall at the waterside toe of the levee was selected as the preferred levee improvement.

ACS A

Reach A of the Arcade Creek South (ACS) Levee is about 1,300 feet long and extends from Station 4000+00 to Station 4013+00. This reach was originally constructed in the 1930s, but specific construction details and documentation are unavailable. The levee crest was widened and the waterside slope liner was constructed in the 1950s by USACE. The levee ranges between 19.4 and 22.0 feet high, with a crown width ranging from 10–26 feet. A railroad crossing occurs at the downstream boundary of the levee, with a stoplog structure across the rail used to block this crossing during high-water events.

The levee embankment consists of clay, silt, and sand materials, and contains a fine-grained blanket layer comprised of clay and silt. The reach contains riparian habitat, creek, and ruderal land within the construction footprint of proposed levee improvements. Preliminary analysis indicates that this reach does not meet 100-year WSE criteria or ULDC for potential underseepage and stability.

Construction of a soil-bentonite (SB) cutoff wall at the centerline of the levee was selected as the preferred levee improvement.

ACS B

Reach B of the Arcade Creek South Levee is about 3,727 feet long and extends from Station 4031+18 to Station 4068+45. This reach was originally constructed in the 1930s, but specific construction details and documentation are unavailable. The levee crest was widened and the waterside slope liner was constructed in the 1950s by USACE. The levee ranges between 11 and 17 feet high, with a crown width ranging from 17–28 feet.

The levee embankment consists of clay, silt, and sand materials, and contains a fine-grained blanket layer comprised of clay and silt. This reach contains riparian habitat, creek, and ruderal land within the construction footprint of the proposed levee improvements. Preliminary analysis indicates that this reach does not meet 100-year WSE criteria or ULDC for potential underseepage and stability.

Construction of an SB cutoff wall at the centerline of the levee was selected as the preferred levee improvement.

ACS C

Reach C of the Arcade Creek South Levee is about 4,155 feet long and extends from Station 4068+45 to Station 4110+34. The levee was constructed in the 1930s, but the original construction documentation is unavailable. Subsequent improvements to the levee (i.e., crest raise and floodwall) were completed by SAFCA in the 1990s. The downstream (western) boundary of this reach occurs at the intersection of the levee reach with Rio Linda Boulevard. The upstream (eastern) boundary is located at the intersection of the levee and Marysville Boulevard. The levee ranges between 19.4 and 22.0 feet high, with a crown width ranging from 10–26 feet. A low concrete flood wall curb extends along the waterside of the levee crest from Rio Linda Boulevard to Marysville Boulevard.

The levee embankment consists of clayey and silty sand materials, with a foundation layer comprised of silty and clayey sand over silt. The reach contains riparian habitat, creek, and ruderal land within the construction footprint of proposed levee improvements. Preliminary analysis indicates that this reach does not meet 100-year WSE underseepage and stability criteria, as well as ULDC for underseepage, through-seepage or stability.

Construction of a CB slurry cutoff wall at the waterside toe combined with waterside slope replacement was selected as the preferred levee improvement.

ACN A

Reach A of the Arcade Creek North Levee is about 1,050 feet long and extends from Station 5023+00 to Station 5033+50. This levee reach was originally constructed in the 1950s by USACE. Subsequent improvements to the levee's landside and waterside slopes, in conjunction with a levee raise, were completed in the 1990s by SAFCA. A concrete-lined ditch owned by the City of Sacramento at Drainage Pumping Plant No. 158 is located approximately 30 feet from the landside toe up to Station 5031+00. From there, this concrete-lined toe ditch descend into the pump station sump. This reach includes the lined channel and the concrete paved pump station sump area. The levee ranges between 15 and 28 feet high, with a crown width ranging from 8–16 feet.

The levee embankment consists of silty and clayey sand materials. Preliminary analysis indicates that this reach does not meet 100-year WSE underseepage and stability criteria, as well as ULDC for underseepage, through-seepage, or stability.

Installation of pressure relief wells along the landside of the levee was selected as the preferred levee improvement.

ACN B

Reach B of the Arcade Creek North Levee is about 3,700 feet long and extends from Station 5038+00 to Station 5075+00. The upstream (eastern) boundary of this reach occurs at the beginning of the concrete floodwall that runs along the levee crest between Stations 5068+10 and Marysville Boulevard. The levee ranges between 10 and 18 feet high, with a crown width ranging from 8–23 feet. This levee reach was originally constructed in the 1950s by USACE. Subsequent improvements to the levee's landside and waterside slopes, in conjunction with a levee raise, were completed in the 1990s by SAFCA.

The levee embankment consists of silty and clayey sand materials. The downstream blanket layer is comprised of silty and clayey sand, while the upstream blanket layer is comprised of clay and silt. This reach contains riparian habitat, creek, and ruderal land within the construction footprint of proposed levee improvements. Preliminary analysis indicates that this reach does not meet 100-year WSE criteria or ULDC for underseepage and stability.

Construction of an SB cutoff wall at the centerline of the levee was selected as the preferred levee improvement.

ACN C

Reach C of the Arcade Creek South Levee is about 3,743 feet long and extends from Station 5075+00 to Station 5112+3. This levee reach was originally constructed in the 1950s by USACE. The floodwall that runs along the waterside of the levee crest was constructed in the 1990s by SAFCA. The downstream (western) boundary of this reach is located at the beginning of the concrete floodwall that runs along the levee crest between Stations 5075+00 and Marysville Boulevard. The upstream (eastern) boundary of this reach is located at the intersection of the levee and Marysville Boulevard. The levee ranges between 1 and 9 feet high, with a crown width ranging from 5–17 feet.

The levee embankment consists of silty and clayey sand materials, with a coarse-grained blanket layer comprised of silty and clayey sand. This reach contains riparian habitat, creek, and ruderal land within the construction footprint of proposed levee improvements. Preliminary analysis indicates that this reach does not meet 100-year WSE criteria or ULDC for underseepage and stability.

Construction of a CB cutoff wall at the waterside toe combined with waterside slope replacement from Station 5075+00 to Station 5100+00, and construction of a sheet pile cutoff wall at the centerline of the levee from Station 5100+00 to Marysville Boulevard was selected as the preferred levee improvement.

BORROW AREAS AND HAUL ROUTES

Based on proximity to the improvement areas, SAFCA has identified three preferred borrow sites to provide suitable material for levee improvements for the NSS Levee Improvements area. The preferred borrow sources are illustrated in **Exhibit 2** and their locations are briefly described below.

- **Site 1** - Three soil stockpiles located on the grounds of a new high school, near Sorento Road and East Levee Road.
- **Site 2** - Site 2K - Up to 35,000 cubic yards (cy) available above the water table.
- **Site 3** - Area north of Robla Creek and the Dry Creek South Levee, east of Rio Linda Boulevard.

The most likely sources for borrow currently under consideration are Sites 1 and 2. While Site 3 is a possible source, the suitability and available quantities of borrow material from each source must be investigated further and confirmed as part of project design.

The goal in selecting haul routes is to use existing levee crowns for hauling wherever possible (**Exhibit 3**). However, there are locations where hauling on paved public roads is the best available option because the levee crown is already paved for public use or because there is inadequate room on the waterside of the levee to develop a temporary toe road without affecting standing water or low flow channels. Final haul routes would be selected based on constraints, the construction schedule, and in coordination with the City.

Borrow site strippings would either be reused as part of post-borrow reclamation or hauled off-site. Borrow sites would be returned to pre-project conditions following construction activities.

POTENTIAL STAGING AREAS

Four potential staging areas have been identified for potential use to support construction of of the NSS Levee Improvements Project (see **Exhibit 3 4**). Several of these areas have been used previously to support levee improvements along Arcade Creek. The areas would require little preparation other than surface stripping, and temporary connection roads and ramps to the levee crown.

The primary use for the staging areas would be for temporary trailers, parking, and material staging and for stockpiling and blending of excavated soils with imported borrow to make the excavated soils suitable for use in levee reconstruction. This would involve stockpiles of material to be processed, a processing area where excavated soils and imported soils would be spread out and processed to mix and moisture condition the material, and stockpiles of processed material. Importing, processing, and exporting material for levee reconstruction would all be continuous activities once the work flow is established during the start of the construction season. Other disturbed areas would be also be stabilized. Staging areas would be returned to pre-project conditions following construction activities unless the owner agrees to some grade raising to help dispose of excess construction soils.

ADDITIONAL LEVEE IMPROVEMENTS COMPONENTS

Erosion Protection

The only erosion protection currently envisioned includes placement of rip rap on waterside benches where waterside toe slurry walls are constructed. Following construction, levee slopes and other areas disturbed by construction would be revegetated and brought back to pre-project conditions.

Locations where erosion is identified along the waterside levee slope and riverbank have been evaluated to determine whether levee integrity or stability may be affected. Insufficient embankment protection may cause a levee to be undermined by erosive forces due to wave action and/or high flow velocities along the levee bank. In many cases, the placement of embankment protection material, such as engineered armoring (rip-rap), would dissipate wave and velocity forces and reduce the potential for erosion to occur. Other factors to be considered prior to installing embankment protection material include grading the levee waterside slope to address stability issues, and environmental impacts within the vicinity of the embankment repair site.

Utility Relocation

SAFCA prepared an inventory and assessment of existing encroachments and penetrations within the NSS Levee Improvements Project area. Known utilities that cross or are adjacent to the levee include gas pipelines; storm drainage and pump station discharge pipes; and numerous water supply mains, culverts, electrical conduits, and sanitary sewers. The construction contractor can work around many of these utilities. However, some utilities may need to be temporarily removed or relocated prior to construction. Temporary bypass pumping may be required for sanitary sewers. SAFCA and the construction contractor would coordinate closely with utility owners to manage the utilities in advance of construction. Disturbed utilities would be restored after construction consistent with CVFPB requirements. Coordination between SAFCA and the utility owner would be required for those utilities that do not currently have CVFPB encroachment permits.

Stormwater Pollution Prevention

Temporary erosion/runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. These temporary control measures may include implementing construction staging in a manner that minimizes the amount of area disturbed at any one time; secondary containment for storage of fuel and oil; and the management of stockpiles and disturbed areas by means of earth berms, diversion ditches, straw wattles, straw bales, silt fences, gravel filters, mulching, revegetation, and temporary covers as appropriate. Erosion and stormwater pollution control measures would be consistent with National Pollutant Discharge Elimination System (NPDES) permit requirements and would be included in a Stormwater Pollution Prevention Plan (SWPPP).

After completion of construction activities, the temporary facilities (construction trailers and batch plants) would be removed and the site would be restored to pre-project conditions. Site restoration activities for areas disturbed by construction activities, including borrow areas and staging areas, will include a combination of regrading,

reseeding, constructing permanent diversion ditches, using straw wattles and bales, and applying straw mulch and other measures deemed appropriate.

PROPOSED SEQUENCE OF PROJECT CONSTRUCTION

It is anticipated that the North Sacramento Streams levee improvements would be implemented in one construction season (2016). The construction season would take place from April 15 to November 1. An approximate construction sequence includes the following:

- **Mobilization:** Mobilization would include setting up construction offices and the slurry batch plant and transporting heavy earthmoving equipment to the site. These activities may take up to 1 month.

- **Vegetation and encroachment removal:** Trees and other encroachments that impact remedial measures would be removed consistent with established SAFCA policies regarding vegetation and encroachments. These activities may take 1–4 weeks depending upon the reach being remediated.

- **Levee degradation for cutoff wall installation:** Beginning of levee degradation would follow vegetation and encroachment removal and precede cutoff wall installation. Degradation would take a total of about 4 months but it would not likely be conducted in one simultaneous operation. Rather, levee reaches would be degraded for specific lengths of cutoff wall to minimize the total length of degraded levee at any one time. Construction would take approximately 3 months.

- **Cutoff wall installation:** This activity would begin with construction of the work pad once a sufficient length of levee was degraded and was available for construction. Assuming four headings, construction would take approximately 4 months.

- **Drainage blanket construction:** Drainage blanket would be constructed prior to placing overlying slope reconstruction fill. Portions of drainage blanket extending up levee cut slopes would be placed as the adjacent slope reconstruction material is placed. Construction would take approximately 1 month since such construction is a small part of the proposed project.

- **Toe cutoff wall erosion protection:** Toe cutoff wall rip rap erosion protection would be placed after the toe cutoff wall bench has been completed to final lines and grades. Construction would take approximately 2 months.

- **Utility relocation:** Any required utility relocation would be conducted concurrent with the levee degradation, toe cutoff wall bench construction, and reconstruction operations. Construction would take approximately 4 months.

- **Levee reconstruction:** Levee reconstruction would begin once there was sufficient length completed cutoff wall to efficiently begin reconstructing the levee embankment. Total time estimated for levee reconstruction is about 6 months.

- **Seepage Wells:** Seepage wells can be installed at any time during the construction season. Installation and development of relief wells and reconstruction of paved channel and basin inverts would likely take about 2 month.

- **Site restoration and demobilization:** Upon completion of the main construction activities, the levee patrol road would be resurfaced, disturbed areas would be revegetated, staging and borrow areas would be restored, and the contractor would demobilize the site(s). These activities are expected to take about 2 months.

Construction would be staged and sequenced with the appropriate stakeholders: the City, County, Reclamation District, utility and service providers, biological resource construction work windows, and other environmental and land use/real estate constraints, to the greatest extent practical to minimize impacts and effects on the community.

4.3.2 HIGH HAZARD LEVEE ENCROACHMENT AND VEGETATION REMOVAL

ENCROACHMENT MANAGEMENT

The National Flood Insurance Program (NFIP) standards for levee accreditation and the State's ULDC both require removal or modification of encroachments that pose an unacceptably high risk to the performance and safety of a levee either by undermining its structural integrity or by interfering with necessary inspection, operation, and maintenance activities. To address this requirement, SAFCA has identified and evaluated all of the encroachments in the NSS Levee Improvements area. Each of these encroachments has been evaluated to determine whether it constitutes an unacceptably high risk to the performance of the levee either by undermining the stability of the levee or by interfering with necessary patrolling, operation, and maintenance activities. Based on this evaluation, the encroachments have been classified as either:

- High-risk – poses a threat to levee integrity, removable prior to the levee being accredited;
- High-risk – impedes operation, maintenance, and inspection, removable within 3 years after the levee is accredited; or
- Low-risk – not identified as high hazard.

In the NSS Levee Improvements area, high-risk encroachments to be removed are limited to residential landscaping located at approximately 10 locations along the landside of the south and north levees of Arcade Creek (mainly between Marysville Boulevard and Rio Linda Boulevard) and along the Robla Creek South Levee, east of Rio Linda Boulevard.

VEGETATION MANAGEMENT

The levee accreditation element of the proposed project also includes a vegetation management component. Although the NFIP does not identify specific standards for managing vegetation on levees, ULDC provides criteria that reflect the underlying risk management objectives of the NFIP. Under these criteria, vegetation on levees must be modified or removed if it presents an unacceptable risk to the structural integrity or impedes operation and maintenance of the levee.

In the NSS Levee Improvements area, approximately 8 high-risk trees along Arcade Creek have been identified for removal. All of the trees are either nonnative (7) or snags (3). Five are located on the waterside of the levees. These trees are in addition to any trees that would be removed as a result of implementation of levee improvements in the NSS Levee Improvements area.

4.3.3 CONSERVATION STRATEGY

Implementation of the NSS Levee Improvements Project would result in impacts on sensitive biological resources such as riparian woodland, near-shore aquatic, and special-status species habitat on the NEMDC/Steelhead Creek

and Arcade Creek. The measures outlined in the Conservation Strategy would avoid and reduce some of these impacts. However, even with implementation of avoidance and minimization measures and with self-mitigating projects, impacts on sensitive biological resources would require compensatory mitigation to reduce impacts to less-than-significant levels, and to comply with permit conditions. These compensatory mitigation actions and potential mitigation sites are described below. Mitigation sites would be planned, designed and constructed to avoid impacts to sensitive biological and cultural resources, and if further analysis indicates potential impacts would be unavoidable, the site would be removed from further consideration.

AVOIDANCE AND MINIMIZATION MEASURES

A key element of the Conservation Strategy is to avoid and/or minimize impacts on sensitive habitats and special-status species during implementation of the NSS Levee Improvements Project. The following general and resource-specific conservation measures will be incorporated by SAFCA during construction (which also includes demolition), operation, and maintenance.

General Conservation Measures

- **CM-1: Limit Ground Disturbance to Construction Areas and Avoid and Limit Disturbance to River and Creek Banks and Habitats when Feasible.** Ground disturbance shall be limited to construction areas, including necessary access routes and staging areas. The number of access routes, size of staging areas, and total area of the project activity shall be limited to the minimum necessary. When possible, existing access routes and points shall be used. All roads, staging areas, and other facilities shall be placed to avoid and limit disturbance to river and creek banks and habitat when feasible.

- **CM-2: Clearly Mark Project Construction Limits.** To minimize ground and vegetation disturbance during project construction, project limits shall be clearly marked, including the boundaries of designated equipment staging areas; ingress and egress corridors; stockpile areas for spoils disposal, soil, and materials; and equipment exclusion zones.

- **CM-3: Observe 20-Mile-Per-Hour Speed Limits within Construction Areas on City, Private, and Levee Roads.** Project-related vehicles shall observe a 20-mile-per-hour speed limit within construction areas, except on County roads and on State and Federal highways.

- **CM-4: Avoid Disturbing or Exceeding the Minimum Vegetation Removal Necessary.** Disturbance or removal of vegetation by machinery shall not exceed the minimum necessary to complete project construction and operations.

- **CM-5: Replant or Reseed with Native Species and Monitor and Maintain Growth to Ensure Success for Areas Requiring Vegetation Removal.** When vegetation removal is required, the disturbed areas shall be replanted or reseeded with native species and monitored and maintained to ensure the revegetation effort is successful. If erosion control fabrics are used in revegetated areas, they shall be slit in appropriate locations as necessary to allow for plant root growth.

- **CM-6: Limit Rock Riprap for Erosion Protection.** The amount of rock riprap and other materials used for bank protection shall be limited to the minimum needed for erosion protection and establishment of planting benches.

- **CM-7: Destroy and Dispose of Invasive Species using Approved Protocols and Disposal Sites.** Invasive species that are removed shall be destroyed using approved protocols and disposed of in an appropriate disposal area out of the stream channel.

- **CM-8: Use All Pesticides in Accordance with Laws and Regulations.** All pesticides/herbicides (pesticides) used to control nonnative vegetation shall be used in accordance with label directions. Methods and materials used for herbicide application shall be in accordance with DWR's most current guidelines on herbicide use and with laws and regulations administered by the California Department of Pesticide Regulation.

- **CM-9: Store All Construction Materials at Designated Construction Staging Areas.** Construction materials such as portable equipment, vehicles, and supplies, including chemicals, shall be stored at designated construction staging areas.

- **CM-10: Prepare and Implement a Storm Water Pollution Prevention Plan.** A SWPPP that identifies specific best management practices to avoid and minimize impacts on water quality during construction activities shall be prepared and implemented.

- **CM-11: Install, Monitor, and Maintain Erosion Control Measures that Minimize Soil or Sediment from Entering Waterways or Wetlands.** Erosion control measures that minimize soil or sediment from entering waterways and wetlands shall be installed, monitored for effectiveness, and maintained throughout construction operations.

- **CM-12: Use Acceptable Erosion Control Materials to Minimize Potential for Small Animals to Become Entangled.** If use of erosion control fabrics is necessary, tightly-woven fiber netting (mesh size less than 0.25-inch) or similar material shall be used to minimize potential for small animals to become entangled. Coconut coir matting is an acceptable erosion control material, but no plastic mono-filament matting shall be used. The edge of the material shall be buried in the ground to prevent animals from crawling underneath the material.

- **CM-13: Avoid Use of Materials in Locations Where it can Erode from Normal or Expected High Flows.** No material shall be placed in a manner or location where it can be eroded by normal or expected high flows. Jute netting or another non-monofilament erosion control fabric shall be used to cover soil that is placed over or mixed into riprap or other revetment materials.

- **CM-14: Implement Precautionary Measures to Minimize Turbidity/Siltation during Construction.** Precautions to minimize turbidity/siltation shall be implemented during construction. This may require placing barriers (e.g., silt curtains) to prevent silt and/or other deleterious materials from entering downstream reaches.

- **CM-15: Inspect Sediment and Turbidity Control Barriers Daily during Construction for Proper Function and Replace Immediately if Not Functioning Effectively.** Performance of sediment and turbidity control barriers shall be inspected at least once each day during construction to check that they are functioning properly. Should a control barrier not function effectively, it shall be immediately repaired or replaced. Additional controls shall be installed as necessary.

- **CM-16: Remove Sediment from Sediment Controls and Dispose of Properly.** Sediment shall be removed from sediment controls once the sediment has reached 1/3 of the exposed height of the control. Sediment collected in these devices shall be disposed of away from the collection site at designated upland disposal sites.

- **CM-17: Treat Water with Silt or Mud from Construction Activities to Prevent it from Entering Live Waterways.** Water containing mud or silt from construction activities shall be treated by filtration, or retention in a settling pond, adequate to prevent muddy water from entering live waterways.

- **CM-18: Treat All Disturbed Soils with Appropriate Erosion Control.** All disturbed soils shall undergo appropriate erosion control treatment (e.g., sterile straw mulching, seeding, planting) prior to the end of the construction season, or prior to November 1, whichever comes first.

- **CM-19: Dispose of All Construction Materials at an Approved Disposal Site.** All debris, sediment, rubbish, vegetation, or other material removed from the construction areas shall be disposed of at an approved disposal site.

- **CM-20: Dispose Daily all Construction-related Materials and Equipment that Cannot be Secured at an Appropriate Disposal/Storage Site.** All litter, debris, unused materials, equipment, and supplies that cannot reasonably be secured shall be removed daily from the project work area and deposited at an appropriate disposal or storage site.

- **CM-21: Remove Immediately All Construction-Related Pads/Debris from Work Sites Upon Completion.** All work pads and construction debris shall be removed from work sites immediately when work is completed at each site.

- **CM-22: Use Safer Alternative Products to Protect Streams and Other Waters.** Every reasonable precaution shall be exercised to protect streams and other waters from pollution with fuels, oils, and other harmful materials. Safer alternative products (such as biodegradable hydraulic fluids) shall be used where feasible.

- **CM-23: Prevent Any Contaminated Construction By-Products from Entering Flowing Waters; Collect and Transport Such By-Products to An Authorized Disposal Area.** Petroleum products, chemicals, fresh cement, and construction by-products containing, or water contaminated by, any such materials shall not be allowed to enter flowing waters and shall be collected and transported to an authorized upland disposal area.

- **CM-24: Prevent Hazardous Petroleum or Other Hazardous Substances to Aquatic Life from Contaminating the Soil or Entering Waters of the State or U.S.** Gas, oil, other petroleum products, or any other substances that could be hazardous to aquatic life and resulting from project-related activities, shall be prevented from contaminating the soil and/or entering waters of the State and/or waters of the U.S.

- **CM-25: Prepare and Implement a Spill Prevention and Control Plan.** A written spill prevention and control plan (SPCP) shall be prepared and implemented. The SPCP and all material necessary for its implementation shall be accessible on-site prior to initiation of project construction and throughout the construction period. The SPCP shall include a plan for the emergency cleanup of any spills of fuel or other

material. Employees/construction workers shall be provided the necessary information from the SPCP to prevent or reduce the discharge of pollutants from construction activities to waters and to use the appropriate measures should a spill occur. In the event of a spill, work shall stop immediately and the California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Central Valley Regional Water Quality Control Board (RWQCB), and USACE shall be notified within 24 hours.

- **CM-26: Properly Maintain All Construction Vehicles and Equipment and Inspect Daily for Leaks; Remove and Repair Equipment/Vehicles with Leaks.** Construction vehicles and equipment shall be properly maintained to prevent contamination of soil or water from external grease and oil or from leaking hydraulic fluid, fuel, oil, and grease. Vehicles and equipment shall be checked daily for leaks. If leaks are found, the equipment shall be removed from the site and shall not be used until the leaks are repaired.

- **CM-27: Refuel and Service Equipment at Designated Refueling and Staging Areas.** Equipment shall be refueled and serviced at designated refueling and staging sites located on the crown or landside of the levee and at least 50 feet from active stream channels or other water bodies. All refueling, maintenance, and staging of equipment and vehicles shall be conducted in a location where a spill shall not drain directly toward aquatic habitat. Appropriate containment materials shall be installed to collect any discharge, and adequate materials for spill cleanup shall be maintained on-site throughout the construction period.

- **CM-28: Store Heavy Equipment, Vehicles, and Supplies at Designated Staging Areas.** All heavy equipment, vehicles, and supplies shall be stored at the designated staging areas at the end of each work period.

- **CM-29: Install an Impermeable Membrane Between the Ground and Any Hazardous Material in Construction Storage Areas.** Storage areas for construction material that contains hazardous or potentially toxic materials shall have an impermeable membrane between the ground and the hazardous material and shall be bermed as necessary to prevent the discharge of pollutants to groundwater and runoff water.

- **CM-30: Use Water Trucks to Control Fugitive Dust during Construction.** Water (e.g., trucks, portable pumps with hoses) shall be used to control fugitive dust during temporary access road construction.

- **CM-31: Use Only Nontoxic Materials and Materials Placed in Any Waters with No Coatings or Treatments Deleterious to Aquatic Organisms.** All materials placed in streams, rivers, or other waters shall be nontoxic and shall not contain coatings or treatments or consist of substances deleterious to aquatic organisms that may leach into the surrounding environment in amounts harmful to aquatic organisms.

- **CM-32: Clean Construction Vehicles and Equipment Used Within the Stream Channel Before Arrival at the Project Construction Areas, and Inspect Vehicles/Equipment to Ensure They Are Free of Soil, Debris, and Nonnative Aquatic Species.** Construction vehicles and equipment operated within the channel margins (high water line) shall be cleaned of mud and other debris with a scrub brush and dry, or pressure-washed with hot (>140°F) water, before arrival at the project construction areas and prior to transporting the equipment to another stream or watershed. All equipment operated within the channel margins shall be carefully inspected for signs of aquatic invasive species (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=4958&inline), including mussels and plant materials, with special attention paid to shaded,

sheltered, and protected areas which might contain standing water and areas that form 'edges' or 'right angles,' such as tracks, feet, and/or tires. If vehicles or equipment are found to be contaminated with non-native invasive species, vehicles and equipment shall be stored in a dry location for at least one week prior to transport to a different stream or watershed, or alternatively, will be pressure-washed with hot (>140°F) water after each use. All water shall be drained from watercraft, including motor cooling system and bilge, and allow to dry as thoroughly as possible prior to entering a new stream or watershed. Large vessels and barges transported via the stream channel shall be contracted from nearby locations or shall undergo similar hull-cleaning prior to use for the project. Watercraft transported from distant areas, including barges, shall not release bilge water into the project area, unless screened to prohibit fish, plant, or other animal transport.

Resource-Specific Conservation Measures

Sensitive Biological Resources

- **SBR-1: Conduct Environmental Awareness Training.** A qualified biologist shall provide environmental awareness training to workers before project construction activities begin, and as needed when new personnel begin work on the project. The environmental awareness training shall inform all construction personnel about the relevant species and habitats that are known to occur in the project study area and vicinity, the need to avoid damaging these resources and causing mortality, measures to avoid and minimize impacts on the sensitive biological resources, the conditions of relevant regulatory permits, and the possible penalties for not complying with these requirements.

- **SBR-2: Erect High-Visibility Fencing to Protect Sensitive Biological Resource Areas, Inspect Fencing Daily, and Incorporate Sensitive Habitat Information into Bid Specifications.** Before the commencement of construction activities, high-visibility fencing shall be erected to protect areas of sensitive biological resources that are located adjacent to construction areas, but can be avoided, from encroachment of personnel and equipment. The fencing shall be inspected before the start of each work day and shall be removed only when the construction within a given area is completed. Sensitive habitat information shall be incorporated into project bid specifications, along with a requirement for contractors to avoid these areas.

- **SBR-3: Monitor Construction Activities in Sensitive Biological Resource Areas and Stop Work if Unauthorized Project Impacts Occur.** A qualified biologist shall monitor all construction activities in sensitive biological resource areas to ensure that avoidance and minimization measures are being properly implemented and no unauthorized activities occur. The biological monitor shall be empowered to stop construction activities that threaten to cause unanticipated and/or unauthorized project impacts. Project activity shall not resume until the conflict has been resolved.

- **SBR-4: Conduct Vegetation Removal Between September 16 and January 31 to the Extent Feasible.** Vegetation removal, particularly tree removal, shall be conducted between September 16 and January 31, to the extent feasible, to minimize potential loss of active bird nests and bat maternity roosts.

Vernal Pool Crustaceans

- **VPC-1: Provide Suitable Vernal Pool Crustacean Habitat with Protective Buffers, to the Extent Feasible, and Temporarily Fence and Designate the Buffers as Environmental Sensitive Areas.** Suitable habitat for vernal pool crustaceans shall be provided with protective buffers, to the extent feasible. The size

and shape of the buffers shall depend on the local topography and potential for project activities to affect hydrology of the habitat. All buffers shall be temporarily fenced and designated as environmentally sensitive areas. These areas shall be avoided by all construction personnel.

- **VPC-2: Monitor All Construction Activities in Sensitive Biological Resources to Ensure that Avoidance and Minimization Measures Are Being Properly Implemented and Stop Construction Activities that Threaten Unauthorized Project Impacts.** A qualified biologist shall monitor all construction activities in sensitive biological resource areas to ensure that avoidance and minimization measures are being properly implemented and no unauthorized activities occur. The biological monitor shall be empowered to stop construction activities that threaten to cause unanticipated and/or unauthorized project impacts. Project activity shall not resume until the conflict has been resolved.

Valley Elderberry Longhorn Beetle

- **VELB-1: Temporarily Fence All Elderberry Shrubs Adjacent to Construction Areas and Designate the Area as Environmentally Sensitive.** All elderberry shrubs that are located adjacent to construction areas, but can be avoided, shall be temporarily fenced and designated as environmentally sensitive areas. These areas shall be avoided by all construction personnel. Fencing shall be placed at least 20 feet from the dripline of each shrub, unless otherwise approved by USFWS.

- **VELB-2: Prohibit Use of Pesticides or Chemicals within 100 Feet of Elderberry Shrubs.** No insecticides, herbicides, or other chemicals that might harm the beetle or its host plant shall be used within 100 feet of the elderberry shrubs.

- **VELB-3: Transplant Elderberry Shrubs Requiring Removal to Riparian Habitat Creation Areas, or Alternative Transplant Areas.** Elderberry shrubs that require removal shall be transplanted to the riparian habitat creation areas. If none of the areas of suitable habitat to be created as part of the proposed project would be available before the impact would occur, alternative transplant locations shall be identified. Transplant activities shall be conducted in accordance with USFWS guidelines.

Special-Status Fish

- **SSF-1: Conduct In-Water Construction Work Within In-Water Work Windows (June-October).** In-water construction activities shall be conducted within in-water work windows to avoid impacts to critical salmonid life stages (juvenile rearing, and juvenile and adult passage), typically from June through October.

- **SSF-2: Avoid SRA Habitat to the Maximum Extent Practicable and Temporarily Fence and Designate SRA Habitat as Environmentally Sensitive.** Natural woody riparian and/or SRA habitat shall be avoided to the maximum extent practicable. Habitat to be avoided shall be temporarily fenced and designated as environmentally sensitive areas. These areas shall be avoided by all construction personnel.

- **SSF-3: Install Screens on Any Construction-Related Water Pump Intakes Located on Waterways with Salmonids.** Screens shall be installed on any construction-related water pump intakes located on waterways with salmonids in accordance with current salmonid screening specifications of NMFS and CDFW.

Giant Garter Snake

- **GGS-1: Avoid Construction Activities within 200 Feet from the Banks of Suitable Giant Garter Snake Habitat and Confine Movement of Heavy Equipment to Existing Roadways, Where Feasible in These Areas.** To the extent possible, construction activities shall be avoided within 200 feet from the banks of suitable giant garter snake habitat. Movement of heavy equipment in these areas shall be confined to existing roadways, where feasible, to minimize habitat disturbance.

- **GGS-2: Temporarily Fence and Designate Suitable Giant Garter Snake Habitat to be Avoided as an Environmentally Sensitive Area.** Suitable giant garter snake habitat to be avoided within or adjacent to construction areas shall be temporarily fenced and designated as environmentally sensitive areas. These areas shall be avoided by all construction personnel.

- **GGS-3: Limit Ground Disturbance within 200 Feet of Suitable Giant Garter Snake Habitat and Conduct Activities Between May 1 and October 1, Unless Authorized by USFWS.** Unless authorized by USFWS, construction and other ground-disturbing activities within 200 feet of suitable aquatic habitat for the giant garter snake shall not commence before May 1, with initial ground disturbance expected to correspond with the snake's active season (as feasible in combination with minimizing disturbance of nesting Swainson's hawks). Initial ground disturbance shall be completed by October 1.

- **GGS-4: Ensure that Suitable Giant Garter Snake Aquatic Habitat that is Dewatered Remains Dry for 15 Consecutive Days after April 15 and if Not Possible, Potential Snake Prey is Removed.** Any suitable giant garter snake aquatic habitat that is dewatered shall remain dry for at least 15 consecutive days after April 15 and before excavating or filling of the dewatered habitat. If complete dewatering is not possible, potential snake prey (e.g., fish and tadpoles) shall be removed so that snakes and other wildlife are not attracted to the construction area.

- **GGS-5: Conduct a Preconstruction Survey within 200 Feet of Suitable Giant Garter Snake Habitat Within 24 Hours Before Commencement of Ground-Disturbing Activities.** Within 24 hours before the commencement of ground-disturbing activities, areas within 200 feet of suitable giant garter snake habitat shall be surveyed for giant garter snakes by a qualified biologist. The biologist shall provide USFWS with written documentation of the monitoring efforts within 48 hours after the survey is completed. The project area shall be reinspected by a qualified biologist whenever a lapse in construction activity of 2 weeks or greater has occurred.

- **GGS-6: Allow Snakes to Leave the Construction Area on Their Own and Notify USFWS and CDFW Immediately if a Giant Garter Snake is Found On Site.** No snakes shall be harassed, harmed, or killed, and they shall be allowed to leave the construction area on their own volition. If any snake is observed retreating into an underground burrow within the project limits, a 50-foot radius nondisturbance buffer zone shall be established until a qualified biologist determines that the snake is not a giant garter snake or the snake has left the area. The biologist shall notify USFWS and CDFW immediately if a giant garter snake is found on-site, and shall submit a report, including date(s), location(s), habitat description, and any corrective measures taken to protect the snake.

- **GGS-7: Restore All Suitable Giant Garter Snake Habitat Subject to Temporary Ground Disturbance to Preproject Conditions.** After construction activities are complete, all suitable giant garter snake habitat subject to temporary ground disturbances, including storage and staging areas and temporary roads, shall be restored to preproject conditions. These areas shall be recontoured, if appropriate, and revegetated with appropriate native plant species to promote restoration of the area to preproject conditions. Appropriate methods and plant species used to revegetate such areas shall be determined on a site-specific basis in consultation with USFWS and CDFW.

- **GGS-8: Maintain and Monitor Temporarily-Disturbed Areas of Suitable Giant Garter Snake Habitat Following Completion of Construction and Restoration Activities.** Temporarily-disturbed areas of suitable giant garter snake habitat shall be maintained and monitored for 1 year following the completion of construction and restoration activities. Monitoring reports documenting restoration of these areas shall be submitted to USFWS and CDFW upon the completion of the restoration implementation and 1 year after the restoration implementation.

COMPENSATION MEASURES

To mitigate for impacts to riparian habitat caused by levee improvements along Arcade Creek, and for removal of high-hazard trees that may affect the performance and reliability of existing levees on the Arcade Creek, SAFCA has identified some locations where native riparian vegetation could be established. Planting locations were selected to increase the patch size, improve habitat connectivity, and expand age class and species diversity of woodland habitat. These improvements would enhance nesting opportunities for native bird species, and, if necessary, could provide opportunities to satisfy VELB compensation.

- **Arcade Creek Habitat Improvements:** Impacts caused by levee improvements and high-hazard tree removal along Arcade Creek would be mitigated on-site to the extent feasible by improving and expanding native wetland and riparian habitat adjacent to the low-flow channel within the reach between Rio Linda Boulevard and Marysville Boulevard, which is currently dominated by nonnative annual grasses and broadleaf weeds. Following construction, native wetland vegetation (e.g., Santa Barbara sedge, Baltic rush) would be planted along the banks of Arcade Creek, and one row of large riparian tree species (e.g., valley oak) would be planted along each bank of the low-flow channel. The tree spacing would be determined by the capacity of the floodplain to accommodate vegetation without impacting the desired flood performance. The dense, high overhead canopy of the trees as they mature would provide important shade to the low-flow channel and bank, cover for small mammals and a connected migration corridor for flying and gliding animals (both vertebrates and invertebrates). The SRA habitat along the active channel would benefit water quality by keeping temperatures lower (cooler water retains higher levels of dissolved oxygen needed to sustain native fish and aquatic invertebrates), and provide leaf drop and other organic material to support aquatic food webs. In addition, shade from streamside trees would help suppress some growth of dense red sesbania and willows in the understory, and prevent new colonization of invasive species.

- **Robla Creek Habitat Improvements:** Replacement riparian woodlands are proposed either on Robla Creek Mitigation Site A (which is also Borrow Site 3, approximately 6 acres north of Rio Linda Boulevard) or on Robla Creek Mitigation Site B (approximately 7.1 acres south of Rio Linda Boulevard). Both sites are adjacent to and west of Robla Creek, (see **Exhibit 5**). Site A is a previous borrow site and is at a lower elevation making this area better suited for wetland mitigation. Site B is connected to the Robla Creek floodplain and is the site of a future multi-use recreational trail. SAFCA would provide right-of-way for future construction of the trail.

5.0 ACTION AREA

The action area is defined here in accordance with ESA guidelines as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 Code of Federal Regulations [CFR] 402.02). The action area includes all areas that would be directly or indirectly affected by the components of the NSS Levee Improvements Project. Areas downstream of the NSS Levee Improvements Project area might also be indirectly affected by the flood risk management component of the project through improved water quality and flood risk management conditions. The extent of this potential effect is difficult to quantify.

For the purpose of the proposed project, project activities would occur in the following areas, which collectively comprise the action area:

- The section of NEMDC/Steelhead Creek that extends approximately 0.5-mile south from the confluence of Arcade Creek.
- The section of Arcade Creek between NEMDC/Steelhead Creek and Marysville Boulevard.
- A small section along the Robla Creek south levee, east of Rio Linda Boulevard near Dry Creek Road.
- The 3 borrow sites.
- The 4 potential staging areas.
- The one woodland mitigation site along Robla Creek.

6.0 ENVIRONMENTAL BASELINE

The NSS Levee Improvements Area includes NEMDC/Steelhead Creek and two of its tributaries: Arcade and Robla Creeks, as well as the borrow sites, potential staging areas, and tree mitigation site.

6.1 VEGETATION AND HABITAT

6.1.1 NEMDC/STEELHEAD CREEK

NEMDC/Steelhead Creek is an approximately 13.3-mile, human-made, partially leveed drainage channel that provides drainage from Sankey Road and connects streams of the American Basin (Dry, Robla, and Arcade Creeks) to the American River. The NEMDC/Steelhead Creek forms a portion of the eastern boundary of the Natomas Basin and under high flows connects to the Pleasant Grove Creek Canal which drains into the Natomas Cross Canal and carries flows to the Sacramento River. For the purpose of the proposed project, levee improvements would occur on a portion of the NEMDC/Steelhead Creek levee that extends approximately 0.5-mile south from the confluence of Arcade Creek. The East Levee Road extends along the crown of the west levee, and a levee road and railroad tracks extend along the crown of the east levee.

South of the confluence with Arcade Creek, the east and west levees of NEMDC/Steelhead Creek are dominated by wild oats grasslands, while the channel of NEMDC/Steelhead Creek is characterized by Fremont cottonwood forest, with smaller amounts of valley oak woodland, smart-weed cocklebur patches, and perennial rye grass fields.

6.1.2 ARCADE CREEK

The approximately 16.2-mile-long channel of Arcade Creek extends east-to-west from Orangevale to the American River, via NEMDC/Steelhead Creek. Levee improvements, as well as components of the Conservation Strategy, would occur on the section of Arcade Creek between NEMDC/Steelhead Creek and Marysville Boulevard, and encroachment removal and vegetation management would occur mainly in the section between Rio Linda and Marysville Boulevards.

The north and south levees are dominated by wild oats grasslands, with a paved or gravel road along the levee crowns and the landside levee toe. Developed areas along Arcade Creek include the four bridges that cross the channel; from east to west, these are: Norwood Avenue, the Sacramento Northern Bike Trail, Rio Linda Boulevard, and Marysville Boulevard. Residential developments and Gateway Park, located north of Arcade Creek and respectively east and west of Norwood Avenue, and Hagginwood Park, located north Arcade Creek east of Marysville Boulevard, include landscaped areas. Valley oak woodland is the main riparian vegetation type along Arcade Creek, but Fremont cottonwood forest occurs in small patches along the easternmost reach of Arcade Creek near NEMDC/Steelhead Creek. Hardstem bulrush marsh is found within Arcade Creek near Norwood Avenue while water primrose wetlands are predominant within the channel of Arcade Creek from approximately the confluence with NEMDC/Steelhead Creek to Norwood Avenue. East of Norwood Avenue, the creek channel becomes narrower, and dominated by a shaded canopy of valley oak woodland.

6.1.3 ROBLA CREEK

Robla Creek is a perennial stream located just south of Dry Creek, extending east-to-west from near McClellan Air Force Base to the American River (via NEMDC/Steelhead Creek). In the 1970s, a reach of Robla Creek between Dry Creek Road and the Sacramento Northern Bike Trail was relocated to facilitate the construction of a housing development and recreational lakes. This channelized section of Robla Creek was restricted to a very

narrow corridor that contained low-quality habitat and did not provide adequate room for flood flows (SAFCA 2014). In 1993, SAFCA constructed a new Rio Linda Creek channel west of Dry Creek Road. A section of the Robla Creek channel west of Dry Creek Road was filled in 2002 to accommodate the Robla Creek north levee, and a new channel was built to replace it. This new creek section provides a sinuous, meandering channel with improved flood flow capabilities and increased habitat values (SAFCA 2014). The area adjacent to NEMDC/ Steelhead Creek is characterized as seasonal wetlands, while further east, the creek channel is surrounded by, invasive red sesbania, wild oats grasslands with some clusters of valley oak woodland. For the purposes of the proposed project, a limited amount of encroachment removal would occur in a small footprint along the Robla Creek south levee, east of Rio Linda Boulevard near Dry Creek Road.

6.1.4 BORROW AND STAGING AREAS

Three potential borrow sites have been identified to support levee improvements in the North Sacramento Streams Levee Improvements area. The environmental effects that would result from use of borrow materials from Borrow Site 1 were evaluated in the Phase 3 FEIS/FEIR (USACE and SAFCA 2009).

Borrow Site 2 is a narrow site dominated by yellow star thistle and nonnative grasslands, located between the NEMDC/Steelhead Creek levees (East Levee Road and Sorrento Road), immediately east of the channel. Just east of the southern portion of this borrow site is the approximately 60-acre Wolf Ranch Wildlife Sanctuary, on which SAFCA created mitigation wetland and upland habitats after using the site as a borrow source for a previous levee improvement project (SAFCA 2014).

Borrow Site 3 is located north of Robla Creek and the Robla Creek South Levee, east of Rio Linda Boulevard on a site that is comprised of ruderal fields. This site would also serve as a potential tree mitigation site for the North Sacramento Streams Levee Improvements.

Four potential staging areas have been identified to support the levee improvements in the North Sacramento Streams Levee Improvements area. As depicted in **Exhibit 4.6-1**, three of these occur adjacent to, but not within the levee improvement footprint; thus, these areas are considered additional impacts. Staging Area 1 is considered developed. Staging Areas 2 and 4 are primarily wild oats grassland with some developed. Staging Area 3 is primarily developed with some wild oats grasslands. Staging within these areas would be located to avoid the removal of sensitive vegetation and trees. Wild oats grasslands are found in the levee maintenance easements.

6.1.5 WOODLAND MITIGATION SITES

Two areas have been identified where riparian woodlands could replaced as off-site mitigation for tree removal associated with levee improvements along Arcade Creek and NEMDC/Steelhead Creek. These two sites are located north of and immediately adjacent to Robla Creek, distributed along both sides of Rio Linda Boulevard. Both sites are owned by SAFCA and are currently ruderal grassland. The approximately 6-acre Site A is also the potential Borrow Site 3. Site B is an approximately 7.1-acre area.

6.2 WILDLIFE

The NSS Levee Improvements area provides a variety of wildlife habitats associated with the various creeks that are present. The NEMDC/Steelhead Creek habitat corridor and downstream portion of the Arcade Creek corridor generally provide higher-quality wildlife habitat than the upper portions of Arcade Creek, because they are wider and support more diversity of habitat types. A variety of common wildlife species are anticipated to be resident in the North Sacramento Streams Levee Improvements area, and additional species are likely to use the channels on a seasonal or other irregular basis as movement corridors between upstream and downstream areas.

7.0 SPECIES ACCOUNTS

[Refer to the USACE GRR BA.]

8.0 EFFECTS

8.1 DIRECT AND INDIRECT EFFECTS ON SPECIES IN THE ACTION AREA

Under the ESA, direct effects are those that are caused by the project and that occur at the same time as the action (see, e.g., construction-related effects). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur (e.g., operational effects). Avoidance and minimization measures for both direct and indirect effects are presented in the "Conservation Strategy" section above.

8.1.1 VERNAL POOL INVERTEBRATES

Seasonal wetland habitat is present in annual grassland north of Robla Creek, including in the eastern portion of Borrow Site 3/Robla woodland mitigation site A. Although borrow extraction and riparian planting activities associated with levee improvements and the Conservation Strategy in the NSS Levee Improvements area would not directly affect the seasonal wetland habitat, these activities could indirectly affect potentially suitable habitat for vernal pool invertebrates in this area by altering hydrology and/or degrading water quality. These effects could result in temporary loss of individuals, but the population could persist if the habitat is restored to its prior condition.

However, implementation of the Conservation Strategy avoidance and minimization measures, and specifically VPC-1, "Provide Suitable Vernal Pool Crustacean Habitat with Protective Buffers, to the Extent Feasible, and Temporarily Fence and Designate the Buffers as Environmental Sensitive Areas," and VPC-2, "Monitor All Construction Activities in Sensitive Biological Resources to Ensure that Avoidance and Minimization Measures Are Being Properly Implemented and Stop Construction Activities that Threaten Unauthorized Project Impacts," would avoid and minimize the potential for indirect effects on suitable habitat for vernal pool invertebrates through the establishment of appropriate buffers.

8.1.2 VALLEY ELDERBERRY LONGHORN BEETLE

Blue elderberry shrubs (Sambucas mexicana), the host plant for valley elderberry longhorn beetle larvae, are sparsely scattered throughout the action area. There are no known documented occurrences of VELB in the NSS Levee Improvements Project area, but the species could use elderberry shrubs in the action area.

Elderberry shrubs were not observed along Arcade Creek or NEMDC/Steelhead Creek during field surveys and are not expected to occur at Borrow Sites 2 and 3. Encroachment removal along Robla Creek would be limited to trimming back residential landscaping from a fence line and would have no potential for adverse impact to any elderberry shrubs, if present nearby. Elderberry shrubs could be present adjacent to potential woodland mitigation sites, including along Robla Creek. However, the Conservation Strategy would focus tree mitigation efforts on open grassland areas and avoid disturbance of elderberry shrubs that may be nearby. Further, implementation of the Conservation Strategy avoidance and minimization measures, and specifically VELB-1 "Temporarily Fence All Elderberry Shrubs Adjacent to Construction Areas and Designate the Area as Environmentally Sensitive," would avoid the potential for direct and indirect effects on elderberry shrubs through the establishment of appropriate buffers. Other Conservation Strategy avoidance and minimization measures, such as VELB-2, "Prohibit Use of Pesticides or Chemicals within 100 Feet of Elderberry Shrubs,"

8.1.3 SPECIAL-STATUS FISH SPECIES [PLACEHOLDER]

8.1.4 GIANT GARTER SNAKE

Giant garter snakes have not been documented in NEMDC/Steelhead Creek or its eastside tributaries (CDFW 2014), and historical habitat conditions are thought to have limited dispersal of the species east of NEMDC/ Steelhead Creek (Halstead et al. 2014; B. Halstead, pers. comm., 2015; E. Hansen, pers. comm., 2015). Based on these factors and current habitat conditions, such as close proximity to urban development, high levels of human disturbance, scarcity of upland habitat, and riparian vegetation along the banks of most channel reaches, giant garter snakes are unlikely to occur in the eastside tributaries and the southern portion of NEMDC/Steelhead Creek. Therefore, all proposed project elements that would occur in these areas, including encroachment removal and levee improvements along Arcade Creek and levee improvements along the adjacent portion of the NEMDC/ Steelhead Creek east levee, are unlikely to directly or indirectly impact giant garter snakes or adversely affect habitat occupied by the species.

The quality of habitat for giant garter snake improves along NEDMC/Steelhead Creek north of Dry Creek, where aquatic habitat is more extensive, very little riparian vegetation is present, urban development is less extensive, and large areas of open grasslands are present landside of the levees. Giant garter snakes are known to occur in rice fields, associated canals, and managed marshes in the Natomas Basin. An occurrence was documented along Elkhorn Boulevard, approximately 0.7 mile northwest of Borrow Site 2, and the species occurs at the complex of TNBC reserves immediately west of NEMDC/Steelhead Creek, approximately 3.5 miles farther north (CDFW 2014). Based on habitat conditions and known occurrences of giant garter snake, there is potential for the species to occur, at least occasionally, in nearby portions of NEMDC/Steelhead Creek. Borrow Site 2 is located immediately east of NEMDC/Steelhead Creek and may support potentially suitable upland habitat for the species. If giant garter snakes are present during borrow activities, these activities would result in direct and indirect effects to this species.

Ground disturbing activities at Borrow Site 2, where uplands adjacent to suitable aquatic habitat would be disturbed, could result in direct displacement, injury, or death of snakes if the habitat is used for basking, hibernating, or aestivating. Indirect effects could occur if snakes are displaced from occupied habitat or disturbed by nearby construction activities. Displacement and disturbance resulting from human activity, construction noise, and equipment vibrations could affect the ability of snakes to conduct essential life history functions, such as dispersal, movement, or foraging, and could result in increased competition for food and space and vulnerability to predation. Construction activities could temporarily degrade aquatic habitat, but the overall result of implementing the Conservation Strategy would be an enhancement of habitat quality.

All project-related impacts at Borrow Site 2 would occur within one active season and, therefore, are considered temporary. Borrow Site 2 would be restored /enhanced and re-graded to a condition that exceeds the pre-project condition by lowering the land surface closer to the low flow channel elevation and through establishment of a more diverse mosaic of aquatic and wetland habitat components.

9.0 CUMULATIVE EFFECTS

[Refer to the USACE GRR BA.]

10.0 CONCLUSIONS AND DETERMINATION

In conclusion, based on the biology and ecology of the federally listed species that have the potential to occur in the NSS Levee Improvements Project area, the environmental baseline for the action area, and the effects of the proposed action and its cumulative effects, implementing the NSS Levee Improvements Project may affect and is likely to adversely affect giant garter snake and would result in no effect on listed vernal pool invertebrates, valley elderberry longhorn beetle, and Central Valley steelhead. Designated critical habitat in the action area has been designated for Central Valley steelhead; however, none would be adversely modified or destroyed.

- **Vernal pool invertebrates:** The NSS Levee Improvements Project would result in no effect on federally listed vernal pool invertebrates considered in this preliminary biological evaluation. Effects are not expected to occur because of the avoidance and minimization measures incorporated into the NSS Levee Improvements Project. The NSS Levee Improvements Project includes several measures that would avoid potential direct and indirect environmental effects during project construction. The potential indirect effects impacts of altered hydrology or degraded water quality, would be avoided and minimized through the use of best management practices (e.g., establishment and maintenance of appropriate buffers, erosion control, and revegetation).

- **Valley elderberry longhorn beetle:** The NSS Levee Improvements Project would result in no effect to VELB. Any elderberry shrubs located in the NSS Levee Improvements Project area would be avoided (see VELB-1 “Temporarily Fence All Elderberry Shrubs Adjacent to Construction Areas and Designate the Area as Environmentally Sensitive”), thereby avoiding direct effects to VELB. Additional conservation measures (VELB-2, “Prohibit Use of Pesticides or Chemicals within 100 Feet of Elderberry Shrubs.”.

- **Federally listed fish species:** [Placeholder]

- **Giant garter snake:** The NSS Levee Improvements Project may affect and is likely to adversely affect giant garter snake through the implementation of activities at Borrow Site 2. Ground disturbing activities at Borrow Site 2 could result in direct displacement, injury, or death of snakes and indirect displacement of snakes. These direct and indirect effects, which could affect the ability of snakes to conduct essential life history functions, such as dispersal, movement, or foraging, would be temporary (occurring during one active season). Construction activities could temporarily degrade aquatic habitat, but the overall result of implementing the Conservation Strategy would be an enhancement of habitat quality.

11.0 ESSENTIAL FISH HABITAT ASSESSMENT

The Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 USC 1801), requires that EFH be identified and described in federal fishery management plans. Federal agencies must consult with NMFS on any activity that they fund, permit, or carry out that may adversely affect EFH. The EFH regulations require that federal agencies obligated to consult on EFH also provide NMFS with a written assessment of the effects of any action on EFH (50 CFR 600.920). NMFS is required to provide EFH conservation and enhancement recommendations to federal agencies. The statute also requires federal agencies receiving NMFS EFH conservation recommendations to provide a detailed written response to NMFS within 30 days of receipt, detailing how they intend to avoid, mitigate, or offset the impact of activity on EFH (Section 305[b][4][B]).

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle.

The Pacific Fishery Management Council has identified and described EFH, adverse impacts, and recommended conservation measures for salmon in Amendment 14 to the *Pacific Coast Salmon Plan* (PFMC 2003). Freshwater EFH for Pacific salmon in the Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem, as described in Myers et al. (1998), and includes the segment of the NEMDC/Steelhead Creek in the action area. Central Valley fall-/late fall–run Chinook salmon is a species managed under the *Pacific Coast Salmon Plan* that occur in the NEMDC/Steelhead Creek.

THE PROPOSED ACTION

The proposed action is described in detail in the "Description of the Proposed Action" section of this preliminary biological evaluation. The action area, environmental baseline, and species accounts, respectively, are described in the "Action Area," "Environmental Baseline," and "Species Accounts" sections of this preliminary biological evaluation.

ESSENTIAL FISH HABITAT DESIGNATION IN THE ACTION AREA [PLACEHOLDER]

EFFECTS OF THE PROPOSED ACTION [PLACEHOLDER]

PROPOSED CONSERVATION MEASURES [PLACEHOLDER]

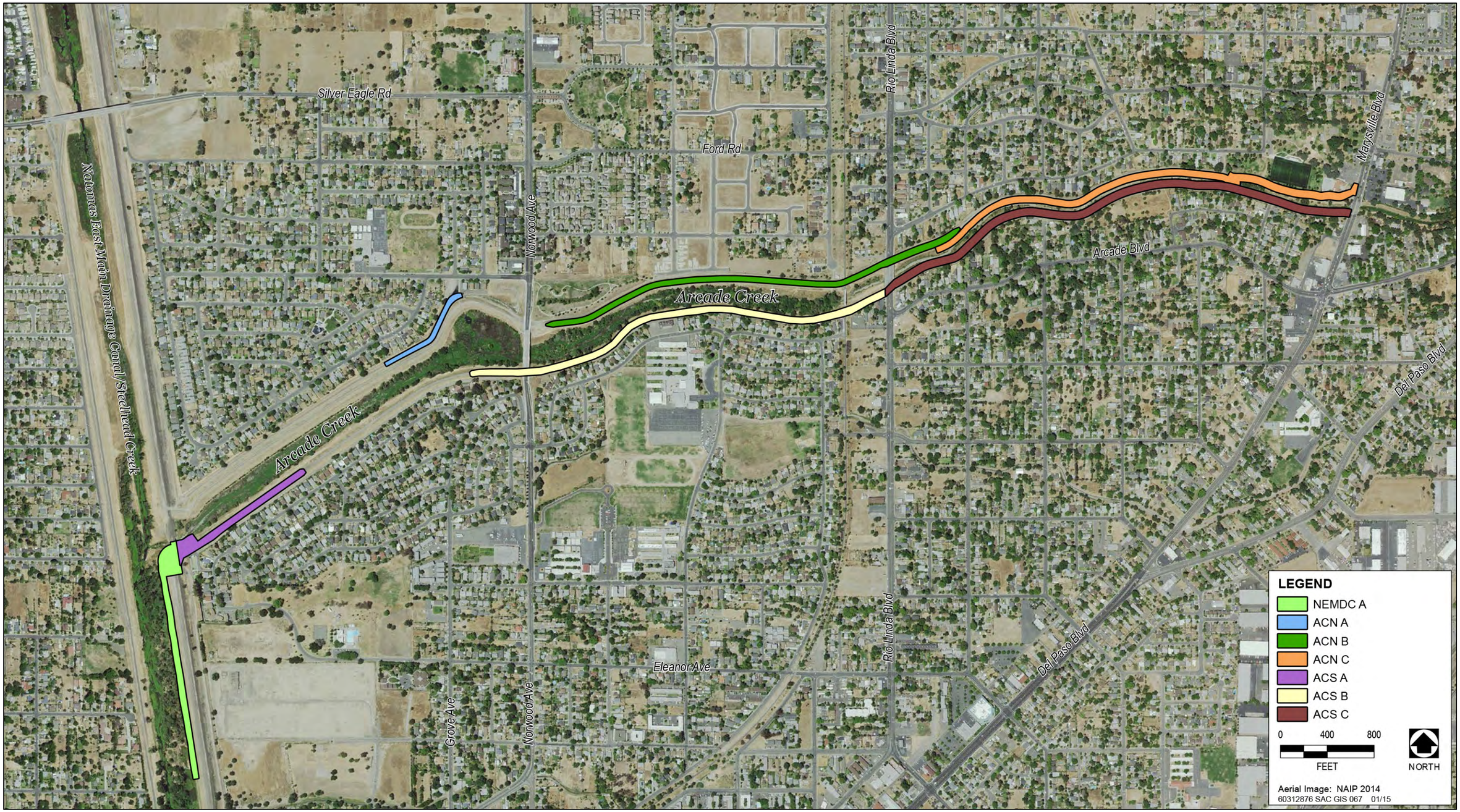
CONCLUSIONS [PLACEHOLDER]

12.0 REFERENCES

[To be provided].

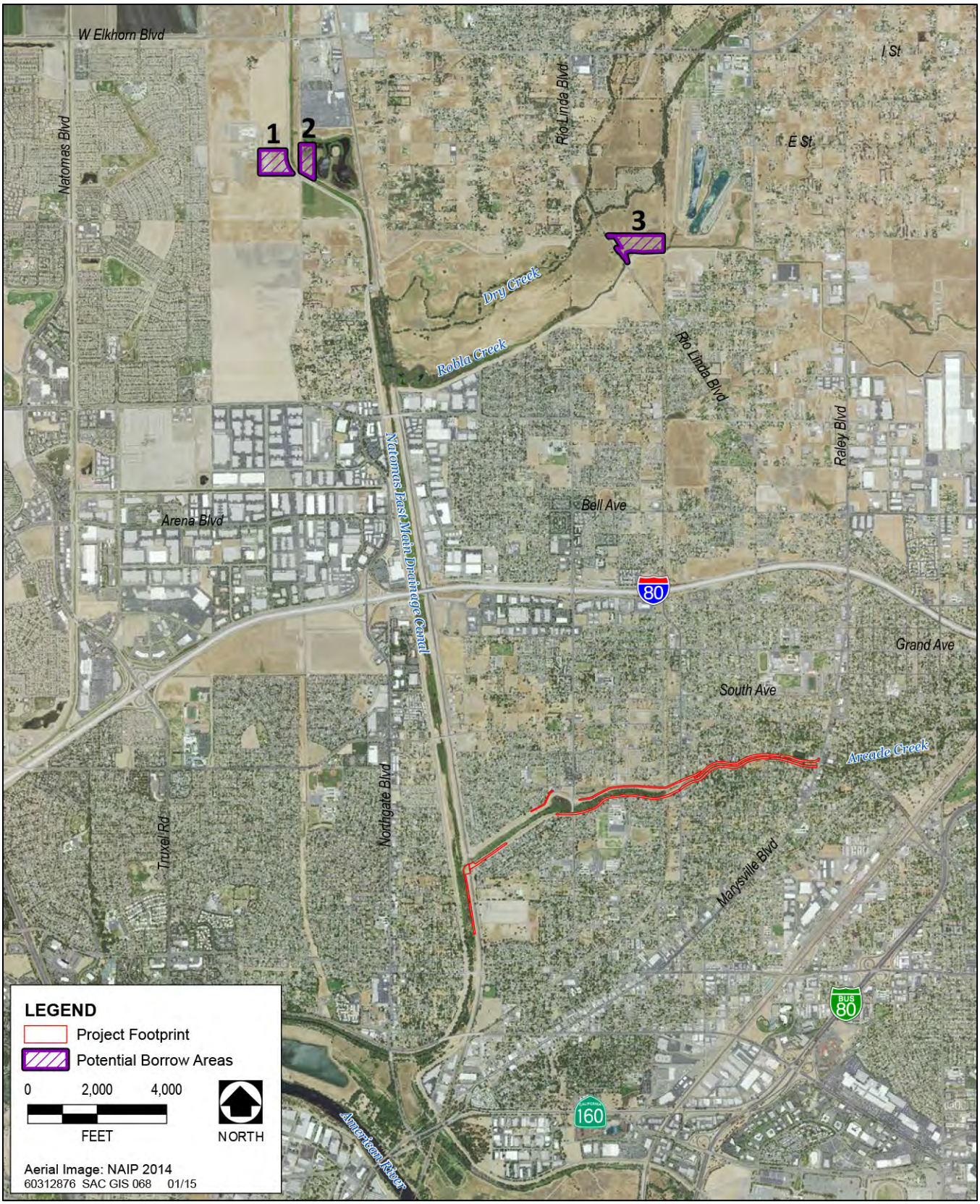
APPENDIX A

Exhibits



Source: MBK Engineers 2014, adapted by AECOM in 2014

Exhibit 1. **North Sacramento Streams Levee Improvements Area Reaches**

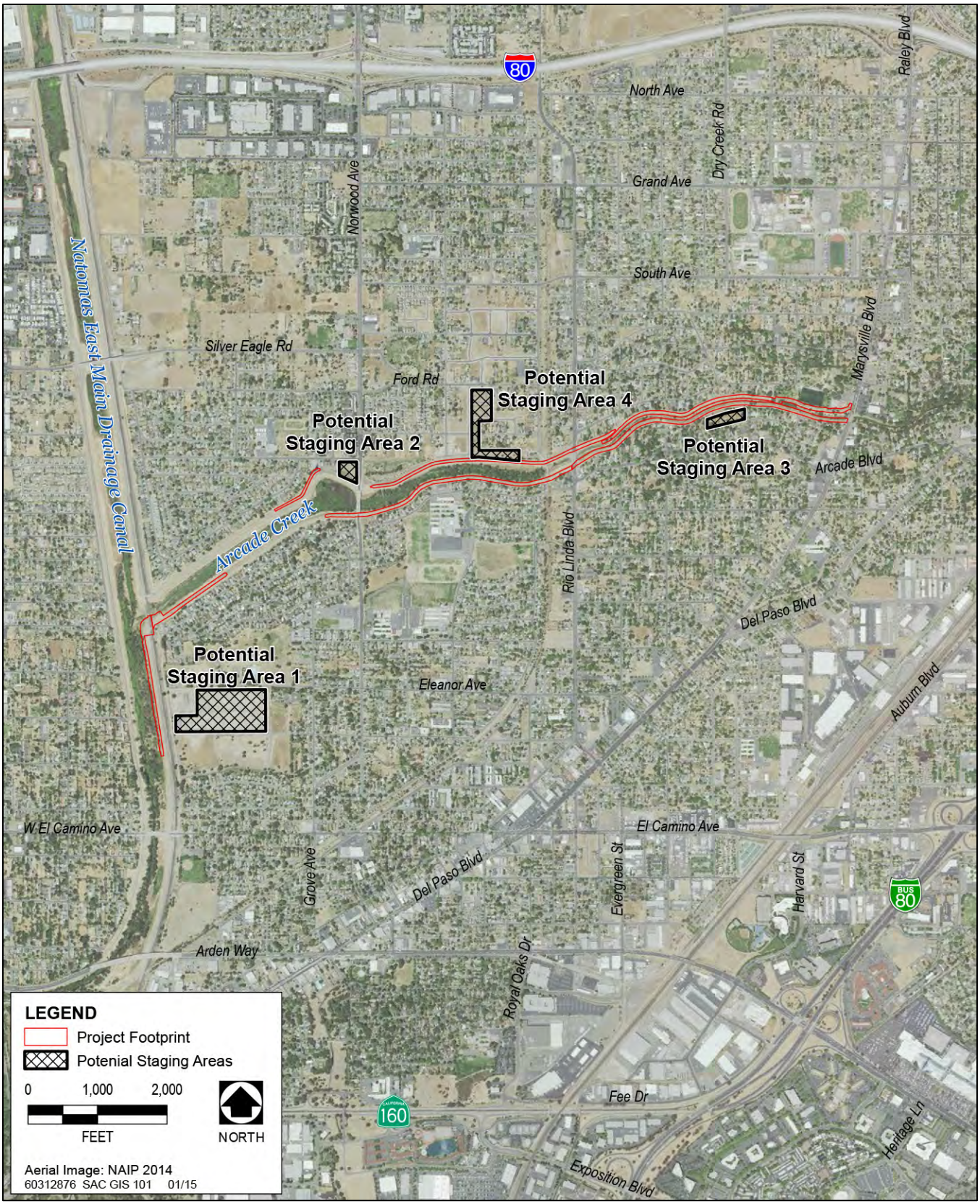


Source: SAFCA 2014, adapted by AECOM in 2014

Exhibit 2. **North Sacramento Streams Borrow Areas**

Source: URS Corporation 2014, adapted by AECOM in 2014

Exhibit 3. **North Sacramento Streams Haul Routes**



Source: URS Corporation 2014, adapted by AECOM in 2014

Exhibit 4. **North Sacramento Streams Staging Areas**

Source: AECOM 2014

Exhibit 5. Potential Mitigation Sites – Robla Creek

Appendix E

Magpie Creek Flood Control Project

Biological Opinion

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In reply refer to:
1-1-04-F-0132

SEP 15 2004

Mr. Mark Charlton
Department of the Army
U.S. Army Engineer District, Sacramento
Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: Review of the Proposed Magpie Creek Flood Control Project, Sacramento County, California, for Inclusion with the Vernal Pool Crustaceans Programmatic Consultation (File Number 1-1-96-F-0001) and a Separate Formal Consultation for the Giant Garter Snake

Dear Mr. Charlton:

This letter responds to your March 25, 2004, letter requesting formal consultation with the U. S. Fish and Wildlife Service (Service) and concurrence to append the U. S. Army Corps of Engineers' (Corps) proposed Magpie Creek Flood Control Project (project) in Sacramento, California, to the programmatic formal consultations for the threatened giant garter snake (*Thamnophis gigas*), and the endangered vernal pool tadpole shrimp (*Lepidurus packardi*) and the threatened vernal pool fairy shrimp (*Branchinecta lynchi*) (File Numbers 1-1-F-97-149 and 1-1-96-F-1, respectively).

As explained below, we determined during our review of your request that the proposed project qualifies for inclusion under the programmatic consultation for vernal pool crustaceans only. Accordingly, a separate consultation for giant garter snake was deemed necessary and is provided in this letter. The findings in this consultation are based on information provided in your March 25, 2004, letter and attached *Draft Environmental Assessment* (DEA), dated January 2004; your *Draft Detailed Project Report/Environmental Assessment* dated January 14, 2004; a *Second Revised Draft Fish and Wildlife Coordination Act* (FWCA) *Report*, dated May 8, 2003, prepared by the Service; site visits on April 27 and May 20, 2004, with the Corps and Sacramento Area Flood Control Agency (SAFCA), the project local sponsor; electronic mail (e-mail) communications to the Service from the Corps dated May 17 and June 9, 2004,

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providing project description language pertaining to preservation of purchased land; and our review of earlier FWCA Reports, numerous other file documents, and meeting and site visit notes during the 1993-2004 period of Service coordination and consultation activity on this project.

CONSULTATION HISTORY

In the early 1990s, the Corps investigated flood protection needs in the Magpie Creek area, compared detention basin and channel widening (channel plan) alternatives that included the former McClellan Air Force Base (currently known as McClellan Business Park), and recommended the channel plan. The Service's biological opinion dated September 20, 1995 (File Number 1-1-95-F-30) determined that the channel plan would have direct and indirect effects on vernal pools and other wetlands that would involve significant compensation for impacts. The opinion did not address effects on giant garter snake. The Service met with the local sponsor on November 20, 1997, regarding the potential for use of habitat within the lower Dry Creek corridor for mitigation of project impacts, but did not reach agreement. In late 1999 to early 2000, the channel plan was redesigned with an upstream terminus just east of Raley Boulevard. This plan provided for reduced effects to seasonal wetlands and increased vegetation allowance (with reduced maintenance) within the widened Magpie Creek Diversion Channel (MCDC), with raising of Raley Boulevard and relocation of a portion of Don Julio Creek. On February 27, 2001, Service and Corps staff met and discussed effects of the project on floodplain development. Beginning June 2001, the project was again redesigned based on additional hydraulic analysis and preliminary alternatives developed by David Ford Consulting Engineers (Magpie Creek Floodplain Analysis, dated November 19, 2001). The selected alternative which is described in more detail below, would accomplish flood protection using modest levee and culvert improvements together with purchase of land primarily east of Raley Boulevard for the purpose of peak flood detention, and would not involve widening or other modification of the existing MCDC channel.

Recent consultation activities directly related to this proposed project are as follows:

March 26, 2004: Service received letter from the Corps (Mark Charlton) dated March 25, 2004, and draft Environmental Assessment dated January 2004, requesting appendage of the proposed project to the programmatic biological opinions for giant garter snake and vernal pool crustaceans.

April 29, 2004: Service, Corps, and SAFCA staff met in the field to review proposed project features and confirm type of disturbance associated with Robla Creek bikeway trail culvert.

May 7, 2004: Service staff (Steve Schoenberg) submitted an e-mail request to Corps staff (Ed Stewart) to clarify protective mechanism by which purchased lands would be preserved in perpetuity.

May 17, 2004: Service received an e-mail response from Corps staff (Ed Stewart), forwarding language from SAFCA (Grant Kreinberg) that it would place a flood control easement on the land in addition to purchase and would request purchased land be re-zoned as open space.

May 18, 2004: Service informed Corps by an e-mail of the need for a second site visit to verify vernal pool indirect effects near Kelly-Moore Paint Store, and assess status of vernal pools south of MCDC between Vinci Avenue and Dry Creek Road previously mapped in 1993.

May 19, 2004: Service faxed the Corps additional information on locations of vernal pool crustacean habitat which required confirmation.

May 20, 2004: Service and Corps staff met in field, concluded that pool impacts near the Kelly-Moore Paint Store were at most no greater in size than indicated in the March 25, 2004, biological assessment, and the pool areas between Vinci Avenue and Dry Creek Road were no longer present, possibly due to recent grading from an unrelated project.

May 22, 2004: Service requested via an e-mail to the Corps, clarification as to whether unrelated grading/construction activity between Vinci Avenue and Dry Creek Road would require modification of the proposed flood control project, specifically, the location of the maintenance road.

June 8, 2004: Corps (Charles Rairdan) replied via an e-mail that the Corps had contacted the developer who had conducted subject unrelated grading, and confirmed that the maintenance road element of the proposed flood control project would be constructed in the location as originally planned.

June 9, 2004: Corps (Charles Rairdan) e-mailed Service revisions to proposed project description language.

July 30, 2004: Service requested via an e-mail to the Corps to confirm areas of habitat disturbance and loss.

August 3, 2004: Corps (Ed Stewart) replied via an e-mail to the Service confirming habitat disturbance and loss areas.

PROJECT DESCRIPTION

The proposed project would be located in Sacramento County north of Interstate 80 and west of McClellan Business Park, and would provide for improved flood protection within the historic Magpie Creek floodplain between Raley Boulevard and the Natomas East Main Drainage Canal. Currently, drainage is provided by the MCDC, an existing artificial channel which spans between

Raley Boulevard and the confluence of Robla Creek with the MCDC. The MCDC includes existing sections of levees between Raley Boulevard and Vinci Avenue, and between Dry Creek Road and the Robla Creek confluence. Proposed project features include:

- raising the MCDC levee between Raley Boulevard and Vinci Avenue;
- constructing maintenance roads - for the 2,100 feet between Raley Boulevard and Vinci Avenue, the existing road on top of the levee would be reconstructed and a second new road would be built land side of the levee base; for the 2,700 feet between Vinci Avenue and Dry Creek Road, a new maintenance road would be constructed immediately adjacent to the top of slope of the MCDC;
- constructing a new 1,000-foot-long levee along the west side of Raley Boulevard between the existing MCDC crossing and Santa Ana Avenue to prevent outflanking flows (with floodgates at the entrance to the Kelly-Moore Paint Store);
- excavating a new overflow channel and installing culverts under the bike trail bridge near the Robla Creek confluence with the MCDC;
- relocating and replacing the existing slide gate outlet between the MCDC and historic Magpie Creek;
- disposing of abandoned tanks between the MCDC and Raley Boulevard, and;
- acquiring and preserving in perpetuity 79 acres (76.5 acres excluding roadways and channels) between Raley Boulevard, McClellan Business Park, and Magpie and Don Julio Creeks.

The MCDC levee raise and new Raley Boulevard levee segment are designed to detain the 250 year flood within the 79-acre area which would be acquired (hereafter termed "preservation area"). The raise would range from about five feet at Raley Boulevard and taper to existing ground a short distance south of Vinci Street. The Raley Boulevard levee would be about five feet high where it meets the MCDC levee, tapering to existing ground near Santa Ana Avenue. The bike trail culvert is sized to result in no change in peak flood stage on the MCDC upstream of Dry Creek Road. The maintenance roads allows the full length of proposed project features (both levee and channel) to be maintained. The 20-foot-wide overflow channel near the bike bridge would be above the invert of the MCDC and configured to avoid existing oak trees. The new slide gate outlet to historic Magpie Creek would retain the flexibility to release flows into the historic channel.

Construction will take one season. Two staging areas have been designated, an existing borrow storage and disposal location near Dry Creek Road and Ascot Avenue, and a section of Vinci Avenue just west of the MCDC. The bike trail culvert and overflow channel would be

constructed first, and suitable material stockpiled for use in subsequent construction of the new Raley Boulevard levee or MCDC levee raise work described above. Remaining material would be obtained from the existing borrow storage area. After the levee work is completed, the maintenance roads would be built with an aggregate base. All soils exposed by grading would be revegetated by seeding and mulching.

The action area includes the MCDC and adjacent lands where levee, channel, culvert, or road construction would occur, a small area along Raley Boulevard where levee construction would occur, the preservation area, and the historic Magpie Creek floodplain. These areas are dominated by uplands, primarily herbaceous, non-native grasslands, with scattered houses and a few light industries near Raley Boulevard. Most areas are relatively undisturbed, but other areas near residences are more frequently disturbed by tilling, and ongoing activities such as grazing, storage of a variety of items, and off-road vehicle travel. Magpie and Don Julio Creeks, and the MCDC, have both wetland and primarily young woody vegetation within the channel banks. Larger and more dense woody vegetation is present around some sections of Don Julio Creek, and several mature oaks are in the vicinity of the bike trail culvert element. The preservation area as well as portions of the historic Magpie Creek floodplain have a variety of seasonal and permanent wetlands. The MCDC currently is subject to occasional maintenance of vegetation. The proposed work would occur outside of the channels and no change in channel maintenance is proposed. Approximately 0.25 acres of wetland that is potential vernal pool crustacean habitat near the MCDC would be indirectly affected by elimination of outflanking flows. About 6.1 acres of lands adjacent to the MCDC that are potential giant garter snake habitat, would be disturbed by the proposed project (upland plus the existing maintenance road), of which 1.4 acres would be a permanent conversion of upland to additional maintenance road surface.

The Corps has recommended fee title acquisition of the preservation area and SAFCA has indicated it will purchase the property in fee and also place a flood control easement on the title. The intention of these actions is to prohibit construction of any structures on the properties and to permanently prevent the properties from being developed. Although conservation areas in accordance with programmatic formal consultations are typically protected by a conservation easement, the Corps can only require a flowage easement to fulfill the proposed project's flood control purpose. However, the restrictiveness and compensation for such an easement has been determined by the Corps to be tantamount to fee title. Following purchase, SAFCA will request the City of Sacramento to change the land use and zoning designation on the property to reflect the permanent preservation of the properties as open space. SAFCA has further indicated it will develop, separate from the proposed flood control project, a habitat management plan for the properties with a view toward enhancing the habitat, such as by native tree planting adjacent to Magpie and Don Julio Creeks, and has stated its intention to coordinate such enhancement activity with appropriate regulatory agencies, which would include the Service.

Proposed Minimization and Compensation Measures: The Corps has proposed to acquire 0.5 mitigation credits from a Service-approved mitigation bank for preservation of vernal pool habitat. As it concerns measures to protect the giant garter snake, the Corps states that it will

limit such construction to between May 1 and October 1, instruct personnel in awareness training by a Service-approved biologist, confine construction equipment to existing roads and levee surfaces, conduct pre-construction surveys and re-surveys between construction lapses, report any giant garter snake sitings and, upon any siting, halt construction until such time avoidance measures are developed in consultation with the Service. These are consistent with the standard avoidance and minimization measures 1-7 of the Service's *Programmatic Formal Consultation for U.S. Army Corps of Engineers 404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties* (Snake Programmatic Consultation) (Appendix C, attached).

APPENDMENT TO VERNAL POOL FAIRY SHRIMP PROGRAMMATIC OPINION

With respect to listed vernal pool crustaceans, indirect effects of the proposed project could result from elimination of outflanking storm flows to pools within 250 feet of proposed project elements. Two wetlands totaling about 0.25 acre are present west of the Kelly Moore Paint Store. The Corps has proposed to acquire 0.5 mitigation credits from a Service-approved mitigation bank for preservation of vernal pool habitat to offset this impact. The proposed project will also have slight effects on flood depth and duration in the area proposed for purchase and preservation. Increasing the levee height of the MCDC levee would increase the depth of flooding of the area between Magpie and Don Julio Creeks by less than 1 foot for several hours during a 250-year flood event, and by much less (0.01-0.05 feet) during the average annual (2-year) flood event. The hydraulic changes in this area caused by the proposed project are determined by the Service to be of insufficient magnitude, frequency, and duration to cause an adverse effect to listed vernal pool crustaceans or their habitat.

The Service has determined that, based on the effects on listed vernal pool crustaceans described in your March 25, 2004, letter, it is appropriate to append the proposed Magpie Creek Flood Control Project to the Service's *Programmatic Formal Endangered Species Act Consultation on Issuance of 404 Permits for Projects with Relatively Small Effects on Listed Vernal Pool Crustaceans within the Jurisdiction of the Sacramento Field Office, California* (Vernal Pool Programmatic Consultation).

The Service is tracking losses of habitat permitted under the Vernal Pool Programmatic Consultation. We reevaluate the effectiveness of the Vernal Pool Programmatic Consultation at least every six (6) months to ensure that continued implementation will not result in unacceptable effects to the listed species.

The conservation measures identified in the Vernal Pool Programmatic Consultation include the following:

1. Preservation component: For every acre of habitat directly or indirectly affected, at least two vernal pool credits will be dedicated within a Service-approved ecosystem preservation bank or, based on Service evaluation of site-specific conservation values, three acres of vernal pool habitat may be preserved on the project site or another non-bank site as approved by the Service.

2. Creation component: For every acre of habitat directly affected, at least one vernal pool creation credit will be dedicated within a Service-approved habitat creation bank or, based on Service evaluation of site-specific conservation values, two acres of vernal pool habitat will be created and monitored on the project site or another non-bank site as approved by the Service.

3. Listed vernal pool crustacean habitat and associated uplands utilized as on-site compensation will be protected from adverse effects and managed in perpetuity or until the Corps, the applicant, and the Service agree on a process to exchange such areas for credits within a Service-approved conservation banking system. Off-site conservation at a Service-approved non-bank location will be protected and managed in perpetuity through a Service-approved conservation easement, Service-approved management plan, and a sufficient endowment fund to manage the site in perpetuity in accordance with the management plan

4. If habitat is avoided (preserved) on site, then a Service-approved biologist (monitor) will inspect any construction-related activities at the proposed project site to ensure that no unnecessary take of listed species or destruction of their habitat occurs. The biologist will have the authority to stop all activities that may result in such take or destruction until appropriate corrective measures have been completed. The biologist also will be required to immediately report any unauthorized impacts to the Service and the California Department of Fish and Game.

5. Adequate fencing will be placed and maintained around any avoided (preserved) vernal pool habitat to prevent impacts from vehicles.

6. All on-site construction personnel will receive instruction regarding the presence of listed species and the importance of avoiding impacts to these species and their habitat.

7. The applicant will ensure that activities that are inconsistent with the maintenance of the suitability of remaining habitat and associated on-site watershed are prohibited. This includes, but is not limited to: (i) alteration of existing topography or any other alteration or uses for any purposes, including the exploration for or development of mineral extraction; (ii) placement of any new structures on these parcels; (iii) dumping, burning, and/or burying of rubbish, garbage, or any other wastes or fill materials; (iv) building of any new roads or trails; (v) killing, removal, alteration, or replacement of any existing

native vegetation; (vi) placement of storm water drains; (vii) fire protection activities not required to protect existing structures at the project site; and (viii) use of pesticides or other toxic chemicals.

The proposed project will result in 0.25 acre of indirect effects to vernal pools/swales of potentially suitable vernal pool shrimp and vernal pool tadpole shrimp habitat. The applicant has identified and agreed to purchase 0.5 vernal pool preservation credits at a Service-approved conservation bank or Service-approved fund. Credits will be purchased prior to the effect on any vernal pool habitat.

The agreed upon conservation responsibilities of the applicant are as follows:

1. Prior to any earth-moving activities at the proposed project site, the applicant shall purchase at least 0.5 vernal pool preservation credits within a Service-approved ecosystem preservation bank or fund account.

SEPARATE BIOLOGICAL OPINION ON GIANT GARTER SNAKE

With respect to the giant garter snake, certain sections of Magpie and Don Julio Creeks and the MCDC contain suitable habitat for the giant garter snake. The DEA references a professional consultant's opinion that potential presence of giant garter snake cannot be discounted in these sections, and notes the connection between and proximity of the proposed project watercourses to the Natomas drainage system as well as a nearby siting of giant garter snake within McClellan Business Park at Robla Creek. Accordingly, the presence of giant garter snake in the proposed project area is assumed. Although no construction would occur in aquatic habitat, your March 25, 2004, letter which requested formal consultation incorrectly states that there would be no removal of upland habitat during channel modifications. In fact, the DEA states that construction would take place in uplands within 200 feet and/or adjacent to aquatic habitat, in the forms of: (1) 4,800 feet of a new 10-foot-wide maintenance road (and an additional one foot of shoulder on each side); and (2) approximately 200 feet of new 20-foot-wide channel excavation near the bicycle bridge in the vicinity of the Robla Creek Confluence. The total area of upland that would be adversely affected would be 6.1 acres, of which 1.4 acres of impact related to the construction of the new maintenance road would be permanent, as this road would be surfaced with aggregate stone and maintained free of vegetation (areas provided by an e-mail communication from the Corps (Ed Stewart) dated August 3, 2004). Snakes would be able to move across this surface but it would lack the vegetation of typical uplands that provide essential habitat functions. The construction of a culvert and associated channel near the bicycle bridge would be considered a temporary effect, as it would be earth-surfaced, and assumed to be lightly maintained by mowing and debris removal similar to what is currently done on the MCDC. The adjacent upland habitat at the proposed project site represents giant garter snake habitat because snakes prefer upland habitat that consists of grassy banks and openings in waterside vegetation such as occurs in the project site.

Under the Service's Snake Programmatic Consultation, "permanent impacts" are defined as those proposed project activities which result in a loss of essential habitat components, and upland habitat within a 200-foot radius is recognized within that definition of essential habitat and the determination of potential take. Regardless of whether the impact is upland or aquatic in nature, the compensation for all such permanent impact under the guidelines for the Snake Programmatic Consultation is replacement at a 3:1 ratio, with a 2:1 replacement ratio of upland to aquatic area. Applying this guidance to the subject proposed project, 1.40 acres of impact would require 4.20 acres of replacement habitat, which must meet all Terms and Conditions, guidelines, and criteria in Appendices A and C of the Snake Programmatic Consultation (attached).

We have reviewed the Corps' proposed purchase and preservation in perpetuity of 76.5 acres of upland-wetland habitat near the proposed project site. This type of preservation and purchase proposed is not in accordance with Appendix A (replacement guideline #1) and Appendix C (avoidance and minimization measure #8), and is atypical of the protective covenant description in Term and Condition 2D of the Snake Programmatic Consultation. Therefore, the Service has determined that appending this proposed project to the Snake Programmatic Consultation is not appropriate, and a separate biological opinion is required for consultation for this species and consideration of the merits of the proposed preservation area. Despite the inconsistencies with the Snake Programmatic Consultation, the 76.5 acres of habitat that would be protected as part of the proposed project description far exceed the 4.20 acres which would be required if compensation were deemed necessary.

STATUS OF THE SPECIES

The Service published a proposal to list the giant garter snake as an endangered species on December 27, 1991 (56 **FR** 67046). The Service re-evaluated the status of the snake before adopting the final rule. The snake was listed as a threatened species on October 20, 1993 (58 **FR** 54053).

Description. The giant garter snake is one of the largest garter snakes and may reach a total length of at least 64 inches. Females tend to be slightly longer and proportionately heavier than males. The weight of adult female snakes is typically 500-700 grams (1.1-1.5 pounds). Dorsal background coloration varies from brownish to olive with a checkered pattern of black spots, separated by a yellow dorsal stripe and two light-colored lateral stripes. Background coloration and prominence of a black-checkered pattern and the three yellow stripes are geographically and individually variable (Hansen 1980). The ventral surface is cream to olive or brown and sometimes infused with orange, especially in northern populations.

Historical and Current Range. This species formerly occurred throughout the wetlands that were extensive and widely distributed in the Central Valley. Fitch (1941) described the historical range of the snake as extending from the vicinity of Sacramento and Contra Costa Counties southward to Buena Vista Lake, near Bakersfield, in Kern County. Prior to 1970, the snake was recorded historically from 17 localities (Hansen and Brode 1980). Five of these localities were

clustered in and around Los Banos, Merced County. The paucity of information makes it difficult to determine precisely the species' former range. Nonetheless, these records coincide with the historical distribution of large flood basins, fresh water marshes, and tributary streams. Destruction of wetlands for agriculture and other purposes apparently extirpated the species from the southern one-third of its range by the 1940s -1950s, including the former Buena Vista Lake and Kern Lake in Kern County, and the historic Tulare Lake and other wetlands in Kings and Tulare Counties (Hansen and Brode 1980, Hansen 1980).

Surveys over the last two decades have found the snake as far north as the Butte Basin in the Sacramento Valley. As recently as the 1970s, the range of the snake extended from near Burrell, Fresno County (Hansen and Brode 1980), northward to the vicinity of Chico, Butte County (Rossman and Stewart 1987). California Department of Fish and Game (CDFG) studies (Hansen 1988) indicate that snake populations currently are distributed in portions of the rice production zones of Sacramento, Sutter, Butte, Colusa, and Glenn Counties; along the western border of the Yolo Bypass in Yolo County; and along the eastern fringes of the Sacramento-San Joaquin River Delta from the Laguna Creek-Elk Grove region of central Sacramento County southward to the Stockton area of San Joaquin County.

Essential Habitat Components. Endemic to wetlands in the Sacramento and San Joaquin valleys, the snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways and agricultural wetlands, such as irrigation and drainage canals and rice fields, and the adjacent uplands. The snake feeds on small fishes, tadpoles, and frogs (Fitch 1941, Hansen 1980, Hansen 1988). Essential habitat components consist of: (1) wetlands with adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season; (3) upland habitat with grassy banks and openings in waterside vegetation for basking; and (4) higher elevation uplands for escape cover (vegetation, burrows) and underground refugia (crevices and small mammal burrows) (Hansen 1980).

Reproductive Ecology. The breeding season extends through March and April, and females give birth to live young from late July through early September (Hansen and Hansen 1990). Brood size is variable, ranging from 10 to 46 young, with a mean of 23 individuals (Hansen and Hansen 1990). At birth young average about 20.6 cm snout-vent length and 3-5 grams. Young immediately scatter into dense cover and absorb their yolk sacs, after which they begin feeding on their own. Although growth rates are variable, young typically more than double in size by one year of age, and sexual maturity averages three years in males and five years for females (58 FR 54053).

Movements and Habitat Use. The giant garter snake typically inhabits small mammal burrows and other soil crevices throughout its winter dormancy period (November to mid-March). Although these areas are generally thought to be above prevailing flood elevations, snakes may not always utilize high ground during their winter dormancy period. The Biological Resources Division (BRD) has documented giant garter snakes at the Colusa National Wildlife Refuge

overwintering in areas with few high ground retreat sites (Wylie *et al.* 1997). Snakes in another study population at Gilsizer Slough overwintered in a low elevation wetland area, even though higher ground was present nearby. Both of these populations survived flooding and were not displaced from the area. The snake also uses burrows as refuge from extreme heat during their active period. While the snakes usually remain in close proximity to wetland habitats, the BRD has documented snakes using burrows as much as 165 feet away from the marsh edge to escape extreme heat (Wylie *et al.* 1997). Overwintering snakes have been documented to use burrows as far as 820 feet from the edge of marsh habitat. Snakes typically select south- and west-facing burrows as hibernacula (58 **FR** 54053).

In studies of marked snakes in the Natomas Basin, snakes moved about 0.25 to 0.5 mile per day (Brode and Hansen 1992). However, total activity varies widely between individuals, and individual snakes have been documented moving up to 5 miles over the period of a few days in response to dewatering of habitat (Wylie *et al.* 1997). In agricultural areas, snakes were documented using rice fields in 19-20 percent of the observations, marsh habitat in 20-23 percent of observations, and canal and agricultural waterway habitats in 50-56 percent of the observations (Wylie 1999). Telemetry studies have also shown that active snakes use uplands extensively–more than 31 percent of observations were in uplands (Wylie 1999). Almost all snakes observed in uplands during the active season were near vegetative cover, where cover exceeded 50 percent in the area within 1.6 feet of the snake; less than 1 percent of observations were of snakes in uplands with less than 50 percent cover nearby (Wylie 1999).

Reasons for Decline and Threats to Survival. The current distribution and abundance of the snake is much reduced from former times. Loss of habitat due to agricultural activities and flood control have extirpated the snake from the southern one third of its range in former wetlands associated with the historic Buena Vista, Tulare, and Kern lakebeds. These lakebeds once supported vast expanses of ideal snake habitat, consisting of cattail and bulrush dominated marshes. Vast expanses of bulrush and cattail floodplain habitat also typified much of the Sacramento Valley historically (Hinds 1952). Prior to reclamation activities beginning in the mid to late 1800s, about 60 percent of the Sacramento Valley was subject to seasonal overflow flooding in broad, shallow flood basins that provided expansive areas of snake habitat (Hinds 1952). Valley floor wetlands are subject to the cumulative effects of upstream watershed modifications, water storage and diversion projects, as well as urban and agricultural development; all natural habitats have been lost and an unquantifiable but small percentage of semi-natural wetlands remain extant. Only a small percentage of extant wetlands currently provide habitat suitable for the snake.

Ongoing maintenance of aquatic habitats for flood control and agricultural purposes eliminate or prevent the establishment of habitat characteristics required by snakes and can fragment and isolate available habitat, prevent dispersal of snakes among habitat units, and adversely affect the availability of the garter snake's food items (Hansen 1988, Brode and Hansen 1992). In many areas, the restriction of suitable habitat to water canals bordered by roadways and levee tops renders snakes vulnerable to vehicular mortality. Fluctuation in rice and agricultural production

affects stability and availability of habitat. Recreational activities, such as fishing, may disturb snakes and disrupt basking and foraging activities. Nonnative predators, including introduced predatory gamefish, bullfrogs (*Rana catesbiana*), and domestic cats also threaten snake populations. While large areas of seemingly suitable snake habitat exist in the form of duck clubs and waterfowl management areas, water management of these areas typically does not provide the summer water needed by snakes. Although snakes on national wildlife refuges are relatively protected from many of the threats to the species, degraded water quality continues to be a threat to the species both on and off refuges. A number of land use practices and other human activities currently threaten the survival of the snake throughout the remainder of its range. Although some snake populations have persisted at low levels in artificial wetlands associated with agricultural and flood control activities, many of these altered wetlands are now threatened with urban development. Rapidly expanding cities within the current range of the snake include Chico, Yuba City, Sacramento, Galt, Stockton, Gustine, and Los Banos.

Status with Respect to Recovery. Currently, the Service recognizes 13 separate populations of the snake, with each population representing a cluster of discrete locality records (USFWS 1993). The 13 extant population clusters largely coincide with historical riverine flood basins and tributary streams throughout the Central Valley (Hansen 1980; Brode and Hansen 1992): (1) Butte Basin, (2) Colusa Basin, (3) Sutter Basin, (4) American Basin, (5) Yolo Basin-Willow Slough, (6) Yolo Basin-Liberty Farms, (7) Sacramento Basin, (8) Badger Creek-Willow Creek, (9) Caldoni Marsh, (10) East Stockton-Diverting Canal and Duck Creek, (11) North and South Grasslands, (12) Mendota, and (13) Burrell-Lanare. These populations span the Central Valley from just southwest of Fresno (Burrell-Lanare) north to Chico (Hamilton Slough).

The draft recovery plan for the snake subdivided its historic range into four recovery units (Service 1999). These are: (1) the Sacramento Valley unit, extending from the vicinity of Red Bluff south to the confluence of the Sacramento and Feather Rivers; (2) the Mid-Valley unit, extending from the American and Yolo Basins south to Duck Creek near the City of Stockton; (3) the San Joaquin Valley unit, extending south from Duck Creek to the Kings River; and (4) the South Valley unit, extending south of the Kings River to the Kern River Basin. Portions of the Mid-Valley recovery unit are within the action area.

The Sacramento Valley Recovery Unit at the northern end of the species' range is known to support relatively large, stable populations of the snake. This unit contains three populations (Butte Basin, Colusa Basin, and Sutter Basin) and a large amount of suitable habitat, in protected areas on state refuges and refuges of the Sacramento NWR Complex in the Colusa and Sutter Basins, and along waterways associated with rice farming (Service 1999). While populations within this unit have some protection on refuge and other public lands within National Wildlife Refuges, snakes are subjec to flooding and mortality from predatory fish and birds, vehicular traffic agricultural practices, aand maitenance of water channels. The populations within this unit are widely distributed and mostly restricted to unnatural agricultural water delivery and drainage facilities associated with rice fields, and habitat corridors connecting populations and subpopulations are not present and/or protected.

The Mid-Valley Recovery Unit, directly to the south of the Sacramento Valley Recovery Unit, includes seven populations: American Basin, Yolo Basin–Willow Slough, Yolo Basin–Liberty Farms, Sacramento Area, Badger Creek/Willow Creek, Caldoni Marsh, and East Stockton. The status of the seven snake populations in the Mid-Valley Recovery Unit is very uncertain. The East Stockton population may be extirpated, and is not considered recoverable as a result of urban encroachment into habitat (Service 1999). Five of the remaining six populations within the recovery unit are very small, highly fragmented and isolated, and, except for the Badger Creek/Willow Slough population, are also threatened by urbanization. This latter population is within a small isolated area. Within the Mid-Valley unit, only the American Basin population supports a sizeable snake population which is dependent largely upon rice lands. The American Basin population, although threatened by urban development, will receive protection from the approved Metro Air Park Habitat Conservation Plan (HCP) and Natomas Basin HCP (NBHCP), which share a regional strategy to maintain a viable snake population in the basin.

The remaining two recovery units are located to the south in the San Joaquin Valley, where the best available data indicate that the snake's status is precarious. The San Joaquin Valley Recovery Unit contains three historic snake populations: North and South Grasslands; Mendota Area; and Burrell/Lanare Area (Service 1999). This recovery unit formerly supported large snake populations, but numbers have declined severely in recent decades, and recent survey efforts indicate numbers are very low compared to Sacramento Valley populations.

No surviving snake populations are known from the fourth recovery unit, the South Valley Recovery Unit, at the southern end of the snake's historic range; this unit includes only extirpated populations, including the historic but lost Tulare and Buena Visa lakes.

Current Research Related to Recovery Efforts. Since April of 1995, the BRD has further documented occurrences of snakes within some of the known populations. The BRD has studied snake subpopulations at the Sacramento and Colusa NWRs within the Colusa Basin, at Gilsizer Slough within the Sutter Basin, the Badger Creek area of the Cosumnes River Preserve within the Badger Creek-Willow Creek area, and the Natomas area within the American Basin (Wylie *et al.* 1997, Wylie 1999). These subpopulations represent the largest known extant subpopulations. With the exception of the American Basin, these subpopulations are largely protected from many of the threats to the species. Outside of these protected areas, snakes in these populations are still subject to all the threats identified in the final listing rule. The remaining nine populations identified in the final rule are distributed discontinuously in small isolated patches and are vulnerable to extirpation by stochastic environmental, demographic, and genetic processes. The 13 extant populations are largely isolated from each other, with any dispersal corridors between them limited and not protected. When small populations are extirpated, the recolonization is unlikely in most cases, given the isolation from larger populations and the lack of dispersal corridors between them.

ENVIRONMENTAL BASELINE

The action area for the proposed project is included in the American Basin snake population. The American Basin population is within the Mid-Valley Recovery Unit (Service 1999). A description of the recovery unit along with the status of the population is outlined below.

The Mid-Valley Recovery Unit includes seven giant garter snake populations: American Basin, Yolo Basin–Willow Slough, Yolo Basin–Liberty Farms, Sacramento Area, Badger Creek/Willow Creek, Caldoni Marsh, and East Stockton. The status of the seven snake populations in the Mid-Valley Recovery Unit is very uncertain. The East Stockton population may be extirpated, and is not considered recoverable as a result of urban encroachment into habitat (Service 1999). Five of the remaining six populations within the recovery unit are very small, highly fragmented and isolated, and, except for the Badger Creek/Willow Slough population, are also threatened by urbanization. This latter population is within a small isolated area. Within the Mid-Valley unit, only the American Basin population supports a sizeable snake population which is dependent largely upon rice lands. The American Basin population, although threatened by urban development, receives some protection on lands managed by the Natomas Basin Conservancy, which has a goal of maintaining a viable snake population in the basin.

The American Basin has one of the largest and better protected snake poulations, but the unit is subject to the effects of a number of projects. Many development projects have been constructed in or near snake habitat in this rapidly urbanizing area, and snakes are subject to secondary effects of urbanization such as predation by house cats and increased vehicular mortality. Most documented localities have also been adversely impacted by freeway construction, flood control projects, and commercial development. Several former localities are known to have been lost or depleted to the extent that continued viability is in question (Brode and Hansen 1992). The scarcity of remaining suitable habitat, flooding, stochastic processes, and continued threats of habitat loss pose a severe threat to this population.

Factors Affecting the Snake within the Action Area. A number of State, local, private, and unrelated Federal actions have occurred within the action area and adjacent region affecting the environmental baseline of the species. Some of these projects have been subject to prior section 7 consultation. These actions have resulted in both direct and indirect impacts to snake habitat within the region. In addition to projects already discussed, projects affecting the environment in the action area include communication projects (e.g., installation of cable systems) and transportation projects with Federal, county or local involvement. The Corps has consulted the Service on the issuance of wetland fill permits for several bridge replacement projects within the Sacramento Basin that affected snake habitats. The direct effect of these projects is often small and localized, but transportation projects which improve access can indirectly affect snakes by facilitating development of habitat, and by increasing traffic mortality, and these effects are not quantifiable.

Ongoing agricultural activities also affect the environmental baseline for the snake, and are largely not subject to section 7 consultation. Some agriculture, such as rice farming, can provide valuable seasonal foraging and upland habitat for the snake. Although rice fields and agricultural waterways can provide habitat for the snake, agricultural activities such as waterway maintenance, weed abatement, rodent control, and discharge of contaminants into wetlands and waterways can degrade snake habitat and increase the risk of snake mortality (Service 1999). Ongoing maintenance of agricultural waterways can also eliminate or prevent establishment of snake habitat, eliminate food resources for the snake, and can fragment existing habitat and prevent dispersal of snakes (Service 1999). Flood control and maintenance activities which can result in snake mortality and degradation of habitat include levee construction, stream channelization, and the riprapping of streams and canals (Service 1999).

Several flood control programs administered by the Corps are completed or ongoing within the action area. Large completed projects include the Sacramento River Flood Control Project, which constructed and/or improved levees and other flood control features which make up the Federal Sacramento River Flood Control System; this system includes the levee which would receive bank protection under the Corps' proposed action. Subsequent to the 1986 flood events, the Corps initiated the ongoing Sacramento River Flood Control System Evaluation (SRFCSE) to examine the existing flood control system and to develop remedial repair plans to restore the designed level of protection. The Natomas Area Flood Control Project allowed urban development in the Natomas Basin to move forward. The American River Watershed Investigation administered by the Corps will affect snakes in the Natomas and American Basins. A separate recent flood control action in the immediate vicinity of the proposed project area in this consultation is the Lower Dry Creek and Robla Creek Levee Improvement Project (Public Notice 200000541; Service File Number 1-1-01-F-01340), conducted by SAFCA under permit from the Corps. That work involved reconfiguring a section of Robla Creek, and included grading and planting to enhance habitat for the giant garter snake. Other on-going or planned activities include levee raising along the Natomas Cross Canal, modification of the NEMDC Levee, and relocation of canals and stability berms along the various levees. Although the Corps has consulted on previous projects and is expected to continue to do so on future projects, the ongoing nature of these activities and the administration under various programs makes it difficult to determine the continuing and accumulative impacts of these activities.

The Snake in the Proposed Project Area. Numerous California Natural Diversity Database (CNDDB) (CDFG 2001) locality records are known from the Natomas Basin portion of the American Basin and are distributed throughout most of the basin. Robla Creek, Dry Creek, and Magpie Creek all converge with the Natomas East Main Drain Canal east of the Natomas Basin. Recent research efforts by BRD to collect demographic and habitat use data during 1998 and 1999, have further documented occurrences of giant garter snakes within the Natomas Basin (Wylie and Casazza 2000, Wylie *et al.* 2000). BRD surveys have provided significant recent information on the distribution of giant garter snakes within the Basin, and supplements previous research on the snake within Natomas Basin (e.g. Brode and Hansen 1992, Hansen and Brode 1993). BRD capture data and CNDDB records indicate giant garter snakes are distributed

throughout the Basin, but relative abundance varies widely across the Basin. Wylie and Cassaza (2000) concluded that habitat within the Natomas Basin has apparently degraded over time, as compared to previous accounts of habitat in the Basin. They also concluded that the quality of habitat within the Natomas Basin is less than that at other geographic locations where giant garter snakes are found. The other localities studied by BRD included more extensive areas of native or restored and/or protected habitat as compared with the Natomas Basin.

EFFECTS OF THE ACTION

The proposed work would affect giant garter snake upland habitat, adjacent to the MCDC. No snake aquatic habitat would be affected. The disturbance would be temporary and occur within the footprint of existing flood control structures, with the exception of a new maintenance road spanning between Raley Boulevard and Dry Creek Road on the outboard side of the levee or adjacent to the existing channel. The Service acknowledges that the levee raise approach obviates the need to disturb giant garter snake habitat in the MCDC, as would have been required by the channel widening approach considered in our previous biological opinion of September 20, 1995 (File Number 1-1-95-F-30). However, construction activities on upland near aquatic habitat may remove vegetative cover and basking sites used for thermoregulation and fill, or crush burrows/crevices needed for hibernation. Construction or maintenance vehicles may harm or crush snakes, or cause snakes to move to other areas at risk. The risk of take of the snake is reduced by restricted road access (i.e, gates) and limitation on road use for the purpose of channel maintenance. The area of uplands in which the maintenance road would be constructed is currently subject to infrequent disturbance by discing or mowing, and infrequent channel maintenance activity with heavy equipment. Due to the presence of uplands on the levee or uplands on the side of the MCDC opposite the maintenance road, uplands would not be entirely eliminated by the proposed action, and snakes would not be required to cross this maintenance road to access essential habitat elements due to the presence of uplands on the opposite side. Although the Service agrees that the protection measures proposed by the Corps would reduce construction-related effects, these measures do not compensate for the loss of upland in association with aquatic habitat.

Although not specifically identified as a compensation measure, the Service evaluated the potential for the preservation area - which functions as an area to detain peak flood flows - to provide for improved habitat and offset impacts to the giant garter snake not identified in the DEA. The habitat which would be acquired and preserved as part of the proposed project is in the vicinity of portions of Magpie and Don Julio Creeks both of which appear to have more consistent, perennial flow than does the MCDC, and possess essential habitat elements for giant garter snake. The preservation area is also adjacent to and serves as an upland buffer to other undeveloped habitat areas in McClellan Business Park with known vernal pool crustacean populations as well as potential suitability for giant garter snake. Due to its proximity to Raley Boulevard and Interstate 80, and current land use designation for light industry, the preservation area would otherwise be considered at a modest risk of development loss over the long- term. However, due to its lower topography and position between two creeks, portions would require

either extensive pad construction or additional, upstream flood control measures to avoid flood damage. The acquisition and preservation as provided in the project description allow for future opportunity for habitat enhancement actions as discussed in the Service's December 2003, FWCA report, even though specific enhancements are not proposed as part of the flood control project.

The Service also considered whether the proposed flood control project could have an indirect effect in terms of affecting the rate of development and consequential loss of habitat within the floodplain along portions of historic Magpie Creek that may support giant garter snake or other listed species. In evaluating this influence, we note the floodplain is currently designated FEMA Zone X, a classification which does not require flood insurance for loans, but which may still experience damage during some flood conditions. If the proposed project were not built, earth pads could still be feasibly constructed for individual development actions within the floodplain to reduce flood damage risk to the desired level. Thus, development within the floodplain could occur with or without the project, but at a potentially faster rate (and lower cost) with the project. Loss of habitat due to development near the historic Magpie Creek channel may be limited due to provisions of the *North Sacramento Community Plan Amendment: Magpie Creek Goals and Policies* (approved by City Council July 27, 1993) to establish and enhance a creek right of way, but this policy could be modified over the long-term and would not apply to wetlands outside the right-of-way provision. The largest component of seasonal wetlands is outside the right of way near Sunset Lawn Cemetary, and is currently zoned as agriculture. As reviewed in our May 2003 FWCA report, several recent development actions have already occurred in the floodplain in the absence of the flood control project and, to our knowledge, nearly all have been properly considered and compensated under the Service's Programmatic Consultations. Taken together, the flood zoning, protective local policies, and history of permit actions indicate that the effect of the project in terms of accelerated development is modest if at all, and that any related loss of habitat would likely be detected and compensated under the Corps' 404 permit administration.

We note, however, that this same risk of harm to habitat from development is substantially eliminated from the 76.5 acres of habitat in the preservation area. This preservation area includes a mosaic of two creeks, seasonal and permanent wetland types, and associated upland, and includes numerous vernal pools of which four occurrences of the listed vernal pool fairy shrimp have been documented. It is also adjacent to similar habitat within McClellan Business Park. In the Service's opinion, the preservation element of the proposed project offsets the particular net effect of inducing development growth in the floodplain, and the modest loss of upland near the MCDC. The Service expressly limits this finding to any growth-inducing effect of the flood control project only - not the actual loss of habitat or indirect effect near habitat due to future development action(s). Accordingly, consultation is required for any subsequent action, separate from the proposed project, involving take of a listed species in the historic Magpie Creek floodplain.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed project are not considered in this section because they require separate consultation pursuant to section 7 of the Act, and, therefore, are not considered cumulative to the proposed project.

An undetermined number of future land use conversions and routine agricultural practices that are not subject to Federal authorization or funding may alter the habitat or increase incidental take of giant garter snake, vernal pool fairy shrimp, and vernal pool tadpole shrimp and are, therefore, cumulative to the proposed project.

Cumulative effects that apply to giant garter snake include: (1) unpredictable fluctuations in aquatic habitat due to water management; (2) dredging and clearing vegetation from irrigation canals; (3) discing, mowing, ornamental cultivation, and routine grounds maintenance of upland habitat; (4) increased vehicular traffic on access roads adjacent to aquatic habitat; (5) use of burrow fumigants on levees and other potential upland refugia; (6) contaminated runoff from agriculture and urbanization; (7) predation by feral animals and pets; (8) human intrusion into habitat; (9) diversion of water; and (10) rip-rapping or lining of canals and stream banks.

CONCLUSION

After reviewing the current status of the giant garter snake, the environmental baseline, the effects of the proposed action, and any cumulative effects, it is the Service's biological opinion that the proposed project as described, with the proposed protection measures and habitat preservation/acquisition components, is not likely to jeopardize the continued existence of the giant garter snake. No critical habitat has been designated for this species, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking incidental to and not intended as

part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are nondiscretionary for listed species in this opinion and must be implemented by the Corps so they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Federal agency (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

AMOUNT OR EXTENT OF INCIDENTAL TAKE

The Service anticipates incidental take of the snake will be difficult to detect or quantify for the following reasons: snakes are cryptically colored, secretive, and known to be sensitive to human activities. Snakes may avoid detection by retreating to burrows, soil crevices, vegetation, and other cover. Individual snakes are difficult to detect unless they are observed, undisturbed at a distance. Most close-range observations represent chance encounters that are difficult to predict. It is not possible to make an accurate estimate of the number of snakes that would be harassed, harmed, or killed during construction activities, including in staging areas, canal banks, soil burrow areas and roads carrying vehicular traffic to borrow areas. In instances where take is difficult to detect, the Service may estimate take in the form of numbers of a species per acre of habitat affected as a result of the action. The Service expects that all snakes in the 6.1 acres of upland habitat on the proposed project site may be harassed, harmed, or killed by loss and disturbance of habitat as a result of the proposed project. The proposed project may result in the death of one snake.

The Service authorizes the following forms of incidental take:

1. The number of giant garter snakes found in 4.7 acres of upland habitat will be disturbed, harassed, harmed, or killed by project activities resulting from temporary impacts due to use of heavy equipment and earthmoving activity near aquatic habitat. No more than one snake will be killed.

2. 1.4 acres of giant garter snake habitat would be permanently lost due to construction of new maintenance road on upland near aquatic habitat.

Upon implementation of the following reasonable and prudent measures, incidental take associated with the proposed project on the snake, in the form of harm, harassment, or death from habitat loss or direct mortality will become exempt from the prohibitions described under section 9 of the Endangered Species Act for direct and indirect effects.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service has determined that the anticipated take is not likely to jeopardize the giant garter snake or destroy or adversely modify its critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of giant garter snakes.

1. The potential effects of the proposed project on the giant garter snake shall be minimized.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. The terms and conditions are non-discretionary.

The following terms and conditions implement the reasonable and prudent measure:

1. Best Management Practices (BMPs) shall be implemented to prevent sediment from entering areas containing giant garter snake habitat including, but not limited to, silt fencing, temporary berms, no cleaning equipment in or near snake habitat, installation of vegetative strips, and temporary sediment disposal.

2. Project-related vehicles shall observe a 20-mph speed limit within construction areas, except on County rods, and State and Federal highways; this is particularly important during periods when the giant garter snake may be sunning or moving on roadways.

3. To eliminate attraction of predators of the snake, all food-related trash items such as wrappers, cans, bottles, and food scraps must be disposed of in closed containers and removed at least every other day from the entire project site.

4. Plastic monofilament netting (erosion control matting) or similar material shall not be used at the project because giant garter snakes may become entangled and trapped in it. Acceptable substitutes include conconut coir matting or takified hydroseeding.

5. After completion of construction activities, any temporary fill and construction debris shall be removed and the 4.7 acres of disturbed areas shall be restored to pre-project conditions. Project proponents will monitor the project site for one year following completion of construction and restoration of habitat. Monitoring

reports documenting the restoration effort shall be submitted to the Service upon completion of the restoration activity, and after one year. The monitoring reports shall include photo-documention when restoration was completed, what materials were used, specified plantings, and justification of any substitution to the Service-recommended guidelines (refer to Appendix A, Snake Programmatic Consultation, Mitigation Criteria for Restoration and/or Replacement of Giant Garter Snake Habitat, attached).

6. The Corps shall ensure compliance with the Reporting Requirements below.

REPORTING REQUIREMENTS

The Service-approved biologist shall notify the Service immediately if giant garter snakes are found on site, and will submit a report including date(s), location(s), habitat description, and any corrective measures taken to protect the snake(s) found. The Service-approved biologist shall submit locality information to the California Department of Fish & Game (CDFG), using completed California Native Species Field Survey Forms or their equivalent, no more than 90 calendar days after completing the last field visit of the project site. Each form shall have an accompanying scale map of the site such as a photocopy of a portion of the appropriate 7.5 minute U.S. Geological Survey map and shall provide at least the following information: township, range, and quarter section; name of the 7.5' or 15' quadrangle; dates (day, month, year) of field work; number of individuals and life stage (where appropriate) encountered; and a description of the habitat by community-vegetation type.

A post-construction compliance report prepared by the Service-approved monitoring biologist shall be forwarded to the Chief, Endangered Species Division, at the Sacramento Fish and Wildlife Office within 60 calendar days of the completion of the project. This report shall detail: (i) dates that construction occurred; (ii) pertinent information concerning the applicant's success in meeting project mitigation measures; (iii) an explanation of failure to meet such measures, if any; (iv) known project effects on federally listed species, if any; (v) occurrences of incidental take of federally listed species, if any; and (vi) other pertinent information.

The Corps shall also monitor specific execution of the proposed measures for protection in perpetuity of the preservation area provided in the project description, and obtain and submit documentation of property purchase, placement of flood easement, request of zoning change, and the decision pertaining to that request, to the Chief, Endangered Species Division, at the Sacramento Fish and Wildlife Office within 60 calendar days of the completion of the project.

The Sacramento Fish and Wildlife Office is to be notified within three working days of the finding of any dead listed species or any unanticipated harm to the species addressed in this biological opinion. The Service contact person for this is the Chief, Endangered Species Division at (916) 414-6600.

CONSERVATION RECOMMENDATIONS

Section 7 (a) (1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's 7(a)(1) responsibilities for these species.

1. As a Recovery Plan for the giant garter snake is developed, the Corps should assist the Service in its implementation.

2. The Corps should incorporate into bidding documents the "Standard Avoidance and Minimization Measures for Construction Activities in Giant Garter Snake Habitat" provided in the Snake Programmatic Opinion, Appendix C, when appropriate.

3. The Corps, in partnership with the Service, should develop maintenance guidelines for the project that will reduce adverse effects of routine maintenance on giant garter snakes and their habitat. Such actions may contribute to the delisting and recovery of the giant garter snake by preventing degradation of existing habitat and increasing the amount and stability of suitable habitat.

4. The Corps should support and assist SAFCA with development of a habitat management plan for the preservation area element of this project with the goal of maximally protecting and enhancing habitat values for listed species, and overall habitat value of the two creeks, associated riparian, seasonal wetland, and upland habitats. Example actions of this type outlined in our May 2003 FWCA report include: a) modest replanting of native trees and shrubs at the top of creek banks, such as oak and elderberry, willow, cottonwood, or box elder; b) management of star thistle in conjunction with reseeding with native grasses and forbs; c) monitoring and management of beaver activity and damage to riparian trees; and d) potential realignment of Don Julio Creek west of Raley Boulevard to a more westerly alignment away from Raley (and with a reconstructed confluence with the MCDC), and revegetation of this reconstructed creek segment. Density and distribution of tree plantings should be such that they would establish with minimal or no irrigation, require no long term irrigation, and would not adversely affect listed vernal pool crustacean habitat.

5. The Corps should support and assist SAFCA with restoration of the historic section of Magpie Creek west of Raley Boulevard including: a) re-establishing flows through the reconstructed low-flow outlet from the MCDC to the historic creek (an element proposed as part of the flood control project action); and b) reconstructing the channel for sections that are now leveled or filled. These actions should be consistent with the North

Sacramento Community Plan Amendment: Magpie Creek Goals and Policies, reference number M92-071, but are recommended to be implemented in advance of that which would be required by the amendment. We especially encourage re-establishing oaks and elderberry, which are largely absent from this drainage, together with more common natives like cottonwood, willow or box elder, and reseeding with native grasses and forbs.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

This concludes formal consultation on the proposed Magpie Creek Flood Control Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. If you have any questions regarding this biological opinion for the Magpie Creek Flood Control Project, please contact Steven Schoenberg of my staff, at (916) 414-6564.

Sincerely,

for Kenneth D. Sanchez
Acting Field Supervisor

cc:
AES, Portland, OR
American River Flood Control District, Sacramento, CA (Attn: Paul Devereux)
CDFG, Rancho Cordova, CA
COE, Sacramento, CA (Attn: Ed Stewart)
EDAW, Sacramento, CA (Attn: Debra Bishop)
SAFCA, Sacramento, CA (Attn: Grant Kreinberg)

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APPENDIX A

Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat

Replacement and Restoration Guidelines are provided together, as the two conservation measures may not be mutually exclusive. Replacement of habitat may also require restoration of some areas. Preserved habitat may additionally be improved for giant garter snake by using some of the restoration guidelines.

Reference sites

A nearby reference site should be chosen both for restoration of giant garter snake habitat and for creation of replacement habitat. The reference site will be used to determine the success of conservation efforts. For restoration of habitat, the pre-project condition may be used as a reference site if adequate documentation exists. For creation of replacement habitat or for restoration where pre-project conditions are not documented, the reference site should be nearby or adjacent and should represent high quality giant garter snake habitat.

Restoration of giant garter snake habitat

Restoration may include incorporating some of the Replacement guidelines to enhance habitat value for giant garter snake. Restoration should follow the guidelines outlined below:

1. Restoring giant garter snake habitat includes minimizing impacts of project activities to the existing habitat, including using silt fencing, designating environmentally sensitive areas, using protective mats, preventing runoff, and providing worker awareness training. Measures to minimize impacts include:

    a. Avoid construction activities within 200 feet from the banks of giant garter snake aquatic habitat. Confine movement of heavy equipment to existing roadways to minimize habitat disturbance.

    b. Construction activity within habitat should be conducted between May 1 and October 1. This is the active period for giant garter snakes and direct mortality is lessened, because snakes are expected to actively move and avoid danger. Between October 2 and April 30 contact the Service's Sacramento Fish and Wildlife Office to determine if additional measures are necessary to minimize and avoid take.

    c. Confine clearing to the minimal area necessary to facilitate construction activities. Flag and designate avoided giant garter snake habitat within or adjacent to the project area as Environmentally Sensitive Areas. This area should be avoided by all construction personnel.

d. Construction personnel should receive Service-approved worker environmental awareness training. This training instructs workers to recognize giant garter snakes and its habitat(s).

e. 24-hours prior to construction activities, the project area should be surveyed for giant garter snakes. Survey of the project area should be repeated if a lapse in construction activity of two weeks or greater has occurred. If a snake is encountered during construction, activities shall cease until appropriate corrective measures have been completed or it has been determined that the snake will not be harmed. Report any sightings and any incidental take to the Service immediately by telephone at (916) 414-6600.

f. Any dewatered habitat should remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat.

2. Remove all construction debris and stockpiled materials.

3. Regrade area to preexisting contour, or a contour that would improve restoration potential of the site.

4. Replant and hydroseed the restoration area. Recommended plantings consist of a) wetland emergents, b) low-growing cover on or adjacent to banks, and c) upland plantings/hydroseeding mix to encourage use by other wildlife. Riparian plantings are not appropriate because shading may result in lack of basking sites. Native plantings are encouraged except where non-natives will provide additional values to wildlife habitat and will not become invasive in native communities. The applicant should obtain cuttings, plantings, plugs, or seeds, from local sources wherever possible. The applicant should attempt to restore conditions similar to that of adjacent or nearby habitats.

a. Emergent wetland plants recommended for giant garter snake habitat are California bulrush (*Scirpus californicus*), cattail (*Typha* spp.), and water primrose (*Ludwigia peploides*). Additional wetland plantings may include common tule (*Scirpus acutus*), Baltic rush (*Juncus balticus*), or duckweed (*Lemna* spp.).

b. Cover species on or adjacent to the bank may include California blackberry (*Rubus vitifolius*) or wild grape (*Vitis californica*), along with the hydroseeding mix recommended below.

c. Upland plantings/hydroseeding mix: Disturbed soil surfaces such as levee slopes should be hydroseeded to prevent erosion. The Service recommends a mix of at least 20-40 percent native grass seeds [such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.)], 2-10 percent native forb seeds, five percent rose clover (*Trifolium hirtum*), and five

percent alfalfa (*Medicago sativa*). Approximately 40-68 percent of the mixture may be non-aggressive European annual grasses [such as wild oats (*Avena sativa*), wheat (*Triticum* ssp.), and barley (*Hordeum vulgare*)]. The Corps will not include aggressive non-native grasses, such as perennial ryegrass (*Lolium perenne*), cheatgrass (*Bromus tectorum*), fescue (*Festuca* spp.), giant reed (*Arundo donax*), medusa-head (*Taeniatherum caput-medusae*), or Pampas grass (*Cortaderia selloana*) in the hydroseed mix. The Corps will not include endophyte-infected grasses in the mix. Mixes of one-hundred percent native grasses and forbs may also be used, and are encouraged.

Replacement of giant garter snake habitat

Location

Replacement location should be within the same population cluster boundaries (population clusters are defined in 58 **FR** 54053) as the habitat lost. For example: The boundaries of the Sacramento Basin population cluster are approximately, Highway 16 to the north, Sacramento River to the west, Twin Cities Road to the south, and the Folsom Aqueduct to the east. Habitat lost within this area must also be replaced within this area.

Habitat components

Giant Garter Snake Habitat. The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of (1) adequate water during the snake's active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat; (3) upland habitat for basking, cover, and retreat sites; and (4) higher elevation uplands for cover and refuge from flood waters. For the purposes of this programmatic opinion, a basic giant garter snake habitat unit will incorporate 2.00 acres (0.81 hectares) of surrounding upland for every 1.00 acre (0.40 hectare) of aquatic habitat. The 2.00 acres (0.81 hectares) of upland also may be defined as 218 linear feet (66 meters) of bankside habitat which incorporates adjacent uplands to a width of 200 feet (61 meters) from the edge of the bank.

Replacement habitat must provide the above mentioned essential habitat components and include the following:

1. All replacement habitat must include both upland and aquatic habitat components. Upland and aquatic habitat components must be included in the replacement habitat at a ratio of 2:1 upland acres to aquatic acres

2. A semi-permanent or permanent aquatic habitat which provides water during the active period for giant garter snakes (April through October) with suitable vegetative cover present. Linear or meandering channels with slow flowing water over mud or silt substrate are preferred.

3. Upland basking and retreat sites with low growing vegetation cover adjacent to aquatic habitat, and upland retreats and flood refugia with partially buried broken concrete or animal burrows.

4. Small fish and amphibian larvae for foraging, but predatory "gamefish" (bass, *Micropterus* spp.; sunfish, *Lepomis* spp.; catfish, *Ictalurus* spp. and *Ameiurus* spp.) absent or controlled.

5. An adequate buffer (at least 200 feet) from roadways to reduce vehicular mortality.

6. Follow planting recommendation provided above under restoration guidelines.

Monitoring

Habitat restoration

Restoration of habitat should be monitored for one year following implementation. Monitoring reports documenting the restoration effort should be submitted to the Service: (1) upon completion of the restoration implementation; and (2) one year from restoration implementation. Monitoring reports should include photo documentation, when restoration was completed, what materials were used, plantings (if specified) and justification of any substitutions to the Service recommended guidelines. Monitoring reports should also include recommendations for remedial actions and approval from the Service, if necessary, and justification from release of any further monitoring, if requested.

Creation of replacement habitat

Replacement habitat should be monitored for 5 years following implementation. Hydrology should be monitored for the first two years after creation of wetlands. The monitoring effort should continue for three additional years to ensure success criteria are met. Monitoring reports documenting implementation of conservation measures should be submitted to the Service: (1) upon completion of wetland creation; (2) yearly for the first two years of monitoring; and (3) 5 years from implementation. Monitoring reports should include photo documentation, when restoration was completed, what materials were used, plantings (if specified) and justification of any substitutions to the Service recommended guidelines. Monitoring reports should also include recommendations for remedial actions and approval from the Service, if necessary, and justification from release of any further monitoring, if requested.

APPENDIX A

Success criteria for replacement habitat:

1. At completion of monitoring, the cover measured on the habitat area should be 90 percent of cover measured on the reference site.

2. At completion of monitoring, the species composition measured on the habitat area should be 90 percent of that measured on the reference site.

3. At completion of monitoring, wetlands created on the site should meet Corps jurisdictional criteria.

Maintenance and management of replacement giant garter snake habitat

1. A final management plan of replacement habitat must be approved by the Service.

2. All maintenance activities should follow Standard Avoidance and Minimization Measures During Construction Activities in Giant Garter Snake Habitat.

3. Additional guidance includes:

a. Canal Maintenance - Hand clearing of canals is preferred for removal of excessive vegetation or debris. Any equipment should be operated from the bank top. Excavate from only one side of the canal during a given year. Avoid excavating the banks above the high water level. Preferably, one side of the canal should be left undisturbed indefinitely (the preferred side would be the west or north side) so that emergent vegetation and bank side cover is left in place.

b. Place the spoils from canal clearing in a designated location, rather than along bank tops. This will prevent burying or crushing snakes basking on the banks, or trapping snakes taking cover in burrows or bank-top soil crevices.

c. Vegetation control - Uplands should not be disced. Leave vegetation on levees and canal sides wherever possible. Mowing to control vegetation should take place July through September and mower blades should be raised at least six inches to avoid injuring snakes and to leave some grassy cover.

d. Traffic - Control vehicle access to avoid vehicular mortality of giant garter snakes.

4. Use a water maintenance regime that will maintain some open water to provide vegetated edge for giant garter snake to forage along.

5. Eradicate/control non-natives and invasive exotics.

APPENDIX A

Compatible uses of giant garter snake replacement habitat:

Rice farming is a compatible land use for adjacent properties.

Uses of giant garter snake replacement habitat that are incompatible with the habitat of giant garter snake, or represent threats to giant garter snakes include row cropping on uplands, orchards on uplands, OHV (off-highway vehicle) use, and combining with riparian habitat creation which requires dense cover or SRA (shaded riverine aquatic) habitat.

APPENDIX C

Standard Avoidance and Minimization Measures
During Construction Activities in Giant Garter Snake (*Thamnophis gigas*) Habitat

HABITAT TYPE:

Marshes, sloughs, ponds, small lakes, low gradient streams, irrigation and drainage canals, and rice fields. Permanent aquatic habitat, or seasonally flooded during the snake's active season (early-spring through mid-fall), with herbaceous wetland vegetation, such as cattails and bulrushes, grassy banks (often salt grass), and uplands for cover and retreat sites during the snake's active season and for refuge from flood waters during the dormant season (winter). Giant garter snakes are typically absent from larger rivers because of lack of suitable habitat, and from wetlands with sand, gravel, or rock substrates. Some riparian woodlands may not provide suitable habitat because of excessive shade, lack of basking sites, and absence of giant garter snake prey.

AVOIDANCE AND MINIMIZATION MEASURES:

1. Avoid construction activities within 200 feet from the banks of giant garter snake aquatic habitat. Confine movement of heavy equipment to existing roadways to minimize habitat disturbance.

2. Construction activity within habitat should be conducted between May 1 and October 1. This is the active period for giant garter snakes and direct mortality is lessened, because snakes are expected to actively move and avoid danger. Between October 2 and April 30 contact the Service's Sacramento Fish and Wildlife Office to determine if additional measures are necessary to minimize and avoid take.

3. Confine clearing to the minimal area necessary to facilitate construction activities. Flag and designate avoided giant garter snake habitat within or adjacent to the project area as Environmentally Sensitive Areas. This area should be avoided by all construction personnel.

4. Construction personnel should receive Service-approved worker environmental awareness training. This training instructs workers to recognize giant garter snakes and their habitat(s).

5. 24-hours prior to construction activities, the project area should be surveyed for giant garter snakes. Survey of the project area should be repeated if a lapse in construction activity of two weeks or greater has occurred. If a snake is encountered during construction, activities shall cease until appropriate corrective measures have been

completed or it has been determined that the snake will not be harmed. Report any sightings and any incidental take to the Service immediately by telephone at (916) 414-6600.

6. Any dewatered habitat should remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat.

7. After completion of construction activities, remove any temporary fill and construction debris and, wherever feasible, restore disturbed areas to pre-project conditions. Restoration work may include such activities as replanting species removed from banks or replanting emergent vegetation in the active channel.

8. Follow the conservation measures in Table 1 to minimize the effects of loss and disturbance of habitat on giant garter snakes. Replacement ratios are based on the acreage and on the duration of disturbance.

TABLE 1 - SUMMARY OF GIANT GARTER SNAKE CONSERVATION MEASURES

	IMPACTS: DURATION	**IMPACTS:** ACRES	**CONSERVATION MEASURE:** COMPENSATION
LEVEL 1	1 season	Less than 20 and temporary	Restoration
LEVEL 2	2 seasons	Less than 20 and temporary	Restoration plus 1:1 replacement
LEVEL 3	More than 2 seasons and temporary Permanent loss	Less than 20 and temporary Less than 3 acres total giant garter snake habitat AND Less than 1 acre aquatic habitat; OR Less than 218 linear feet bank habitat	3:1 Replacement (or restoration plus 2:1 replacement) 3:1 Replacement

Giant garter snake habitat includes 2.0 acres of surrounding upland habitat for every 1.0 acre of aquatic habitat. The 2.0 acres of upland habitat also may be defined as 218 linear feet of bankside habitat which incorporates adjacent uplands to a width of 200 feet from the edge of

each bank. Each acre of created aquatic habitat should be supported by two acres of surrounding upland habitat. Compensation may include creating upland refuges and hibernacula for the giant garter snake that are above the 100-year flood plain.

A season is defined as the calendar year period between May 1 and October 1, the active period for giant garter snake when mortality is less likely to occur.

Appendix F

American River Parkway Habitat Maps

Steelhead Creek

American River

Sacramento River

0.00

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2

3

4

5

Page 1 of 5

0 1,000 2,000 Feet

1 inch = 2,000 feet

N

RiverMile

CA Levee Database Levee Centerline

Wetlands

Valley Elderberry Shrub Locations

Valley Elderberry Shrub Clumps

Lower American River Study Area

Blue oak Woodland

Cottonwood Woodland

Interior Live Oak Woodland

Mixed Riparian Woodland

Mixed riparian woodland

Oak Woodland

Scrub and Gravel

Riparian Forest

Prairie

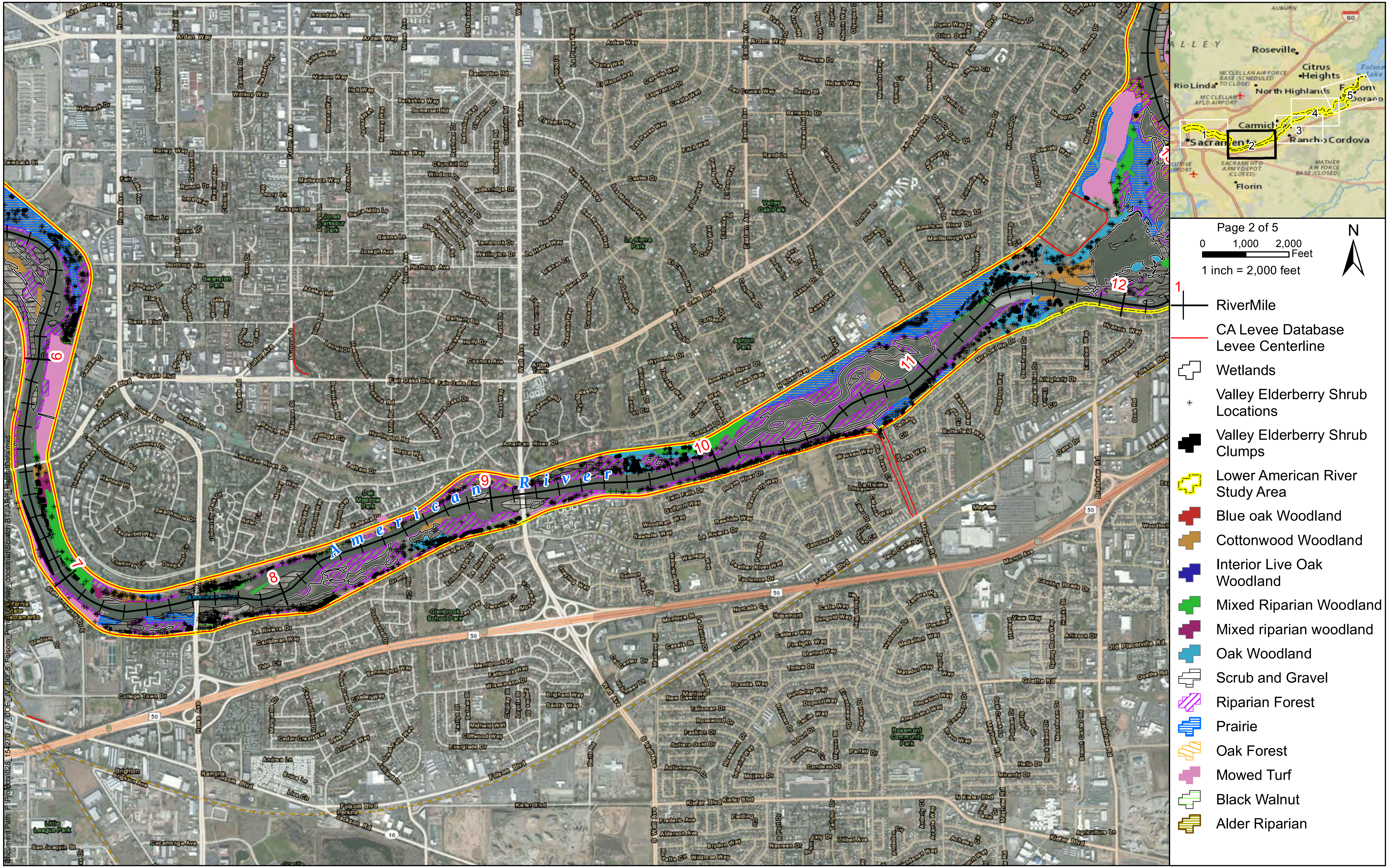
Oak Forest

Mowed Turf

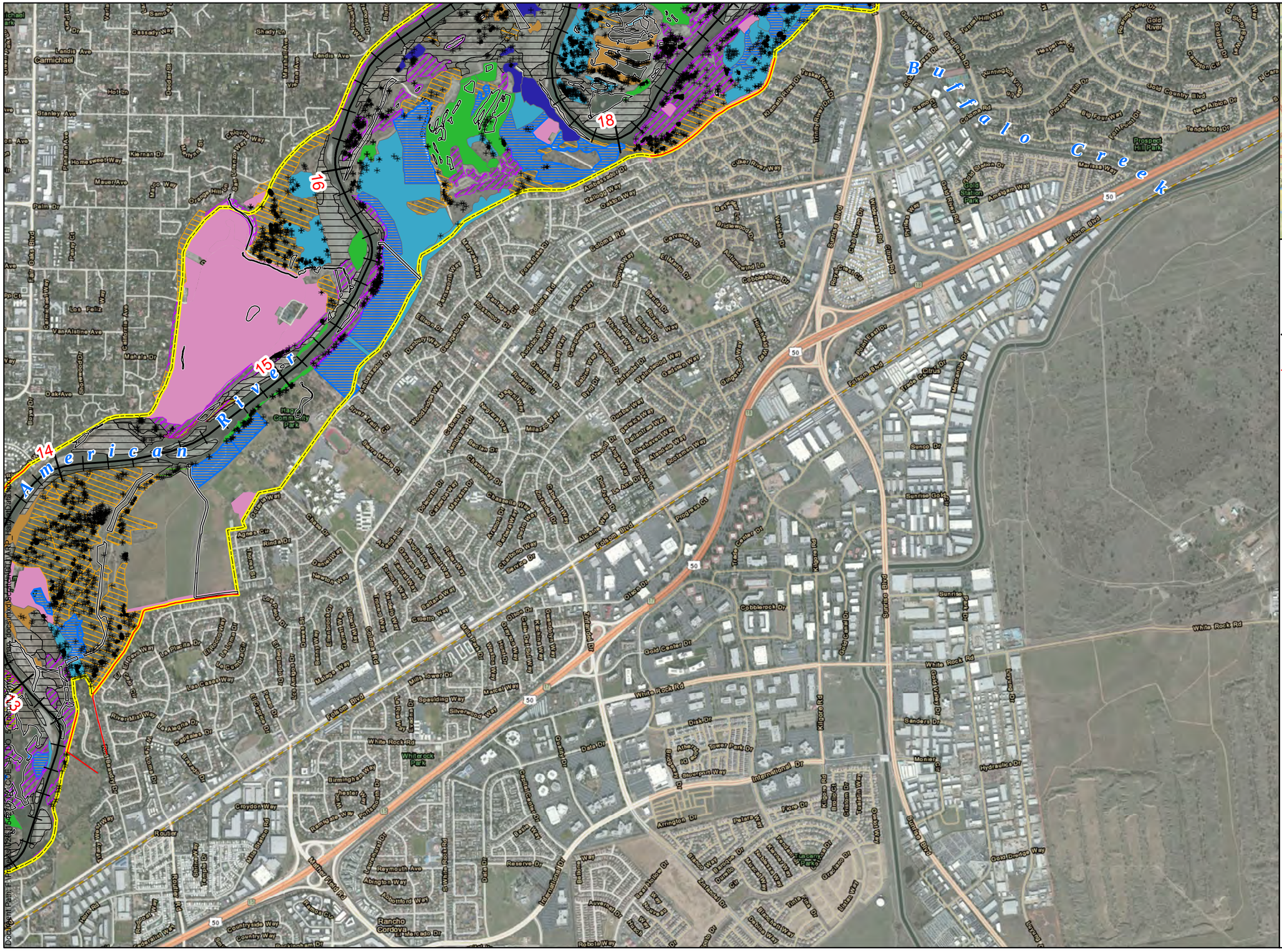
Black Walnut

Alder Riparian

Document Path: F:\Projects\026_154270_01_COE_JV_DO_5_Folsom_Prmnt_Op\map_docs\mxd\ArcMap\Habitat\Habitat.mxd



American River
Page 2 of 5
0 1,000 2,000 Feet
1 inch = 2,000 feet
N
RiverMile
CA Levee Database Levee Centerline
Wetlands
Valley Elderberry Shrub Locations
Valley Elderberry Shrub Clumps
Lower American River Study Area
Blue oak Woodland
Cottonwood Woodland
Interior Live Oak Woodland
Mixed Riparian Woodland
Mixed riparian woodland
Oak Woodland
Scrub and Gravel
Riparian Forest
Prairie
Oak Forest
Mowed Turf
Black Walnut
Alder Riparian
Roseville
Citrus Heights
Rio Linda
North Highlands
Carmichael
Sacramento
Rancho Cordova
Florin
Auburn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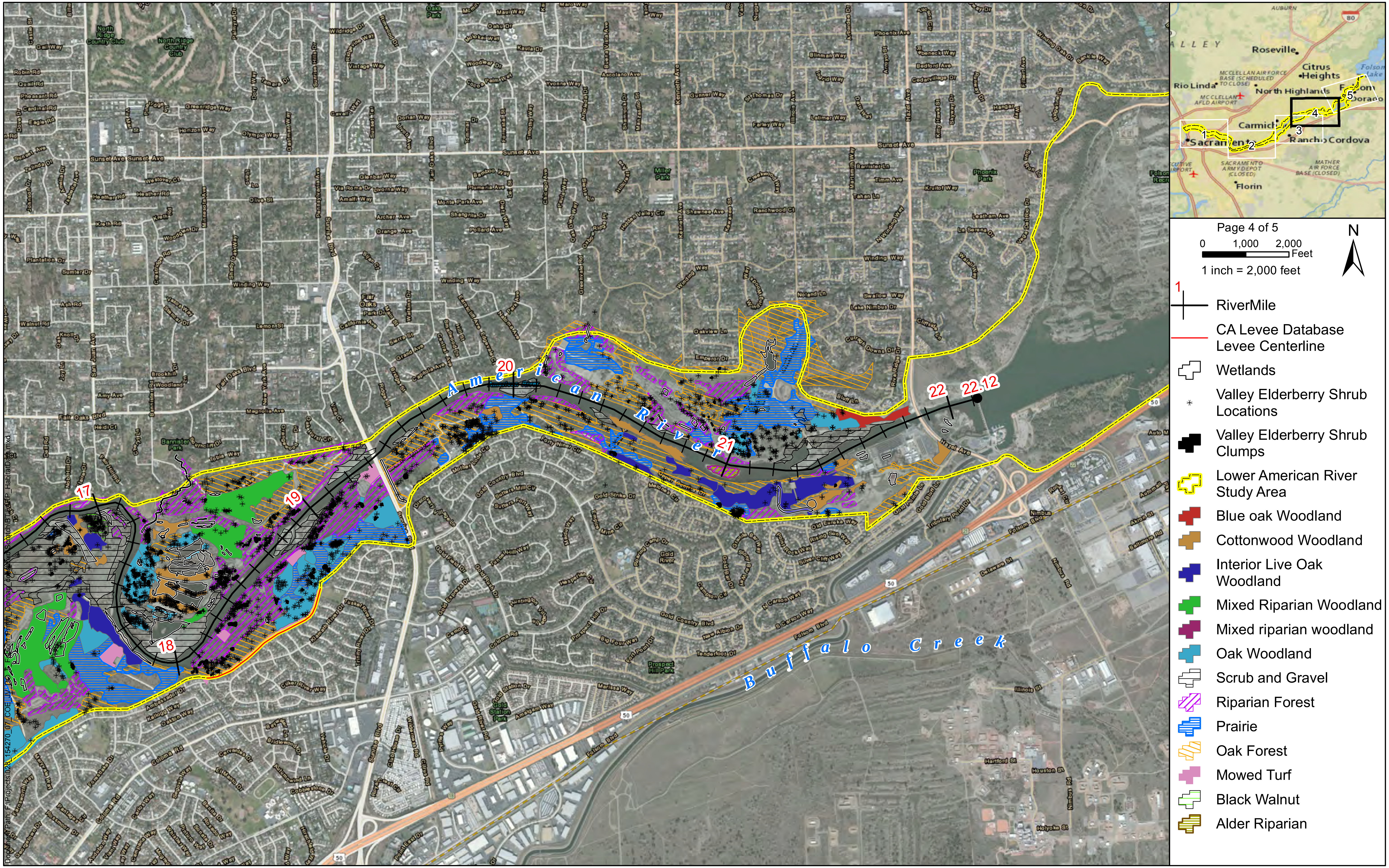
Alder Riparian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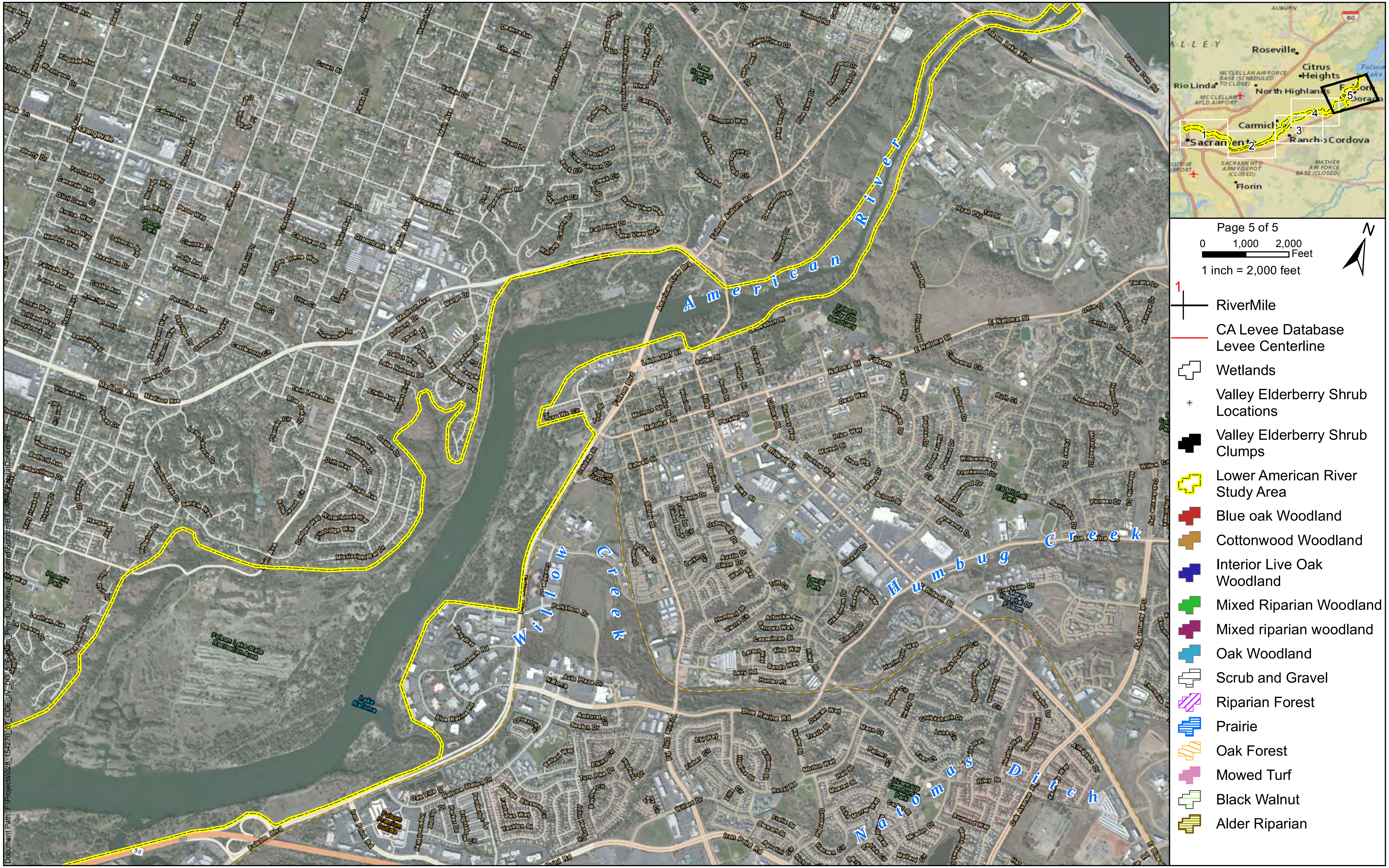
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Oak Forest
Mowed Turf
Black Walnut
Alder Riparian
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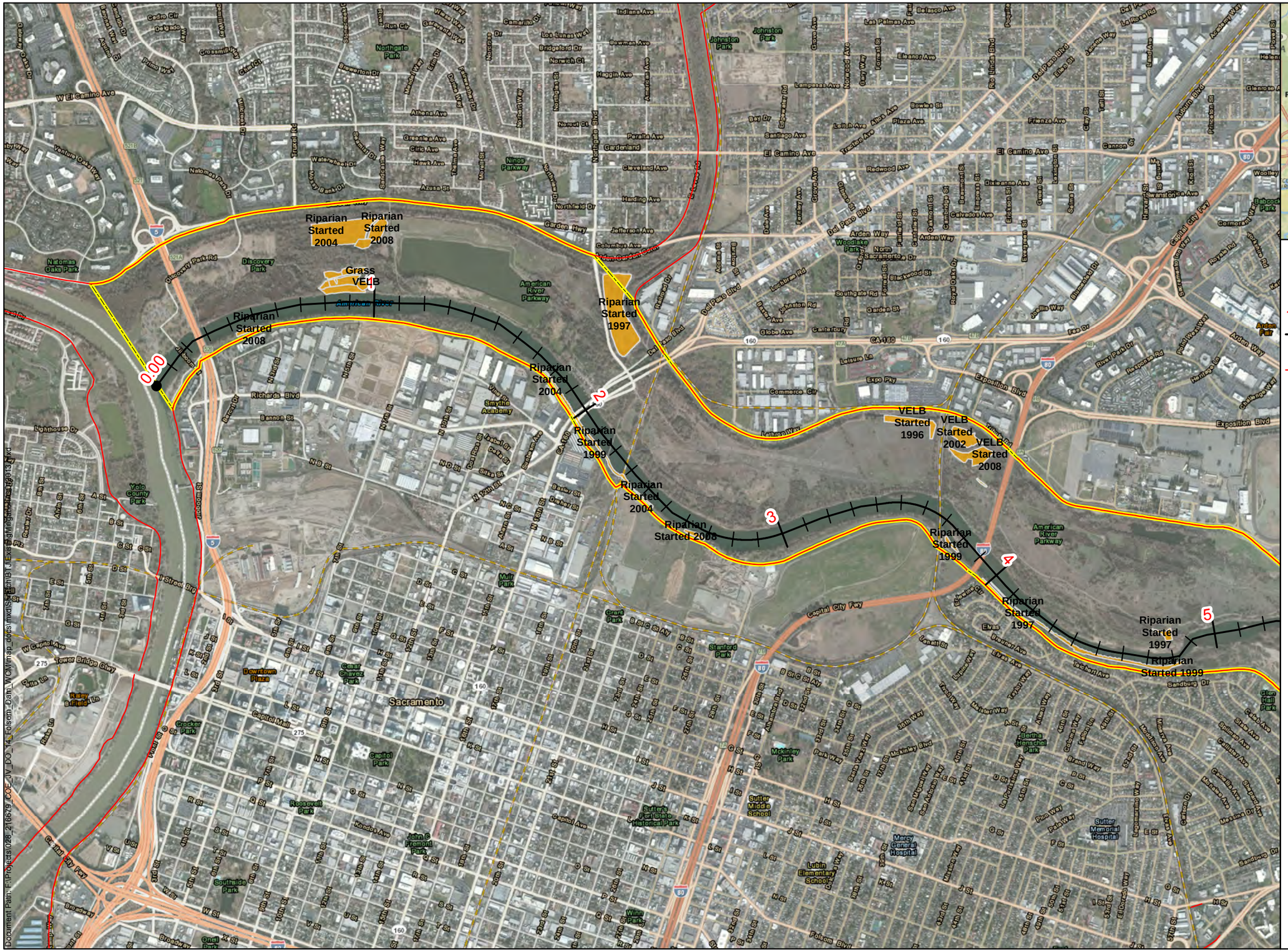
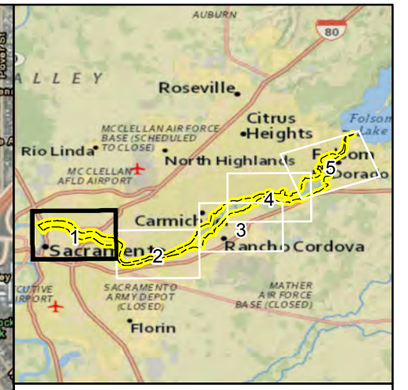
Sacramento
Rancho Cordova
Florin

Appendix G

Existing VELB Mitigation Sites in the American River Parkway





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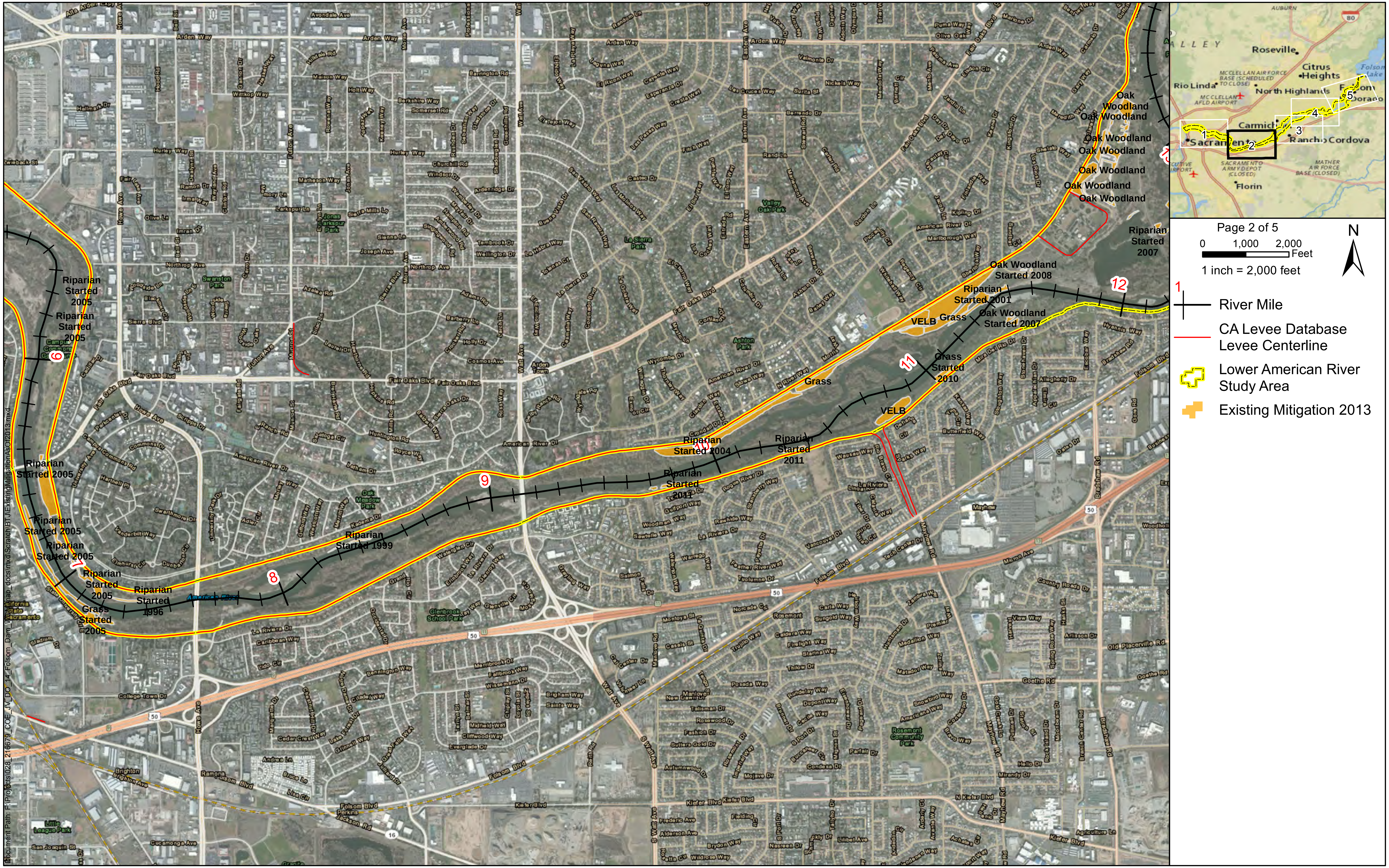
CA Levee Database Levee Centerline

Lower American River Study Area

Existing Mitigation 2013



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1 River Mile

CA Levee Database
Levee Centerline

Lower American River
Study Area

Existing Mitigation 2013

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Folsom Lake Xing
Folsom Dam Rd
Ryan Ply
Tot St
Prison Rd
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Woodmere Rd
Aura Plaza Dr
Natoma Station Dr
Iron Point Rd
Russell Rd
Willard Dr
Folsom Prison Outlets
Folsom Junction
Sutter St
Scott St
Riley St
Glenn Dr
Austin Dr
Orchard Dr
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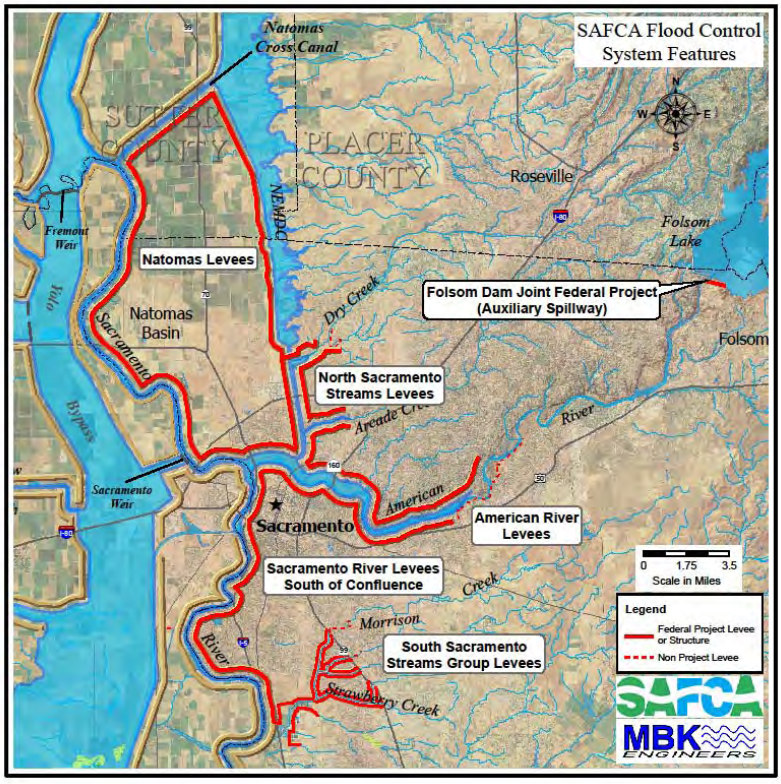
MCCLELLAN AFLD AIRPORT
SACRAMENTO ARMY DEPOT (CLOSED)
MATHER AIR FORCE BASE (CLOSED)

PHASE I ENVIRONMENTAL SITE ASSESSMENT

AMERICAN RIVER COMMON FEATURES GENERAL REEVALUATION REPORT (GRR)

Sacramento, CA



Prepared by:
Environmental Engineering Branch
Sacramento District

US Army Corps of Engineers®

August 2012

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Appendix B Site Classification Report
Appendix C Interviews
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Appendix E EDR Aerial Photo Decade Package, Natomas Basin Aerials for 2095499, Inquiry No. 2215805.1
Appendix F Topographic Maps

ACRONYMS

ARFCD	American River Flood Control District
AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
BTEX	Benzene, Toluene, Ethylbenzene, and total Xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CESPK	US Army Corps of Engineers, Sacramento District
COCs	Contaminates of Concern
DCA	Di-chloro Ethane
DCE	Di-chloro Ethylene
DoD	Department of Defense
DTSC	Department of Toxic Substance Control
DWR	California Department of Water Resources
DWSC	Deep Water Ship Channel
EDR	Environmental Data Resources Inc.
ER	Engineering Regulation (US Army Corps of Engineers)
ESA	Environmental Site Assessment
FUDS	Formerly Used Defense Sites
GRR	General Reevaluation Report
HTRW	Hazardous, Toxic or Radioactive Waste
IAW	In accordance with
KMEP	Kinder Morgan Energy Partners
LUFT	Leaking Underground Fuel Tank
LUST	Leaking Underground Storage Tank
MTBE	Methyl tert-butyl ether
NEPA	National Environmental Policy Act
NFA	No further Action
NGVD29	National Geodetic Vertical Datum of 1929
NPL	National Priority List (Superfund Site)
PCB	Polychlorinated Biphenyl
PCE	Tetra-chloro ethylene
RCRA	Resource Conservation and Recovery Act
RD900	State of California Reclamation District 900 (West Sacramento)
RD1000	State of California Reclamation District 1000 (Natomas)
SAFCA	Sacramento Area Flood Control Agency
SLIC	Spills, Leaks, Investigations and Cleanups
SVE/AS	Soil Vapor Extraction/Air Sparging
SWRCB	State Water Resources Control Board
TARP	Tesoro ARCO Remediation Project
TBA	Tert-butyl Alcohol
TCA	Tri-chloroethane
TCE	Tri-chloroethylene
TPH-d	Total Petroleum Hydrocarbons as Diesel
TPH-g	Total Petroleum Hydrocarbons as Gasoline
TSCA	Toxic Substance Control Act
USACE	United States Army Corps of Engineers

USEPA	US Environmental Protection Agency
USGS	US Geological Survey
WSAFCA	West Sacramento Area Flood Control Agency

EXECUTIVE SUMMARY

The American River Common Features General Reevaluation Report (GRR) project is currently performing a study along approximately 40 miles of the levee system that surround the American River, Natomas Basin and the Sacramento Bypass.

The GRR is in the Feasibility Study phase of the Civil Works process, which requires a Phase 1 Environmental Site Assessment (ESA) to be performed to identify environmental contamination at or near the project construction site. Contaminated sites have the potential to significantly impact future construction activities and need to be identified as early as possible.

Records review identified 491 environmental sites including 7 sites that have the Hazardous, Toxic, Radiologic Waster (HTRW) concerns with the potential to affect future construction activities and 45 sites with HTRW concerns that should not affect future construction activities. Regional contaminants from historic agriculture and mining sources are likely present and should be considered on a site-specific basis if future construction activity generates soil for reuse or disposal.

This Phase 1 ESA identifies and generally describes locations where environmental conditions exist in proximity to the project levee. The purpose of the GRR is to identify deficiencies in the levee system and perform feasibility analysis on potential remedies for these deficiencies. Separate reports and construction plans will be developed for the chosen remedial alternatives. As the American River Common Features GRR project schedule approaches actual construction, an additional Phase 1 ESA may be necessary to provide up-to-date information necessary to comply with the USACE Civil Works process.

The presence of the Old Bryte Landfill adjacent to the Sacramento Bypass may influence alternative selection, as may the presence of the old Southern Pacific rail yard in downtown Sacramento. The bulk fuel facility at Broadway and Front Street near downtown Sacramento is a petroleum release site on both sides of the levee with fuel pipelines going through the levee and may be unavoidable; but non-hazardous waste under CERCLA.

Further investigation of these sites as they may affect the cost of levee relocation or rehabilitation for seepage, stability and erosion is recommended.

1.0 Introduction

1.1 Purpose

The purpose of this Phase 1 ESA is to identify recognized HTRW environmental conditions, including the presence or likely presence of any hazardous substances or petroleum products under conditions that indicate an existing release, a past release, or the material threat of a release into structures, the ground, and groundwater or surface waters of the project site.
A Phase 1 ESA is required by the United States Army Corps of Engineers (USACE) *Engineering Regulation (ER) 1165-2-132; HAZARDOUS, TOXIC AND RADIOACTIVE (HTRW) GUIDANCE FOR CIVIL WORKS PROJECTS. , Policy Guidance Letter 34 Non-CERCLA Regulated Contaminated Materials at Civil Works Projects* and *ASTM 1527-05 – Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* is widely used in the environmental industry and will be followed as applicable in this report.

The American River Common Features GRR will analyze the levee system surrounding the American River, Sacramento Bypass, and east bank of the Sacramento River downstream of the American River. These areas will be addressed in the future by using three alternatives developed from past levee construction and repair. The range of possible future construction activities may use techniques and methods that require soil and/or groundwater disturbance, thereby creating possible contaminant exposure concerns.

1.2 Detailed Scope of Services

The scope of this ESA is limited to assessing the environmental condition of the property associated with the levees under study in the American River Common Features General Reevaluation. It also is concerned with identifying HTRW sites within the project boundaries and the surrounding area using commonly known and reasonably ascertainable information.

1.3 Limitations and Exceptions

The Phase I ESA does not include any sampling or testing of soil, air, water or building materials.

1.4 Special Terms and Conditions

The current American River Common Features GRR project does not involve purchase of property for commercial purposes, and as such, the conditions for the ASTM specifications are not completely applicable. The ASTM standard is used as a guide and sections that are not applicable are deleted or modified to meet the requirements of the project. Where applicable, the format and guidance recommended by ASTM is followed as stated in standard E 1527-05. The ASTM post-dates the Regulation, and there is no requirement to follow it, but the ASTM is the industry standard and a convenient guide to follow in performing the environmental site assessment.

1.5 Site Definition

The approach of this report is to search environmental databases and produce a list of sites that have recognized environmental concerns in proximity to the project levee. Sites identified from the environmental database search are classified using the following criteria. The criteria are based on site characteristics that affect the potential of the site to impact future levee construction and repair activities.

Table 1 - Site Characterization Definitions

Type	Definition
1	Site with significant HTRW concerns that may impact future construction activities
2	Site with HTRW concerns that are not likely to have an impact on future construction activities, but warrant mention due to close proximity
3	Site with no apparent HTRW concerns or concerns that have been remediated and closed in the past, or sufficiently removed from the levees so as to have no possible impact.

Type 1 sites have current, significant HTRW concerns that may impact future construction activities. A significant HTRW concern for the American River GRR study and future levee construction projects include soil contamination within the footprint of levee construction activities, or groundwater contamination present on the site that extends to areas of levee construction. Sites with currently undefined or ill-defined contaminant plumes that have the possibility to affect future activities are also included in this category. Most of these sites are currently undergoing assessment, active remediation, or monitoring activities that are under the regulation of the California State Water Resources Control Board (SWCRB), or the California Department of Toxic Substances Control (DTSC).

Type 2 sites have identified HTRW concerns that present a low potential to impact future construction activities. These sites are removed from the levee centerline and will not be included in future areas of construction activity. Current remediation measures on these sites have stabilized a groundwater contaminant plume, remediated or removed a significant amount of the soil contamination present on the site. The combination of remediation measures and distance from the project centerline lead to the lower risk categorization of the site. Also included are contaminated properties that warrant mention simply due to close proximity (generally immediately adjacent to the levee) but pose no apparent problem for work on the levee unless the property must be used, such as a levee setback or staging area.

Type 3 sites have either been closed by a regulatory agency or have no historical evidence of potential HTRW problems. Sites located outside of the “Approximate Minimum Search Distance” defined in ASTM section 8.2.1 but included in the EDR records report are included in this site category as well. Sites with HTRW problems that are sufficiently removed from the levees, such as a site with a 300 foot petroleum groundwater plume located a half mile away, are included.

The best reasonably ascertainable data available to evaluate potential impacts of surface water on the project sites or other regional contaminant considerations comes from California Regional Water Quality Control Boards. Review of the most recent water quality information showed that COCs in the American River / Sacramento River included PCBs, mercury, and other agricultural related chemicals. Environmental impacts from PCBs was observed in fish tissue and seems to be a river wide problem that is regional (agriculture and mining) and best represented as area sources. Mercury contamination originates from the historic uses of the river basin for mining purposes. The levees themselves may be a source of these contaminants as historical records indicate that they were dredged from the riverbed and constructed after hydraulic mining was banned in the Sierra foothills and long after commencement of agricultural use.

1.6 Guidance

This report was prepared in accordance with ASTM E 1527-05, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process; ER 1165-2-132, HTRW Guidance for Civil Works Projects and Policy Guidance Letter 34: Non-CERCLA Regulated Contaminated Materials at Civil Works Projects. Deviations from the approved guidance procedures are noted where appropriate in the report. Reasons for the deviations generally include the unavailability of required information and feasibility concerns associated with the study. All reasonably ascertainable information has been reviewed in the preparation of this report.

An electronic database search and field observations were conducted in order to compile information for this Phase 1 ESA. This assessment did not include sampling or analysis of environmental media.

ER 11165-2-132 requires that the project avoid hazardous waste as defined by CERCLA. If it cannot be avoided, it must be cleanup at the 100% non-federal sponsor expense. Policy Guidance Letter 34 states that non-hazardous waste (such as State Special or Designated Waste) may be cleaned up as part of the Project; however it is the District's policy that the non-federal sponsor performs the cleanup. Paragraph 8 of the regulation requires that a site investigation and HTRW feasibility study or "ESA Phase 2" should be performed during the flood risk management feasibility study where waste is unavoidable.

HTRW assessments during the feasibility phase will determine the type and extent of HTRW contamination, if any, and how HTRW considerations will impact on the alternative project plans. A preliminary cost estimate of required HTRW response actions will be needed for each project alternative in order to be able to make a reasoned choice among alternative project plans. Alternative project plans may consider avoidance of HTRW as well as possible responses. At least one alternative plan should be formulated to avoid HTRW sites to the maximum extent possible, consistent with project objectives. These assessments, conducted during the feasibility stage, are shared with the local sponsor for cost-shared studies.

2.0 Site Description

The Project incorporates all or part of the following areas:

- Sacramento Area Flood Control Agency
- American River Flood Control District
- Reclamation District 1000 (Natomas Basin)
- Reclamation District 900 (West Sacramento)
- West Sacramento Area Flood Control Agency

2.1 Location and Legal Description

The American River Levee system is a levee system that divides Sacramento County and joins the Sacramento River on the western boundary of the County. The entire flood-prone area was once called Natomas Basin but has since been sub-divided into Reclamation District 1000 (Natomas Basin) north of the River and American River Flood Control District mostly south of the River, and north of the River east of the Natomas main drainage canal. One alternative considers diverting more of the Sacramento River flow into the Yolo Bypass at the Sacramento Bypass and therefore some of the levee system in Yolo County across the Sacramento River is considered. A separate project to raise the height of the levees on the American River is ongoing.

Levees "reaches" have been assigned to segments of the levee to assist with identification of specific locations (see Figure 1). The Project has divided levee reaches into American River North (ARN) including Dry Creek, Magpie Creek and Arcade Creek, American River South (ARS) including the Sacramento River south of the American River confluence, and Natomas (NAT).

2.2 Site Vicinity General Characteristics

The City of Sacramento is in Sacramento Valley located immediately east of the City of West Sacramento at the confluence of the American River and Sacramento River. The two cities are separated by the Sacramento River, which flows from north to south. The City and County contains a mix of residential, commercial, agricultural and industrial properties. Approximately 500,000 people reside in the City and 1,500,000 reside in the County. The City is the Capital of the State of California. It is considered to be at the highest risk of flooding of any major city in the nation. Most of Reclamation District 1000 is included in a separate flood risk management project. The study area includes

• **Natomas Main Drainage Canal South and East Levee** from the confluence of Dry Creek, Magpie Creek and Arcade Creek to the Sacramento River is included.

• **American River North and South Leve**es from Carmichael through the City of Sacramento to the Sacramento River are included.

• **Sacramento River East Levee** from the American River south to Clarksburg, Freeport and Elk Grove/Laguna Creek is included

• **Sacramento Bypass Levee** extends for approximately 1.1 miles along the Sacramento Bypass left bank from the Sacramento Weir west to the Yolo Bypass Levee.

2.3 Current Use of Property

The American River Common Features Levee system property is a currently used a flood protection levee for the City of Sacramento and Sacramento County.

2.4 Descriptions of Structures, Roads, and Other Improvements on the Site

Roads along the levee system are a mix of gravel and paved roads, railroads and bike trails that can be found along the levee crest and at the base of the levee. The levee system is crossed by numerous bridges. There are numerous residences, businesses and landfills built on the project site (levee) within the developed areas of the City.

2.5 Current Uses of Adjoining Properties

Landside adjacent properties are a mix of light industrial, commercial properties, and residential subdivisions and agricultural lands. Waterside adjacent property is the American River Parkway, the undeveloped Sacramento River; the Yolo Bypass, which is a diversionary floodwater channel used during periods of high water. There are several parks and recreational areas located between portions of the levee and the Sacramento River.

2.6 Completed Study Work

Several earlier feasibility studies to include environmental impact statements and environmental site assessments for the American River (USACE, 1991, 1996, 2004) and Magpie Creek (USACE, 1995) were completed by the Sacramento District. This environmental site assessment is an update to previous assessments.

2.7 Possible Project Alternatives

All alternatives include adding erosion control to the American River levees.

One alternative adds measures for levee stability and seepage control to the levees on the east bank of the Sacramento River south of the American River.

Another alternative avoids improvement of Sacramento River levees by widening the Sacramento Bypass north of West Sacramento to divert more water from the Sacramento River into the Yolo Bypass.

The Project has not fully defined all alternatives but they have defined the project area.

3.0 User Provided Information

3.1 Title Records

Title records are not provided because the project site, including the levees and waterways, is essentially public land, easement or right-of-way.

3.2 Environmental Liens or Activity and Use Limitations

There are no NPL or proposed NPL sites located within the study area. There is one delisted NPL site, Jibboom Junkyard. Three CERCLIS sites are located within the study area including: La Quinta Inn and Jibboom Junkyard Super Fund Site. There are no DoD sites within the study area. One FUDS sites, the Sacramento District Engineer Yard is included in the study area. There are no tribal lands included in the search area. No sites with state environmental liens are located within the study area.

3.3 Reason for Performing Phase 1

A Phase 1 ESA for HTRW is required by USACE ER 1165-2-132 for all civil works projects during the reconnaissance or feasibility study phase. A Phase 1 ESA is also required by National Environmental Protection Act (NEPA) for all construction activities.

3.4 Other

This ESA will follow the environmental industry practice of using the guidelines set forth in the USEPA rule concerning "All Appropriate Inquiries," the *ASTM E 1527-05* standard, USACE *Engineering Regulation (ER) 1162-2-132* and *Policy Guidance Letter 34, Non-CERCLA Regulated Contaminated Materials at Civil Works Projects. ASTM E 1527-05* was designed to protect persons purchasing property from liability arising from adverse environmental conditions, but also may be used for other situations per section 4.2.1 of the standard.

4.0 Records Review

4.1 Standard Environmental Record Sources

Environmental Data Resources (EDR) conducted a records research of the study area consisting of 71 federal, state, public, and proprietary available data bases.

Figure 2 shows the EDR map used with the one mile buffer around the project levee. A complete copy of the EDR Report is included as Appendix A. Standard "point" searches apply different levels of scrutiny at the ¼ mile, ½ mile and 1 mile search radius per the ASTM. This "corridor" search applies the same level of scrutiny to the entire one mile search radius.

The report generated by EDR searched the following Federal environmental record sources:

- National Priority List (NPL), including current, proposed, de-listed, liens
- Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), including archived sites (CERC-NFRAP) and CERCLA Lien Information (LIENS 2)
- Resource Conservation and Recovery Act (RCRA), including transporters, storage and disposal (TSDF), large quantity generators (LQG), small quantity generators (SQG), conditionally exempt small quantity generators (CESQG), non-generators (NonGen) and the RCRA Administration Action Tracking System (RAATS)
- The Emergency Response Notification System (ERNS)
- The Hazardous Materials Incident Report System (HMIRS)
- The EPA's listing of Brownfield properties (US BROWNFIELDS)
- Department of Defense sites (DOD) and Formerly Used Defense Sites (FUDS)
- The Toxic Chemical Release Inventory (TRIS)
- Integrated Compliance Information System (ICIS)
- PCB Activity Database (PADS)

The following State and Local environmental record sources were searched:

- California Department of Health Services (CA BOND EXP. PLAN)
- Solid Waste Facilities/Landfill Sites (SWF/LF)
- California Water Resources Control Board Waste Discharge System (CA WDS)
- Water Management Database System (WMUDS/SWAT)
- Leaking Underground Storage Tank Incident Reports (LUST), Facility Inventory Database (CA FID UST), Underground Storage Tank Database (UST), Historical Underground Storage Tank Database (HIST UST) and the Aboveground Storage Tank Database (AST)
- California Regional Water Quality Control Board (SLIC)
- DTSC Liens (LIENS)

- California Hazardous Material Incident Report System (CHMIRS)
- Confirmed release sites involving DTSC (RESPONSE)
- Pollutant emissions data (AIRS)
- The DTSC database that identifies sites that have known contamination or sites that require further investigation (ENVIROSTOR)

There were no tribal records found that applied to the area in question

4.2 Additional Environmental Record Sources

Federal Sources:

- Corrective Action Report (CORRACTS)
- A listing of sites with engineering controls in place (USENG CONTROLS)
- A listing of sites with institutional controls in place (US INST CONTROL)
- Department of Transportation Office of Pipeline Safety incident and accident data (DOT OPS)
- A listing of clandestine drug lab locations (US CDL)
- Land Use Control Information System (LUCIS)
- A listing of sites that cleanup responsibility and standards have been established by U.S. District Courts (CONSENT)
- Uranium Mill Tailings sites (UMTRA)
- Open Dump Inventory (ODI)
- Torres Martinez Reservation Illegal Dump Site Locations (DEBRIS REGON 9)
- Mines Master Index File (MINES)
- Administrative cases and pesticide enforcement actions (FTTS) and (HIST FTTS)
- FIFRA-related reporting (SSTS)
- Material Licensing Tracking System (MLTS) and Radiation Information Database (RADINFO)
- Facility Index System (FINDS)

State and Local Sources:

- Known and potential hazardous substance sites (HIST Cal-Sites, formerly ASPIS and replaced by ENVIROSTOR)
- School Property Evaluation Program (SCH)
- Toxic Pits CEANUP Act Sites (Toxic Pits)
- Sites designated by LUST, SWF/LS and Cal-Sites (Cortese)
- Recycling facilities (SWRCY)
- Statewide Environmental Evaluation and Planning System (SWEEPS UST)
- Proposition 65 Database (Notify 65)
- Recorder Land Use Restrictions (DEED)
- DTSC low threat level properties (VCP)
- Dry cleaning-related facilities with EPA ID numbers (DRYCLEANERS)
- Clandestine Drug Labs (CDL)

- Well Investigation Program Case List (WIP)
- Extracts from hazardous waste manifests (HAZNET)
- List of waste tire haulers (HAULERS)

4.3 Historical Record Review

Historic aerial, topographic, and fire maps were not obtained for this search due to the cost for a search of this magnitude. Instead the assessment reviewed these historical records obtained for a previous assessment (USACE, 2008) which covered most of the same area, with the assumption that the historic records haven't changed significantly since 2008.

4.4 Regional Contaminant Considerations During Future Construction

Environmental records searches are efficient ways to identify and track sites where past releases have occurred. Other types of contaminants unlikely to be picked up in an environmental records database search are considered in this report because they are associated with significant industries that were historically active in the region. Gold mining and large-scale agricultural activities are two historic activities that have produced regional contaminants in the project area and should be considered when future levee construction occurs.

The levee system around the American River and Natomas Basin lies in a region that has a history of gold mining. The regional history of gold mining coupled with the regional agriculture land use and the historic use of dredge material from the rivers as levee construction material, suggests there are some chemicals for which data collection would be useful to confirm if contaminants from these historic process are present. These include arsenic, mercury, pesticides and herbicides.

Additionally, based on the vehicular use of the existing levee crown, lead and petroleum hydrocarbons may have been released to the upper 3 feet of the roadway shoulder on the existing levee, especially at bridge locations where old corrosion-resistant lead paint would be present. Herbicides are sometimes used for weed abatement on the levees.

Railroad tracks are located on the levee on the Sacramento River west of the downtown area. Old railroad ties were preserved with creosote. Newer wooden ties are probably preserved with copper arsenate. If the railroad road bed must be disturbed for the project, further investigation for these contaminants will be warranted.

Sacramento Regional County Sanitation District has regionalized its wastewater treatment system (SRCSD, 20007). Most or all wastewater is collected and pumped to the regional wastewater treatment plant in Elk Grove. Treated wastewater is discharged just south of the Freeport Bridge in the project area. Wastewater from Natomas is moved south to the west of the Sacramento River and now crosses to Elk Grove at the Freeport bridge. There were wastewater treatments plants located between Exposition Park and Howe Avenue (the "Arden Station") and on River Walk Road (the "Northeast Facility") along the north bank of the American River. These old wastewater treatment plants have been converted to pumping and flow equalization stations that today move wastewater through force mains across the American River. The

Sacramento City Interceptor parallels the Sacramento River south of the Sacramento Marina for several miles. The Dry Creek Interceptor crosses Dry Creek and Magpie Creek between Rio Linda Blvd and Dry Creek Road near the Sacramento Northern Bike Trail, and crosses Arcade Creek at Rio Linda Boulevard. There is no record of overflows but the wastewater pipelines are to be avoided and special personal protective equipment for biological hazards may be required when working in close proximity to present and former treated wastewater discharge locations.

5.0 Site Reconnaissance

5.1 Methodology and Limiting Conditions

The study area site visit was conducted for the Phase 1 ESA by staff from the Environmental Engineering and Geology Sections of the United States Army Corps of Engineers, Sacramento District.

The objective of the site visit was to identify recognizable environmental concerns in connection with the property. Common environmental concerns that were looked for include the following: asbestos; construction and demolition debris; drums; landfill or solid waste disposal sites; pits, ponds or lagoons; wastewater; fill dirt, depressions, mounds, or any artificial structures; PCB containing transformers; monitoring wells, and the presence or likely presence of any hazardous substance or petroleum products on the property under conditions that indicate an existing release, a past release, or a material threat of a release on the property or into the ground, groundwater, or surface water of the property.

The mere presence of a contaminated property on the dry side of the levee was generally considered to be avoidable. The presence of contaminated properties on the "wet" side of the levee or features on or inside the levee such as monitoring wells, drains and pipelines were generally assumed to be unavoidable.

5.2 Observations

Site visits to properties screened as likely affecting the Project were conducted on August 2, 2012. Photographs are included in Appendix D. Findings are incorporated in Chapter 8.

6.0 Historical Records

The 2008 assessment consulted Sanborn Fire Insurance records to glean any information about sites along the rivers that was not presented elsewhere. Basically, the maps confirmed the other sources that most of the industrial sites were located at or near the confluence of the American and Sacramento Rivers. Searching the Internet yielded a few aerial and historical photographs, and maps which confirmed earlier findings about the locations of various industrial sites.

6.1 Aerial Photo Review

EDR provided an Aerial Photo Decade Package (EDR, 2008) for the previous environmental site assessment (USACE, 2008). "Birdseye" view drawings, aerial and other historical photographs were obtained from the EDR report, and from the California State Library in Sacramento, California.

It is unlikely any additional historical air photos have been found in the last four years. Therefore this assessment used the 2008 historical record search from the previous study. It is included in Appendix E.

Several industrial sites were noted, especially along the confluence of the American and Sacramento Rivers. Water-borne shipping was more in evidence in the past than it is today, although the modem ships, while fewer in number carry much larger payloads.

6.2 Topographic Maps

The search also consisted of reviewing historical topographic maps (Appendix F):

• Sacramento East Maps

- From the edition of 1949, six specific crossings of the Sacramento River were noted, Highway 99, H Street, a footbridge south of Arden Town and three railroads, Southern Pacific, Sacramento Northern and Western Pacific. In addition, there are power line crossings.
- There are several pumps related to miscellaneous water uses associated with the levees.
- The edition of 1954 showed the same features, except that the footbridge had become the Watts Avenue crossing.
- The map of 1967 added a golf course east of the highway 80 and south of Cal Expo, a sewage disposal plant east of mile 5 and west of Howe Avenue, a filtration plant east of the Sacramento State University campus and a fire station, presumably associated with the Sacramento State campus.
- The Sacramento East map of 1975 was a photo revision of the 1967 edition and added a crossing at Howe Road.

- The editions of 1980 and 1992 did not show any significant additions.

• Sacramento West Maps

- The map of 1949 noted an intake tower and filtration plant south of the confluence of the American River, a pumping plant at the end of the Natomas Canal, a boat launching ways near the confluence of the American River and a clay pit and stack near Clay Bank Bend. Crossings include the Tower Bridge, the I Street Bridge and the Jibboom Street Bridge.
- There are several pumps related to miscellaneous water uses associated with the levees.
- In the 1967 edition, the clay pit has become Lake Greenhaven and the stack is gone. The Sacramento Deep Water Ship Channel is added. There is a new filtration plant south of the end of 10th Avenue, a new sewage disposal plant at the confluence of the barge canal leading to the deep water ship channel, a new marina at Miller Park and borrow pits across the river from the old intake tower. Highway 80, 5 and a proposed crossing for highway 880 are added.
- The photo revision of the 1967 edition shows the actual location of the 880 bridge.

• Clarksburg Maps

- The 1952 edition of the Clarksburg map shows a sugar beet plant located north of Clarksburg on the west side of the Sacramento River and the Borges-Clarksburg Airport at benchmark 13. There are several pumps related to miscellaneous water uses associated with the levees. Crossings include several power lines and a drawbridge south of Freeport.
- The version of 1967 shows three industrial waste ponds in or on the location of the sugar beet plant, just north of Willow Point Road. There is a new water tank and sewage disposal plant at Freeport Bend on the east side of the Sacramento River
- The1975 photo revision of the 1967 edition adds a small waste pond at the old sugar beet plant.
- The 1980 photo revision of the 1967 edition shows a new waste pond at the sugar beet plant.

6.3 Commercial Environmental Database Report

The EDR "Environmental Records Database Search is in Appendix A. Due to the size of the document (over 2,000 pages), the Appendix contains only an extract. The entire document is included in PDF file format on CD.

7.0 Interviews

Six interviews were conducted in the 2008 assessment. One new interview was conducted for this assessment.

7.1 Interviews with Owners/Occupants

Individual Contacted	Date	Title/Organization	Contact Information	Page Number (USACE, 2008)
Mr. Joe Borges	10/23/2008	Owner Borges-Clarksburg Airport	N/A	5

7.2 Interviews with State and Local Government Officials

Tim Kerr, the President of the American River Flood Control Agency (ARFCA) was interviewed. His response is in Appendix C.

Previous interviews included

Individual Contacted	Date	Title/Organization	Contact Information	Page Number (USACE, 2008)
Ms. Mary Perlea	8/31/2007	US Army Corps of Engineers	(916) 557-7185	1
Mr. Terrie Figueroa	9/13/2007	Secretary/ RD1000	(916) 922-1449	2
Mr. Richard Payan	9/13/2007	Battalion Chief/City of Sacramento Fire Department	(916) 216-0311	3
Mr. Paul Devereaux	9/20/2007	General Manager/RD1000	(916) 922-1449	4
Lt(jg) Simone Moss	9/25/2008	Waterways Officer, USCG	(510) 437-2975	6

The interviewees had very limited knowledge of HTRW contaminated properties located along the levees. It is recommended that public officials at the California Department of Toxic Substances Control and Central Valley Regional Water Quality Control Board involved in cleanup of contaminated sites that may affect the Project be interviewed to help define how the Type 1 sites affect project alternatives.

8.0 Findings

The EDR search identified over 600 records of possible HTRW concerns within the study area. All of these sites were identified in the EDR search by a site identification-focus map number identifier. Many of the Site ID's had multiple records of possible HTRW associated with them so the total number of identified sites in the EDR report was 491. Of these, 7 sites were considered to be Type 1 and 45 were found to be Type 2.

Appendix B provides a summary of each site including its levee station and reach, whether or not the site may affect future construction, and links to regulatory information. This information was used to focus the Phase 1 ESA to the potential effects of the identified HTRW sites on future construction activities. Further investigation of potentially hazardous sites included review of available site information in the EnviroStor and GeoTracker databases maintained by the California Department of Toxic Substance Control (DTSC) and California State Water Resources Control Board (SWRCB) respectively. Reports from these databases were used to determine the possible impact identified sites may have on future construction activities. Characteristics used to classify the site included the suspected mass and volume of contaminants, their mobility within the soil-groundwater-air matrix, and the likelihood of traditional levee remediation measures impacting contaminated media.

As previously discussed, sites were classified in one of three types according to the potential for harmful impacts on future construction activities. Tables 2 & 3 below provide a listing of all the Type 1 and Type 2 sites, respectively. Figure 3 provides a map showing the location of all Type 1 and 2 HTRW sites. The remaining Type 3 sites are identified in Appendix A and B.

Whether a contaminated site adjacent to the levee is avoidable depends in part on what work is proposed to be done on the levee; erosion control, stability, seepage control, relocation or raise in elevation. Justification for classification as a Type 1 or Type 2 site is further discussed in Chapter 9, Findings.

Table 2 – Type 1 HTRW Sites

Type 1 Sites – HTRW concerns that may impact future activities					
Site Name	**EDR ID#**	**Assessor Parcel Number**	**Levee Reach**	**Address**	**Summary**
Full Stop Mini Mart	41-5	251-0292-016	ARN_D	3200 Rio Linda Blvd, Sacramento, CA 95815	Gasoline plume at gasoline station adjacent to the levee at a bridge crossing. Active remediation by soil vapor extraction and air sparging is occurring. The oxidizer is immediately adjacent to the levee. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606701131
Old Bryte Landfill	79-6	042-280-011	WS*	50035 County Rd 126, West Sacramento, CA 95691	Old unregulated landfill, uncapped, is immediately adjacent to the Sacramento Bypass levee. Waste from a car battery lead recycling company in West Sacramento was dumped here. http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=60001146 http://www.calrecycle.ca.gov/SWFacilities/Directory/57-CR-0002/Detail/
CA State Railroad Museum Unit SHO	120-7	No parcel number, public land	ARS_D	501 Jibboom ST, Sacramento, CA 95814	Union Pacific Railroad (old Southern Pacific) railyard. The museum appears to be a surrogate for the historic locomotive repair shops being preserved here for reevelopment. There are monitoring wells in the levee and in the waterfront park at this location. http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=80001665
TOSCO Corporation/ ConocoPhillips Sacramento Terminal	174-11	009-0030-054	ARS_D	76 Broadway, Sacramento, CA 95818	Bulk fuel terminal used by ConocoPhillips. Soil and groundwater beneath the site have been impacted by petroleum hydrocarbons, specifically from active gasolines and diesel fuels. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL0606742138
TOSCO Corp. – Sacramento Terminal	174-11	009-0020-001	ARS_D	66 Broadway, Sacramento, CA 95818	Wet side of major petroleum release above still undergoing cleanup. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL372513618
Chevron Sacramento Terminal 1001620	178-11	009-0012-072 009-0012-071	ARS_D	2420 Front St, Sacramento, CA 95818	More dry-side petroleum bulk handling facility. Petroleum pipelines pass through the levee at all properties. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700657
Harbor Sand & Gravel/Bell Marine Co Inc.	128-8	001-0160-011	ARS_B	200 28th St, Sacramento, CA	Release was reported in 1994. The property is now occupied by an asphalt concrete recycling company. The new business has fenced off the levee road and its operation is encroaching on the levee.

					http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL0606705586

Table 3 Type 2 HTRW Sites

Type 2 Sites – HTRW concerns that are not likely to impact future activities					
Site Name	**EDR ID#**	**Distance from Centerline (miles)**	**Levee Reach**	**Address**	**Summary**
PG&E – Sacramento Site	156-11	009-0012-003	ARS_D	2000 Front St, Sacramento, CA 95818	Former manufactured gas plant that produced gas from raw materials such as coal and petroleum from 1873 to 1930. Primary COCs in both soil and groundwater are BTEX, and PAHs including naphthalene. http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=34490048
Shell #204-6678-9003	98-7	001-0011-003	ARS_D	225 Jibboom, Sacramento, CA 95814	Gasoline plume in groundwater. Two gasoline stations, one adjacent to the levee. This waterfront area was a Superfund site that has been redeveloped. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700500
Continental Chemical Company	69-8	275-0111-006	ARN_C	2175 Acoma St Sacramento, CA 95815	LUST, SLIC site http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL185472918
Micheletti Property	69-8	275-0112-005	ARN_C	2147 Barstow St Sacramento, CA 95815	SLIC site,CVOCs http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL0606762702
Martin Sprocket & Gear Inc.	99-8	001-0070-036	ARS_C	1199 Vine St STE 204, Sacramento, CA 95814	Small quantity hazardous waste generator with a diesel tank on-site. No record of releases. A cluster of three monitoring wells was found in the levee near this property, probably associated with Lovotti Bros. at 1275Vine St. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606793627
Petro-Speed	123-8	001-0142-010 001-0142-011 001-0142-012	ARS_B	324 N 16th St Sacramento, CA	Old gasoline station that has been closed. Petroleum plume being monitoring. Sufficiently removed from the River. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700184
Sacramento City Landfill	128-8	001-0170-018	ARS_B	20 28th and A St, Sacramento, CA	Now known as "Sutter's Landing Regional Park". Closed Sacramento public solid waste landfill. The landfill is built right up against the levee so that the levee crown road is downhill from the landfill cap. Stormwater drains on the

					landfill cap go through the levee to the River. Landfill gas collection wells are close to the levee. A Kinder Morgan petroleum pipeline is buried under the water-side toe of the levee. http://www.calrecycle.ca.gov/SWFacilities/Directory/34-AA-0018/Detail/
Scollan (Old Sac City Landfill)	133-8	001-0160-013	ARS_B	24th and A St, Sacramento, CA	Old dump site along the AR between railyard and Sac City landfill http://www.calrecycle.ca.gov/SWFacilities/Directory/34-CR-5005/Detail/
Sacramento Housing & Redevelopment Agency	149-11	009-0012-002	ARS_D	1920 Front St, Sacramento, CA 95814	http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700254 http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=34240036
Sacramento Municipal Utility District (SMUD)	158-11		ARS_D	Front & T St, Sacramento, CA 95814	Across the street from the PG&E site. Historical uses include vehicle maintenance, fueling, and storage. The potential site contaminants of concern are polynuclear aromatic hydrocarbons (PAHs), total petroleum hydrocarbons as gasoline (TPH-Gas), and volatile organics (VOCs). All remedial activities were completed in 2008, however, DTSC required the continued operation and maintenance of the GWETs and associated monitoring wells and prohibited certain uses of the site. http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=34490057
Delta Shores	243-20		ARS_G	8145 Freeport Blvd Sacramento CA 95832	http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000000566
Wastewater Treatment Plant Yolo APN		058-260-016 058-260-019		1991 South River Rd West Sacramento, Ca 95691	Worth noting for Health & Safety while working in this reach of the Sacramento River http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0611300170
Pell Drive	15-4	237-0400-019	ARN_F	4220 Pell Dr Sacramento, CA 95838	Chlorinated solvents in soil http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=60001003
Great American Stage	29-4	250-0122-011	ARN_F	3560 Western Ave #A Sacramento, CA 95838	NPDES/WDS Permit
Strawberry Manor/PCB Site	43-4	263-0313-003	ARN_E	188 Olmstead Dr Sacramento, CA 95838	PCB in soil http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=34330034

Arco #6168	98-7	001-0012-016	ARS_D	222 Jibboom St, Sacramento, CA 95814	TPH release site by the levee, across the street from the Shell release site, monitored. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700277 http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700537
Jibboom Junkyard	119-7	001-0190-015	ARS_D	I-5 and Jibboom St, 240-260 Jibboom St, Sacramento, CA 95814	Redeveloped property, former NPL site http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=34490023
Colfax Yard	63-8	275-0072-002		2225 Colfax St, Sacramento, CA 95815	LUST site, TPH-diesel release http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700685
Lawson Mechanical Yard	69-8	275-0113-022	ARN_C	58 Arden, Sacramento, CA 95815	LUST site http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700395
Rawson Drug & Sundry Corp	69-8	275-0111-001	ARN_C	2189 Acoma St Sacramento, CA 95815	Old North Sacramento, minor release, to groundwater but this property is adjacent to the levee. http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606793621
A-1 Plating Company	69-8	275-0112-017	ARN_C	2170 Acoma St Sacramento, CA 95815	Case closed in 2010 http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=34340002 http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL185792942
Petrocheck	69-8	275-0161-001	ARN_C	2076 Acoma St Sacramento, CA 95815	Old North Sacramento,Historical site, County response with no state involvement, organic liquid in soil
Green Property	69-8	275-0163-001	ARN_C	1000 Del Paso Blvd Sacramento, CA 95815	Old North Sacramento 4-LUSTS, County response
Central Maintenance	74-8	Public land	ARN_C	2080 Railroad Dr Sacramento, CA 95815	LUST, County response , Los Rios Community College
Subway Truck Parts	81-8	275-0200-010	ARN_C	903 Del Paso Blvd Sacramento, CA 95815	LUST, county response
Mells Cargo Supply	84-8	274-0200-005	ARN_C	1940 Railroad Dr Sacramento, CA 95815	LUST Site, RWQCB response http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700530
Special Service	84-8	274-0200-010	ARN_C	1930 Railroad Dr Sacramento, CA 95815	LUST, county response
Robertson Sand & Gravel	92-8	001-0160-011	ARN_B	(28th & A) Sacramento (County), CA	MINES database, no longer operating
Kinder Morgan Energy	95-8	275-0310-031	ARN_B	1111 Exposition Blvd	SLIC site – leaking petroleum pipeline

Partners KMEP Exposition Blvd		thru 275-0310-038		Sacramento, CA 95815	http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000001938
Sacramento Police Dept/Prop MNGT/Armory	96-8	001-0200-035	ARS_C	555 Sequoia Pacific Blvd Sacramento, CA 95814	Clandestine drug lab
Direct Current Inc.	101-8	275-0270-018	ARN_B	150 Commerce Cir Sacramento, CA 95815	RCRA Battery hazwaste, no releases
Sacramento Marina	174-11	009-0020-003	ARS_D	2701 Marina View Dr Sacramento, CA 95818 (2710 Ramp Way?)	LUST Site, County response
Setzer Forest Products Inc.	187-11	009-0030-019 009-0270-009 009-0270-033 009-0030-043 009-0030-045 009-0286-012	ARS_D	2570 3rd St and 2630 5th St, Sacramento, CA 95818	LUST site http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606786234
Sacramento City Unified School District Maint. Yard	191-11	009-0237-013	ARS_D	425 1st Ave (AKA 5th St @ 1st Ave), Sacramento, CA 95818	LUST site http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606728136
Utilities Sump 2A	210-11	017-0036-021 017-0036-020 017-0036-017 017-0036-019	ARS_D	3530 Riverside Blvd, Sacramento, CA 95814	AST with sump County response
Shell	216-11	017-0071-004	ARS_D	4000 S Land Park Dr Sacramento, CA 95822	LUST Site (TPHg) http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700962
Hubacher Cadillac Inc	148-13	295-0020-004	ARN_A	1 Cadillac Dr Sacramento, CA 95825	UST permit
CA State University Sacramento	179-13	005-0010-007 005-0010-027 079-0221-002 079-0221-009	ARS_A	6000 J St Sacramento, CA 95819	hazmat storage http://www.envirostor.dtsc.ca.gov/public/hwmp_profile_report.asp?global_id=CAT080031115&starttab=
Chevron #9-1743	153-14	294-0107-006	ARN_A	3481 Fair Oaks Sacramento, CA 95825	LUST Site (TPHg) http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700085

Arco #4968	153-14	292-0123-002	ARN_A	3501 Fair Oaks Blvd Sacramento, CA 95825	LUST Site (TPHg) http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700223
Shell SS	153-14	292-0141-008	ARN_A	3510 Fair Oaks Blvd Sacramento, CA 95825	LUST Site (TPHg) http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606701030
BP #11176 (Former)	153-14	293-0260-001	ARN_A	3480 Fair Oaks Blvd Sacramento, CA 95825	LUST Site (TPHg) http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0606700100
Glenbrook Shopping Plaza	192-14	078-0011-017	ARS_A	8700-8760 La Riviera Dr, Sacramento, CA 95831	SLIC Site (PCE) http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000003071
Riverside Plaza Shopping Center	225-16	030-0330-015	ARS_F	6401 Riverside Blvd, Sacramento, CA	SLIC Site (PCE) http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL0606734773
Cleaners Express	231-19	031-1030-017 031-0070-077 031-0070-078	ARS_F	7600 Greenhaven Dr, Unit 7, Sacramento, CA 95831	SLIC Site (PCE) http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000003089

9.0 Opinions

All information used to form the following opinions was gathered from the most recent reporting information available in the EnviroStor or GeoTracker databases, site reconnaissance and interviews. If no citation is given, general information on the website or the site details from the EDR report were used.

9.1 Type 1 Sites

76/66 Broadway & 2420 Front St EDR Site 174-11 is a bulk fuel terminal now used by ConocoPhillips. The site is located within an industrial area of Sacramento, north and east of the Sacramento Marina at the intersection of Front and Broadway Streets. Twelve aboveground storage tanks associated above- and below- ground piping, a loading rack, and several buildings are present at the site. Previous site investigations have revealed that the soil and groundwater beneath the site have been impacted by petroleum hydrocarbons, specifically from active gasoline and diesel fuels. Previous remedial activities include a soil vapor extraction system set up in 1991 that removed 26,000 pounds of petroleum hydrocarbons after two months; an expanded soil vapor extraction system. The site is located on both sides of the levee. Pipelines run through the levee from 2420 Front Street to 66 Broadway and from 76 Broadway to the Sacramento Marina. Pipelines also run parallel to the levee from 76 Broadway to 2420 Front Street. 66 Broadway St is on the water side of the levee while 76 Broadway is on the dry side of the levee making this site unavoidable. 2420 Front Street is on the dry side of the levee.

EDR Site 79-6, Yolo County Assessor Parcel Number (APN) 042-280-011 is the Old Bryte Landfill. The landfill was an old unregulated dump site. DTSC has found lead above risk level. The source of the lead is probably scrap from an old car battery lead recycling operation in West Sacramento which is now the site of Sacramento Stucco. The waste would probably classify as CERCLA hazardous waste based on toxicity and leachability. Very likely the north levee for the Sacramento Bypass cannot be moved without dumpsite removal by the non-federal sponsor at 100% non-federal expense.

EDR Site 41-5, Sacramento County APN 251-0292-016 Full Stop Mini Mart in ARN Reach N on Arcade Creek is a leaking underground storage tank adjacent to the Arcade Creek levee adjacent to a bridge. The site is being actively remediated with soil vapor extraction and air sparging and it is possible but not probable that some vapor-laden air from the air sparging escapes the soil vapor extraction system into the levee. The thermal/catalytic oxidizer is trailer-mounted and located at the dry side toe of the levee. The site is included here as it is an actively remediated groundwater contamination site on a parcel adjacent to the levee.

EDR Site Number 120-7 in ARS Reach D is the old Southern Pacific rail yard with engine houses. It has no assessor parcel number as it is now public land for historic preservation and redevelopment. This was a major cleanup site. Monitoring wells are found in and on the west (wet) side of the levee along the Sacramento River. Land use controls are in place. It is

probably possible to avoid contamination at this site but the project will need to work around monitoring wells that will be in the way and will need to avoid digging or pile-driving.

EDR Site 128-8 APN 001-0160-011 "Harbor Sand & Gravel" in ARS Reach B is now the site of an asphalt concrete recycling company. The company has blocked the levee road with a gate and is encroaching on the levee including the wet side with piles of recyclable pavement materials and structures (see photo in Appendix D).

EDR Site 156-11 is a former manufactured gas plant, Pacific Gas & Electric Sacramento Site, which produced gas from raw materials such as coal and petroleum from 1873 to 1930 and was demolished in 1961 (there is a second such site located "south of the western end of Broadway"). The site is located between the Sacramento River levee and Front Street. Residuals of the manufactured gas process include lampblack, tar, total petroleum hydrocarbons (TPH), and spent oxides. Contaminants associated with these residues have been detected in soil and groundwater beneath the Site. The primary COCs in both soil and groundwater are benzene, toluene, ethylbenzene and total xylenes (BTEX), and polycyclic aromatic hydrocarbons (PAHs) including naphthalene. The major benzene plume is located in the north eastern area of the site, while a small separate plume exists at the foot of the levee in the central western part of the site based on monitoring results from May 2008 (DTSC 2011).

Numerous remedial investigations, soil removal actions, and many years of groundwater extraction and treatment have been conducted at the Site. Remedial activities to date include: capping of the PG&E property with a geosynthetic clay liner, soil excavations, operation of a soil vapor extraction treatment system, and operation of a groundwater evapotranspiration system (GWETs). Currently, the site is paved to control soil migration and exposure. The Ranney Collector was decommissioned in 2009, thus necessitating a remedy modification. Soil stabilization/solidification, by the addition of Portland Cement and Activated carbon to the areas where the highest contamination is found in the vadose zone, has been selected as the remedial action. Any future construction work would be impacted by the presence of this plume and monitoring system.

9.2 Type 2 Sites

Several sites were visited during site reconnaissance and downgraded from a preliminary classification as "Type 1" to a final classification of Type 2 or 3 based on avoidability. They are discussed here. ***Sites determined from map reconnaissance and records review to be Type 2 and Type 3 sites without site reconnaissance are not discussed***. Most of the sites discussed here are contaminated properties adjacent to or near to the levee that are unlikely to affect levee improvements so long as the properties are avoided.

EDR Site 158-11 is a vacant parcel owned by the Sacramento Municipal Utility District that is located at the intersection of Front and T Streets with the Sacramento River and levee to the west and the Interstate 5 Highway to the east. EDR 158-11 is located on the other side of Front Street, across from EDR 156-11. The site's historical uses include vehicle maintenance, fueling, and storage. This site was discovered during the groundwater investigation of EDR Site 156-11. The investigation revealed that the site consisted of a source of contaminants that were

migrating to the groundwater. The potential site contaminants of concern are polynuclear aromatic hydrocarbons (PAHs) from diesel fuel, total petroleum hydrocarbons as gasoline (TPH-Gas), and volatile organics (VOCs). The source of contamination was removed in 1999 by excavating 4,290 tons of contaminated soil and disposing of it off-site. A seasonal soil vapor extraction system (SVETs) operated at the site from November 1999 to May 2007. The SVETs is estimated to have captured and treated 34 pounds of reactive organic compounds and 13 pounds of benzene from the vadose zone. Groundwater monitoring continues to occur on site. The site relies on the EDR Site 156-11 GWETs to remove residual amounts of site contaminants. The California Department of Toxic Substances Control (DTSC) certified that all appropriate remedial actions have been completed in April 2008. However, DTSC also recorded land use controls requiring that the operation and maintenance of the GWETs and associated monitoring wells continue and prohibiting certain uses of the site. Any future construction work should avoid this area (DTSC 2010a).

EDR Site 98-7 Sacramento APN 001-011-003 Shell station in ARS Reach C/D on the Sacramento River south of the American River is a monitored leaking UST across the street from another gasoline station that abuts the levee but does not reach it.

EDR Site 99-8 APN 001-0070-036 in ARS Reach C, Martin Sprocket & Gear. The site is adjacent to the levee along with a few other such properties. The presence of a cluster of three monitoring wells in the levee, probably due to a petroleum release at the Lovotti Brothers site at 1275Vine St, is noted here but unlikely to affect erosion control measures.

EDR Site 128-8 Sacramento APN 001-0170-018 in ARS Reach B is the Sacramento City Landfill, now known as the Sutter's Landing Regional Park (Appendix D). This will have a minor impact on erosion control measures for the Project. The landfill uses the levee as a cap so that the landfill crown is topographically above the road on the levee crown. Stormwater drains from the landfill cap penetrate the levee that will need to be avoided. Landfill gas extraction wells are in or next to the levee but if working properly present no problem. The Kinder Morgan petroleum pipeline parallels the Union Pacific Tracks through most of Placer and Sacramento Counties, but the presence of the landfill between the levee and the tracks at this location means they have buried the pipeline at the toe of the levee on the water side at this location. There is no documented petroleum release from the pipeline in this location, but there is such a site in old North Sacramento across the river. It should be feasible to place riprap on the levee at this location, but care must be taken to avoid landfill features such as the storm water drains and the buried pipeline.

EDR Site 133-8 APN 001-0160-013 the Scollan or "Old Sac Landfill" in ARS Reach B is mentioned here because it is an old, unregulated and un-engineered landfill abutting the levee. An on-line aerial photo in Google Map™ appears to show a cap being placed on the landfill. No leachate collection system or landfill gas collection system are visible.

EDR Site 69-8 Sacramento APN 275-0111-006 Continental Chemical and EDR Site APN 275-0112-005 Micheletti Property in ARN Reach B/N along the Natomas Main Drainage Canal are minor groundwater release sites with petroleum and chlorinated solvents. The issue is that there are several more such documented and monitored release sites in close proximity in

this old industrial area in old North Sacramento. There is also a release site immediately adjacent to the levee at EDR Site 69-8, APN 275-0111-001. Due to the close proximity of many contaminated industrial sites and two such properties adjacent to the levee, the project would likely need to ensure that levee improvements would not adversely impact groundwater contaminant plume migration at this location.

1920 Front St - Sacramento Housing and Redevelopment Agency Site: The site was once a lumberyard. A leaking UST and waste from the adjacent manufactured gas plant were found on the property. The property was razed to create a parking lot that caps residual soil waste and has land use controls. A concrete wall 3 feet high separates the parking lot from the levee. A few empty waste drums remain on site. The State of California had a Ranney Well by the river used by the California Department of General Services to provide cooling water for downtown State office buildings. The well was destroyed in 2009.

2000 Front St – PG&E Former Manufactured Gas Plant Site: The site has been razed and paved over. It is located on the dry side of the levee. Land use restrictions are in place. The site is fenced and requires permission from PG&E to access. 40 hour OSHA Hazwoper training is required for access. The site is being remediated by Arcadis with deep soil mixing for soil stabilization/solidification. Remediation may be complete by November. The site is adjacent to the "Boat Section" of Interstate 5 which is lower than the River and actively de-watered. The property must be avoided.

Additional sites were categorized as Type 2 based on record screening without site visit. A summary can be found in Table 3. Type 3 sites are found in Appendix B.

10.0 Conclusions

A Phase 1 Environmental Site Assessment was performed in accordance with the scope and limitations of ASTM E 1527-05 and USACE ER 1165-2-132 for the American River Common Features GRR project. Any exceptions to, or deletions from, these practices have been outlined within the report. There are many contaminated properties adjacent to the levees on the dry side that are considered to be avoidable due to the nature of the contamination or the nature of the work proposed on the levees. This assessment has identified sites with recognized and probably unavoidable environmental conditions at the locations shown in Table 4 below.

Table 4 - Sites with Recognized Environmental Conditions

Site Name	Reach	EDR #	APN	Issue
Old Bryte Landfill	Sacramento Bypass	79-6	042-280-011	Lead in soil,
Southern Pacific Rail Yard	ARS Reach D Sacramento River	120-7	002-0010-049 002-0010-023 002-0010-054	CVOC, TPH Groundwater Plume, land use restrictions
Full Stop Mini Mart	ARN Reach N Arcade Creek	41-5	251-0292-016	TPHg plume at levee bridge crossing with air sparging
Robertson/Harbor Sand & Gravel	ARS Reach B American River	92-8 128-8	001-0160-011	Levee Encroachment, recycled pavement
Old North Sacramento	ARN Reach B/N Natomas Main Drainage Canal	69-8	275-0111-001	CVOC, TPH Groundwater Plumes adjacent to levee, multiple properties
TOSCO Corp./ Conoco-Phillips Sacramento Terminal	ARS_D	174-11	009-0030-054 009-0012-071 009-0012-072	Petroleum release site on dry side of the levee. Petroleum pipelines pass through the levee.
TOSCO Corp. Conoco-Phillips Sacramento Terminal	ARS_D	174-11	009-0020-001	Petroleum release site on wet side of the levee

The historical land uses of the region may also contribute to residual contamination of the entire project area with agricultural fertilizers, herbicides, and pesticides as well as arsenic and mercury from mining operations in the region. Additional sampling will be required during subsequent investigations to determine if project areas have been impacted by these historical contaminants.

On-line records are limited. For contaminated sites identified as unavoidable under the alternatives considered by the American River Common Features GRR, a public records review is recommended at the Central Valley Regional Water Quality Control Board office and the Sacramento Regional Office of the Department of Toxic Substances Control as the next step to determine if additional investigation is required to determine the impact of these sites on the project. Current groundwater plume maps and environmental liens / deed restrictions incorporating land use controls are particularly needed. Emphasis is needed on the Sacramento

Terminal bulk fuel handling facility, the old Southern Pacific rail yard, and the old Bryte landfill as these may affect alternative selection.

Due to the GRR process being a parent project that identifies the need for future actions, a Phase 1 ESA will need to be performed again, either at the appropriate GRR phase planning milestone, or at the beginning of actual construction activity. The subsequent Phase 1 ESA(s) will investigate if new sites have emerged and if existing sites still pose a threat to planned construction.

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12.0 Signature of Environmental Professional

8/6/2012

James C. Powers, PG, CEG, CHg #7062
Environmental Engineering Section

13.0 Qualifications of Environmental Professional

I declare that to the best of my knowledge and belief, I meet the definition of Environmental Professional as defined in 40 CFR , Section 321.10

8/6/2012

James C. Powers, PG, CEG, CHg
Environmental Engineering Section

FIGURES

Figure 1 American River Common Features GRR Levee Reaches and Project Area

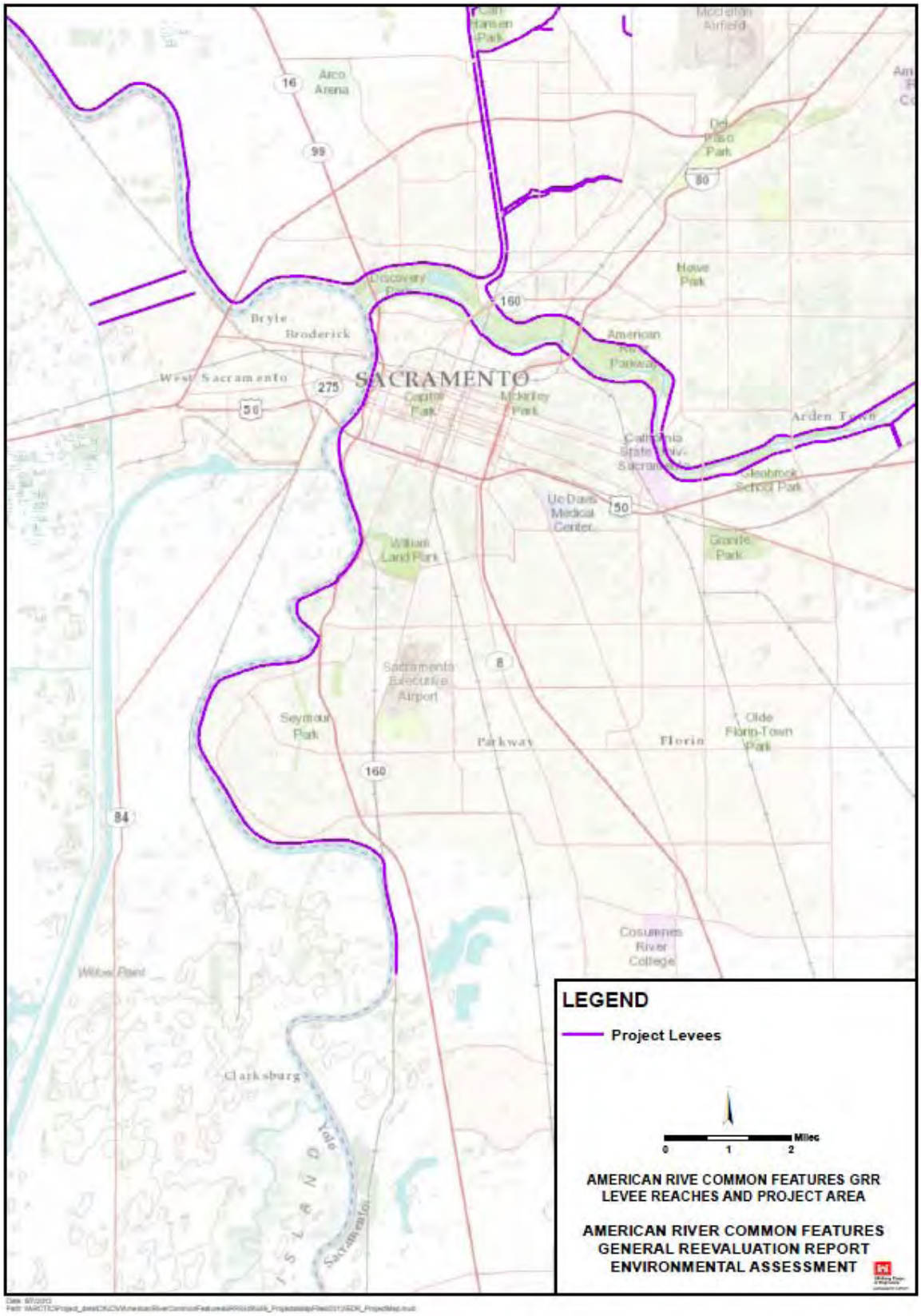


Figure 2 EDR Site Map with Search Radius

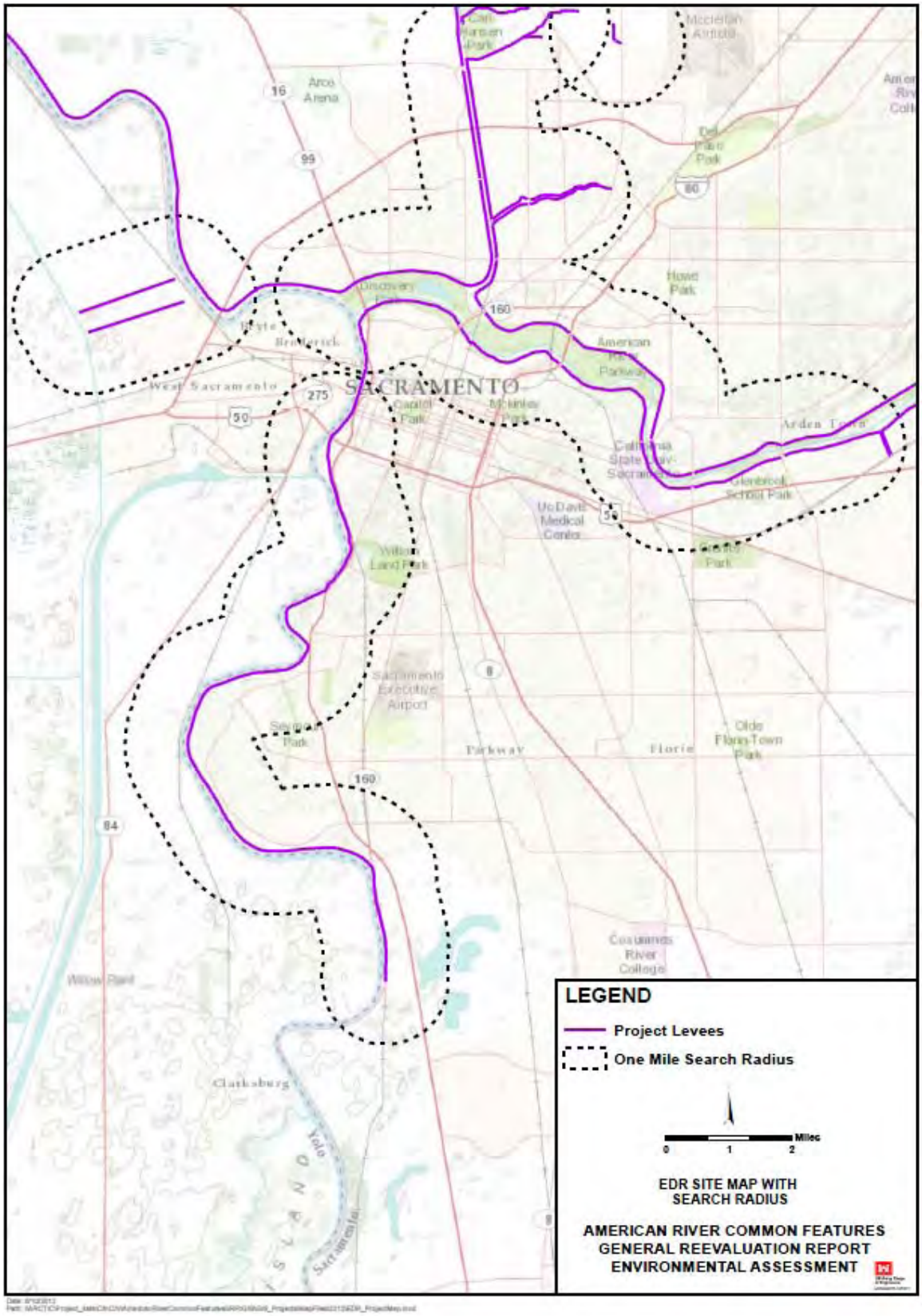
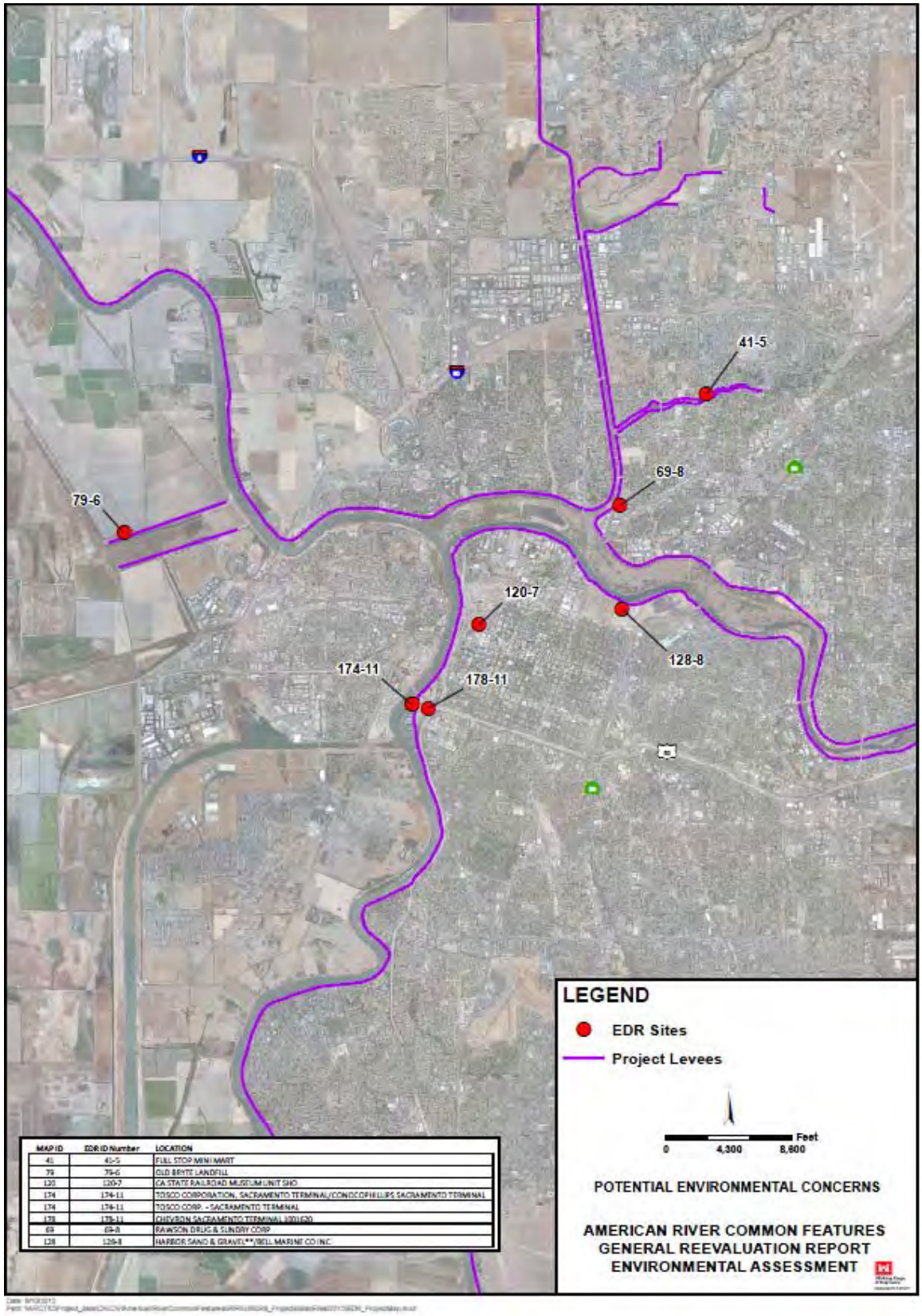


Figure 3 Potential Environmental HTRW Concerns



MAP ID	EDR ID Number	LOCATION
41	41-5	FULL STOP MINI MART
79	79-6	OLD BRYTE LANDFILL
120	120-7	CA STATE RAILROAD MUSEUM UNIT SHO
174	174-11	TOSCO CORPORATION, SACRAMENTO TERMINAL/CONOCOPHILLIPS SACRAMENTO TERMINAL
174	174-11	TOSCO CORP. - SACRAMENTO TERMINAL
178	178-11	CHEVRON SACRAMENTO TERMINAL 100120
69	69-8	RAWSON DRUG & SUNDRY CORP
128	128-8	HARBOR SAND & GRAVEL**/BELL MARINE CO INC

Habitat Mitigation, Monitoring, and Adaptive Management Plan

American River Common Features General Reevaluation Report

December 2015

US Army Corps of Engineers®

Central Valley Flood Protection Board — Public Safety and Flood Management — State of California

SAFCA Sacramento Area Flood Control Agency

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Acronyms and Abbreviations

AAHU	Average Annual Habitat Unit
ARCF	American River Common Features
BA	biological assessment
BO	biological opinion
BPWG	Bank Protection Working Group
Corps	U.S. Army Corps of Engineers
County Parks	Sacramento County Department of Parks and Recreation
EIS/EIR	environmental impact statement/environmental impact report
ERDC	Engineer Research and Development Center
ETL	Engineering Technical Letter
GRR	general reevaluation report
GGS	giant garter snake
HEC-EFM	Hydrologic Engineering Center Ecosystem Function Model
HMMAMP	Habitat Mitigation, Monitoring, and Adaptive Management Plan
HSI	Habitat Suitability Index
HU	Habitat Units
IEP	Interagency Ecological Program
IWG	Interagency Working Group
IWM	instream woody material
NMFS	National Marine Fisheries Service
NEMDC	Natomas East Main Drainage Canal
PCE	primary constituent elements
PED	preconstruction engineering and design
RM	river mile
sDPS	southern distinct population segment
SRA	shaded riverine aquatic habitat
SMART	specific, measurable, attainable, realistic, and timely
SMWSE	summer mean water surface elevation
SWIF	System Wide Improvement Framework
TSP	tentatively selected plan
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
VELB	valley elderberry longhorn beetle
WRDA	Water Resources Development Act
WMWSE	winter mean water surface elevation

1.0 INTRODUCTION

1.1 Purpose and Goals

Mitigation for habitat loss is a requirement to compensate for the loss of habitat due to a Federal action. Section 906(d) of the Water Resources Development Act of 1986 states that project alternatives must support recommendations with a specific plan to mitigate fish and wildlife losses. Additionally, the Endangered Species Act states that the purpose of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts.

The primary purpose of vegetation and habitat monitoring is to determine the level of ecological function at each mitigation site as a part of an overall plan to create sites that offset the loss of habitat affected by construction of the proposed project. This Habitat Mitigation Monitoring and Adaptive Management Plan (HMMAMP) describes the types of habitats that will be impacted, the potential impacts caused by the project, and describes the types and amounts of mitigation that would be established in order to compensate for habitat losses. This plan also establishes a framework for the creation of mitigation sites and methods to evaluate the success of these sites in order to ensure that the goals and requirements of the project's required mitigation are accomplished.

The goal of the HMMAMP is to ensure that the conservation values of the mitigation sites are maintained in good condition in perpetuity. The plan's biological goals are to: (1) preserve the abundance and diversity of native species (particularly special status species) in the established habitats; (2) protect the habitat features from the effects of indiscriminate land use that may adversely impact mitigation habitats; and (3) restore any adverse condition within the mitigation habitat areas that may affect or potentially affect these areas. Monitoring would be conducted in a manner compatible with the type of mitigation site. Mitigation requirements are provided by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) through biological opinions (BOs) received through the Endangered Species Act Section 7 consultation process.

The HMMAMP would be implemented by U.S. Army Corps of Engineers (Corps) staff through coordination with USFWS and NMFS. Monitoring would be conducted by qualified biologists from the Corps, USFWS, the Department of Water Resources (DWR), and the Sacramento Area Flood Control Agency (SAFCA) as necessary. Upon completion of the monitoring term as established by USFWS and NMFS, the land would be turned over to the non-Federal sponsor to be maintained in perpetuity.

1.2 Project Description

The Environmental Impact Statement/Environmental Impact Report (EIS/EIR) prepared for the American River Common Features General Reevaluation Report (ARCF GRR) describes the environmental resources in the project area; evaluates the direct, indirect, and cumulative environmental effects of the three alternative plans; and identifies avoidance, minimization, and mitigation measures. Most potential adverse effects would be either short term or would be avoided or reduced using best management practices.

The proposed project is located in and around the city of Sacramento, California. Sacramento is the state capital of California, located at the confluence of the Sacramento and American Rivers in the northern portion of California's Central Valley. The Sacramento Metropolitan area is the fourth largest in California, and includes seven counties and seven incorporated cities.

The purpose of the ARCF GRR is to evaluate alternatives to reduce the flood risk in the greater Sacramento area. The Sacramento Metropolitan area is one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the American or Sacramento Rivers would stress the network of levees protecting the study area to the point that levees could fail. The consequences of such a levee failure would be catastrophic since the inundated area is highly urbanized and the flooding could be up to 20 feet deep.

The ARFC GRR study area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Arcade Creek, and the Magpie Creek Diversion Canal (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento. A vegetation variance is being sought to allow for vegetation to remain on the lower portion of the waterside levee slope. A complete summary of the proposed measures is shown on Table 1.

Table 1. Proposed Measures for the ARCF Project.

Waterway/Location	Extent of Action	Proposed Measures
American River	North and south levees from the Sacramento River upstream for approximately 12 miles.	Construct bank protection or launchable rock trenches
Sacramento River	East levee from the American River to the North Beach Lake levee.	Install cutoff walls Construct bank protection Construct levee raise (Alternative 1 – 7 miles Alternative 2 – 1 mile) Construct geotextile reinforced soil embankment levee near the town of Freeport
NEMDC	East levee from Dry/Robla Creek to the American River.	Install cutoff walls Construct floodwalls
Arcade Creek	North and south levees from NEMDC to Marysville Boulevard.	Install cutoff walls Raise floodwalls Construct geotextile reinforced soil embankment levee in steep areas on the south levee
Magpie Creek Diversion Canal	Downstream of Raley Boulevard	Raise levees
Magpie Creek area	West side of Raley Boulevard	Construct new levee Install floodgates at two properties
Magpie Creek area	East of Raley Boulevard	Acquire property to create a flood detention basin Widen the Raley Boulevard/Magpie Creek bridge and raise the elevation of the roadway Remove the Don Julio Creek culvert
Magpie Creek area	Sacramento Northern Bike Trail	Install culvert beneath bike trail embankment Excavate new channel connecting culvert to Robla Creek Install stone erosion protection in new channel
Sacramento Weir and Bypass	North bypass levee to 1,500 feet north.	Widen the Sacramento Weir and Bypass by approximately 1,500 feet Construct a new section of weir and levee remove the existing Sacramento Bypass north levee

The Recommended Plan for the ARCF project is to Improve Levees and Widen the Sacramento Weir and Bypass. This alternative would include widening the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass and alleviate the need for most of the raises along the Sacramento River downstream of the bypass. This alternative would also include minimal levee raises along the Sacramento River. In order to reduce the extent of levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The levees along the American River, NEMDC, Arcade, and Magpie Creeks, would be improved to address identified seepage, stability, erosion, and height concerns. The levees along the Sacramento River would be improved to address identified seepage, stability, erosion, and a small amount of levee raising. Due to hydraulic, real estate, and environmental constraints within the study area, the majority of the levees would be fixed in place.

The Recommended Plan is the least environmentally damaging practicable alternative under the Clean Water Act and the environmentally preferable alternative under NEPA. This is mainly because it results in less riparian habitat removal along the Sacramento River.

1.3 Proposed Flood Risk Management Measures

1.3.1 Bank Protection

This measure consists of placing rock revetment on the river's bank, and in some locations on the levee slope, to prevent erosion (Figure 1). When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and loose materials would be removed. In most cases, large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked on site.

1.3.2 Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it (Figure 1). All launchable rock trenches would be constructed outside of the natural river channel. The vegetation would be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench would be excavated at the toe of the existing levee. The bottom of the trench would be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench would be filled with revetment that would be imported from an offsite location. After rock placement the trench would be covered with a minimum of 3 feet of the stockpiled soil to allow for planting over the trench. Some vegetation could be permitted over the trench if planted outside the specified vegetation free zone required by the Engineering Technical Letter (ETL) 1110-2-583. This vegetation would likely be limited to native grasses, shrubs, and trees with shallow root systems to ensure that they do not limit the functionality of the trench during a flood event.

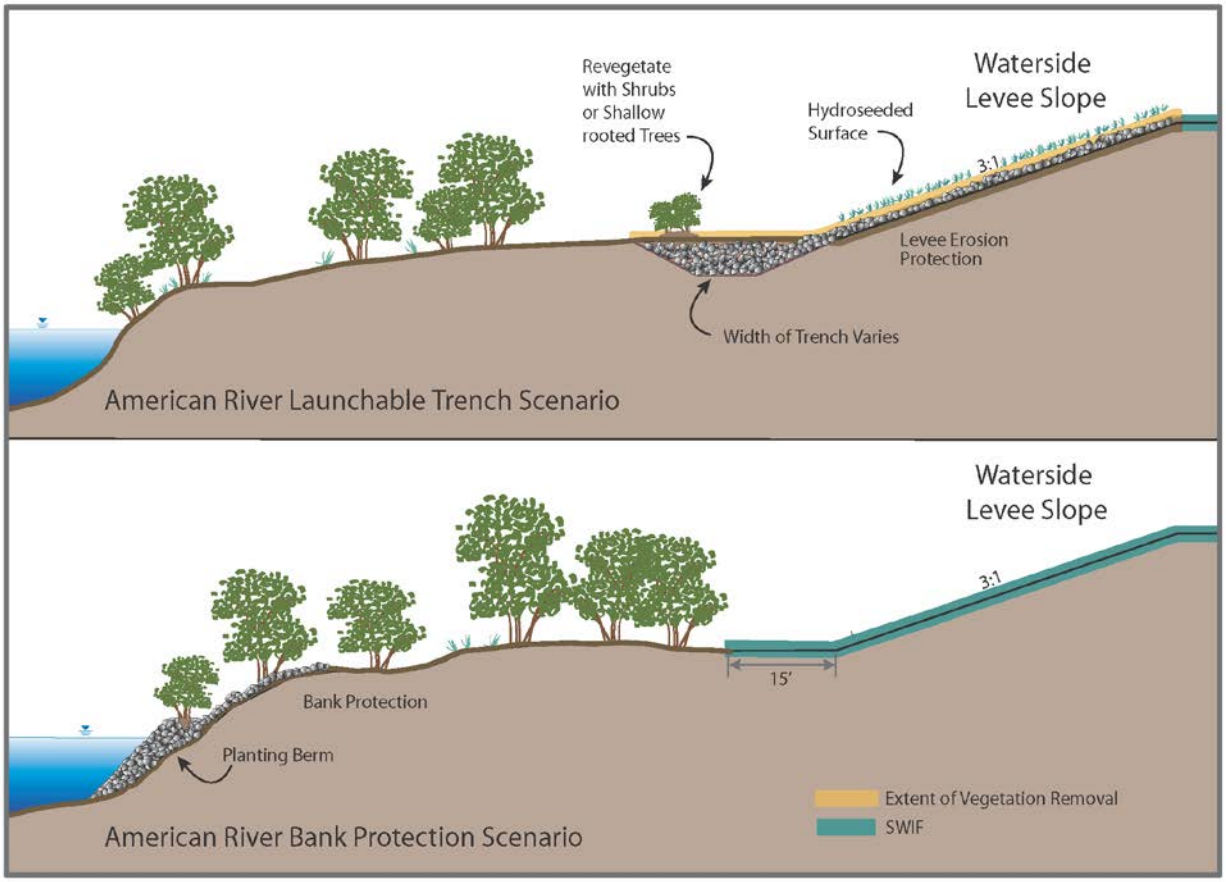

Figure 1. Bank Protection and Launchable Rock Trench Typical Design for American River.

1.3.3 Levee Geometry

Where the existing levee cross section does not meet the levee design requirements, slope flattening, crown widening, and/or a levee raise is required. This improvement measure addresses problems with slope stability, geometry, overtopping, and levee toe and crest access and maintenance. To begin levee embankment grading, the area would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. The existing levee centerline would be shifted landward

where necessary in order to meet Corps standard levee footprint requirements. The levee crown patrol road would be re-established and a new toe access corridor would be added 10 feet landward of the levee toe in areas where levee raises are required.

1.3.4 Cutoff Walls

To address seepage concerns, a cutoff wall would be constructed through the levee crown (Figure 2). A cutoff wall is a water resistant barrier that is constructed vertically into the levee and is designed to prevent through and underseepage in the levee. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 80 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.

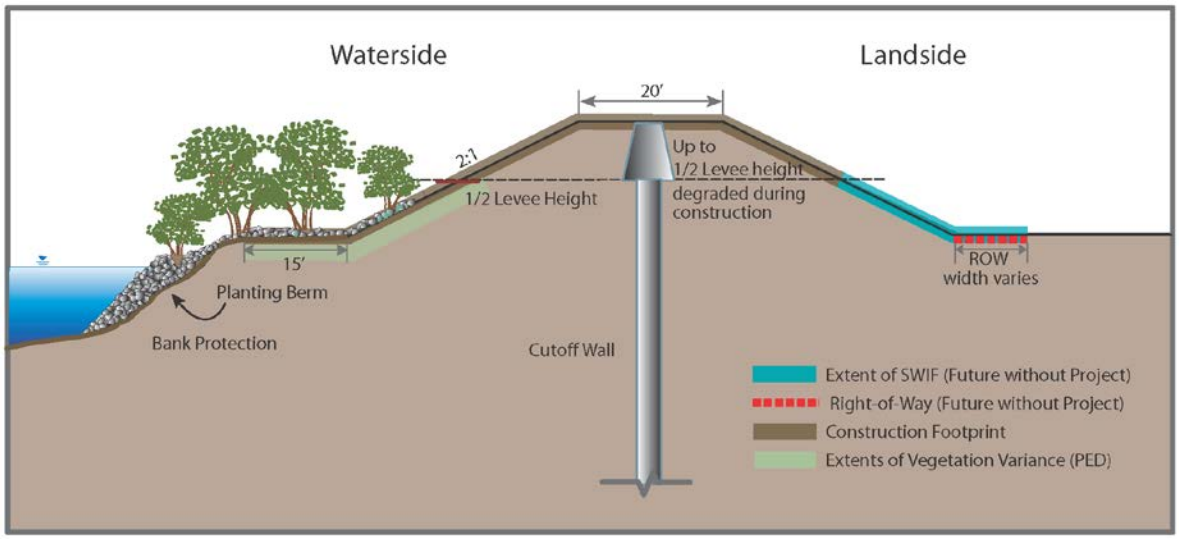

Figure 2. Fix-in-place with Cutoff Wall and No Levee Raise on the Sacramento River.

1.4 Types of Habitats Impacted

A variety of different habitat types occur within the study area including riparian habitat, shaded riverine aquatic habitat, oak woodland, ruderal herbaceous grasslands, and wetlands. These habitats are briefly described below.

1.4.1 Giant Garter Snake Upland Habitat

The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of: (1) adequate water during the snake's active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat; (3) upland habitat for basking, cover, and retreat sites; and (4) higher elevation uplands for cover and refuge from flood waters.

Disturbed soil surfaces such as levee slopes should be hydroseeded to prevent erosion and restore upland habitat for giant garter snake. USFWS recommends a mix of at least 20 to 40 percent native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.); 2 to 10 percent native forbs; 5 percent rose clover (*Trifolium hirtum*); and 5 percent alfalfa (*Medicago sativa*). Approximately 40 to 68 percent of the mixture may be non-aggressive European annual grasses such as wild oats (*Avena sativa*), wheat (*Triticum* ssp.), and barley (*Hordeum vulgare*). The Corps will not include aggressive non-native grasses, such as perennial ryegrass (*Lolium perenne*), cheatgrass (*Bromus tectorum*), fescue (*Festuca* spp.), giant reed (*Arundo donax*), medusa-head (*Taeniatherum caput-medusae*), or Pampas grass (*Cortaderia selloana*) in the hydroseed mix.

1.4.2 Shaded Riverine Aquatic Habitat

Shaded Riverine Aquatic (SRA) habitat is defined as the near shore aquatic area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of this valuable cover type include: (1) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water; and (2) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, as well as variable depths, velocities, and currents. SRA occurs throughout the study area along the riverbanks and levees and is contained within the other identified habitat types in these areas.

1.4.3 Valley Foothill Riparian Habitat

Most valley foothill riparian habitat in the study area (hereafter referred to as “riparian habitat”) occurs along the American and Sacramento Rivers, but smaller riparian areas are found at all of the levees in the study area. The overstory of the riparian habitat consists of mature, well-established trees: Fremont cottonwood (*Populus fremontii)*, valley oak (*Quercus lobata*), black willow (*Salix gooddingii*), and box elder (*Acer negundo var. californicum*). During the surveys, Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*) were also observed. The shrub layer consists of smaller trees and shrubs; representative species observed were poison oak

(*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and California blackberry (*Rubus ursinus*). Elderberry shrubs (*Sambucus mexicana*), the host plant of the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), which is Federally listed as threatened, were observed in the riparian habitat along the American and Sacramento Rivers.

1.4.4 Valley Elderberry Longhorn Beetle Habitat

The valley elderberry longhorn beetle (beetle) is completely dependent on its host plant, elderberry (*Sambucus* spp.), which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley. These forests consist of several canopy layers with a dense undergrowth (Katibah, 1983). Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), willows (Salix spp.), and valley oak (*Quercus lobata*) are common upper canopy species. The shrub layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and California blackberry (*Rubus ursinus*). Studies have found that the beetle is more abundant in dense native plant communities with a mature overstory and a mixed understory.

1.4.5 Oak Woodland

Valley oak woodland is dominated with valley oak, interior live oak, box elder, white alder, Oregon ash, and black walnut. Shrubs in this habitat type include California grape (*Vitis californica*), California blackberry (*Rubus ursinus*), and blue elderberry (*Sambucus cerulea*). Oak woodlands are typically found on higher or upland portions of the study area than the riparian habitat discussed above.

1.4.6 Green Sturgeon Benthic Habitat

Little is known about juvenile green sturgeon freshwater rearing. Green sturgeon are presumed to be generalist, opportunistic benthic feeders. Benthic substrate needs to include abundant prey items within estuarine habitats and soft bottom substrates for juvenile, subadult, and adult life stages. Prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries primarily consist of benthic invertebrates and fishes, including crangonid shrimp, burrowing thalassinidean shrimp (particularly the burrowing ghost shrimp), amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. The benthic substrate should include sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants (e.g., selenium, PAHs, and pesticides) that can cause adverse effects on all life stages of green sturgeon.

1.5 Environmental Baseline

The ARCF action area includes the mainstem Sacramento River from Freeport (river mile [RM] 46) in the Delta upstream to the American River confluence (RM 60). The region also includes the lower American River from the confluence with the Sacramento River upstream to RM 11, NEMDC, Arcade Creek, Dry/Robla Creeks and Magpie Creek.

Downstream from the American River confluence, the Sacramento River is moderately sinuous (average sinuosity of 1.3), with the channel confined on both sides by man-made levees enhanced by decades of man-made additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). Channel migration is similarly limited along the lower American River because of man-made levees and regulated flows from Folsom Dam.

The natural banks and adjacent floodplains of both rivers are composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the rivers, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass (RM 63). Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

NEMDC is an approximately 13.3-mile, human-made, partially leveed drainage channel that provides drainage from Sankey Road and connects streams of the American Basin (Dry, Robla, and Arcade Creeks) to the American River. South of the confluence with Arcade Creek, the east and west levees of NEMDC are dominated by wild oats grasslands while the channel is characterized by Fremont cottonwood forest, with smaller amounts of valley oak woodland, smart-weed cocklebur patches, and perennial rye grass fields.

The approximately 16.2-mile-long channel of Arcade Creek extends east-to-west from Orangevale to the American River, via NEMDC. The north and south levees are dominated by wild oats grasslands. Valley oak woodland is the main riparian vegetation type along Arcade Creek, but Fremont cottonwood forest occurs in small patches along the easternmost reach of Arcade Creek near NEMDC. Hardstem bulrush marsh is found within Arcade Creek near Norwood Avenue while water primrose wetlands are predominant within the channel of Arcade Creek from approximately the confluence with NEMDC to Norwood Avenue. East of Norwood Avenue, the creek channel becomes narrower, and

dominated by a shaded canopy of valley oak woodland.

The environmental baseline in the ARCF GRR action area includes the sites completed under the Water Resources Development Act (WRDA) 1996 and WRDA 1999 authorizations. The WRDA 1996 construction included installing slurry walls in the American River levees to address seepage and slope stability concerns. The WRDA 1999 construction included shape and slope improvements to specific reaches of the American River levee system and some segments of the Sacramento River levees.

1.6 Potential Project Impacts

A vegetation variance is being sought by the Sacramento District to comply with ETL 1110-2-583 on the waterside of the levee. The vegetation variance request requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained if the vegetation were to remain in place. This would allow most of the trees on the lower one half of the waterside slope to remain in place, reducing the impacts to vegetation and wildlife. In addition, a System Wide Improvement Framework (SWIF) agreement with the non-Federal sponsor would allow vegetation and encroachment compliance on the landside of the levee to be deferred and addressed by the local maintaining agency at a later time. This would be a beneficial effect to vegetation and wildlife, as standard long-term Operations and Maintenance (O&M) of the levee system in the study area would otherwise require the immediate removal of all vegetation. Vegetation impacts throughout the project area would occur in the proposed construction footprint.

Infestation of invasive weeds has an influence on hydraulic roughness during high-flow events, decreases the capacity of the floodway, and adversely affects bank erosion and sedimentation processes. The Corps would remove the noxious weeds from the various plant communities prior to construction. For each of the action alternatives, direct effects to stands of grassland habitat with invasive plants would result from clearing and grubbing and rock placement activities once levee improvements and construction begin. The total number of acres of grassland affected would be refined during the design phase.

The estimated impacts for the habitats discussed above and special-status species impacts as established in the BOs are shown below on Table 2.

Table 2. Impacts for ARCF GRR Recommended Plan.

	GGS Upland ***	GGS Aquatic ***	Riparian/ Western Yellow-billed Cuckoo **	SRA Habitat ***	Elderberry Shrubs **	Vernal Pools **	Delta Smelt Spawning **	Shallow Water **	Oak Woodland *	Wetlands
American River North										
Reach A (American River)			22 acres	19,000 LF	284 stems					
Reach B (American River)			0.5 acre		183 stems					0.05 acre
Reach C (American River & NEMDC)									1 acre	
Reach D (Arcade Creek)			6 acres							
Reach E (Arcade Creek)			4.5 acres							
Reach F (NEMDC)									1 acre	
Reach G (Dry/ Robla Creek)	*No Measures Proposed*									
Reach H (Dry/ Robla Creek)	*No Measures Proposed*									
Reach I (Magpie Creek)						0.25 acre				
American River South										
Reach A (American River)			37 acres	6,850 LF	1,437 stems					0.35 acre
Reach B (American River)			2 acres	875 LF	1,144 stems					

	GGS Upland ***	GGS Aquatic ***	Riparian/ Western Yellow-billed Cuckoo **	SRA Habitat ***	Elderberry Shrubs **	Vernal Pools **	Delta Smelt Spawning **	Shallow Water **	Oak Woodland *	Wetlands
Reach C (American River)				3,800 LF	81 stems					
Reach D (Sacramento River)			10.6 acres	9,200 LF	163 stems		10 acres	5 acre		
Reach E (Sacramento River)			6.2 acres	8,850 LF			6 acres	4 acre		
Reach F (Sacramento River)			41.6 acres	21,100 LF			12 acres	4 acre		
Reach G (Sacramento River)			12.2 acres	11,150 LF			4 acres	1 acre		
Sacramento Weir and Bypass	30 acres	15 acres	8 acres	1,500 LF						See GGS Aquatic
TOTAL (Alt 2)	**30 acres**	**15 acres**	**150.6 acres**	**82,325 LF**	**3,292 stems**	**0.25 acre**	**32 acres**	**14 acre**	**2 acre**	**0.40 acre**

*State Listed **Federal Listed ***State and Federal Listed

1.7 Habitat Evaluation

For the purposes of evaluating the impacts of the ARCF GRR on fish and wildlife resources in the project area, with a reliance on existing information in the spirit of SMART Planning, the Habitat Evaluation Procedures (HEP) for the *American River Watershed Investigation, Common Features Modifications, Mayhew Drain Site Project* were relied upon as a reference baseline. The HEP for the Mayhew Drain Site Project was conducted in 2005 to quantify anticipated impacts to fish and wildlife and their habitats, and to determine mitigation needs for the project. This HEP was selected for the ARCF GRR because the Mayhew Drain Site is located within the overall study area for the ARCF GRR, and the habitat type and value at the Mayhew site is consistent with the habitat that occurs throughout the ARCF GRR project area.

The HEP provided information for two general types of wildlife habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same areas at future points in time. By combining the two types of comparisons, the impacts of proposed project on wildlife habitat were quantified and compensation needs (in terms of acreage) for the project were determined. The assumption that habitat for selected wildlife species or communities can be numerically described by a model produces a Habitat Suitability Index (HSI). The HSI, a value from 0.0 to 1.0, provides a measure of habitat quality for a sample area in terms of suitability for the particular species or community being evaluated.

For the Mayhew Drain project, the Northern oriole Riparian woodland model was used because it best suited the habitat type in the project area. The quantity part of the formula is any measure of area which is appropriately sized for the study. The product of these two measures is comparable to "habitat value" which equals habitat quantity multiplied by habitat quality. This formula is expressed as a Habitat Unit (HU).

Habitat Type x Habitat Area = Habitat Value

The Average Annual Habitat Units (AAHUs) over the life of the project can then used to determine mitigation needs. The model, variables measured and data collection methods used for the Mayhew Drain Project are shown below in Table 3. For the ARCF GRR, data was estimated visually and using google earth.

Table 3. HSI model, Variables, and Data Collection Methods.

HSI Model and Cover-Type	HSI Model Variables	Data Collection Method
Northern oriole Riparian Woodland	V1 – Average height of deciduous tree canopy	Visual estimation
	V2- Percent deciduous tree crown cover	Densiometer along belt transects
	V3 – Stand width	Estimated using aerial photos

Since it is not possible to empirically determine habitat quality and quantity for future years, future HSI values were projected. This was accomplished by increasing or decreasing specific baseline variables and/or HSI values for each evaluation element for the Northern oriole based on best professional knowledge of performance at other mitigation sites, literature on plant growth, and conditions at reference sites. To predict changes in the HSI for each future scenario, it was necessary to make assumptions regarding baseline and future values within project impact and compensation areas. The assumptions made for the ARCF GRR with project can be seen in Table 4 and without project can be seen in Table 5 below.

Table 4. HSI Variables for the ARCF GRR Based on Habitat Values.

HEP - FUTURE WITH-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY1	20	25%	2	0.60	1.00	1.00	0.84
TY2	10	25%	2	0.30	1.00	1.00	0.67
TY25	20	75%	2	0.60	0.75	1.00	0.77
TY50	35	75%	2	1.00	0.75	1.00	0.91
HSI = (V1*V2*V3)^1/3						Average	0.80

Table 5. HSI Variables for the ARCF Without Project Based on Habitat Values.

HEP - FUTURE WITHOUT-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY1	35	75%	2	1.00	0.75	1.00	0.91
TY2	35	75%	2	1.00	0.75	1.00	0.91
TY25	35	75%	2	1.00	0.75	1.00	0.91
TY50	35	75%	2	1.00	0.75	1.00	0.91
HSI = (V1*V2*V3)^1/3						Average	0.91

The HSI value of 0.80 in Table 4 results from a temporal loss of habitat value and function from the removal of existing mature riparian habitat. This is due to the lower values given to mitigation plantings during the establishment period. The ARCF GRR proposes to implement riparian habitat mitigation at a 2:1 ratio. A 2:1 mitigation ratio is a reasonable requirement for implementation of mitigation for this habitat type, because the proposed project will decrease the connectivity of existing habitat along the Sacramento River system. Additionally, temporal loss of onsite habitat results in a reduction in value and function of the new vegetation within the mitigation areas as it grows to maturity. This also accounts for the loss of other services that riparian vegetation provides, including:

- An essential food source for fish and wildlife, including ESA species;

- Aquatic resting and refugia for resident and migratory fish species;
- Large woody debris recruitment;
- Nesting and rearing habitat for terrestrial wildlife species;
- Nutrients for the ecological system;
- Shade for the river which maintains water temperatures and dissolved oxygen concentrations; and,
- Increased habitat value for VELB.

The above-listed functions and services associated with a newly created acre of habitat are usually expected to be less than those associated with natural habitat. As a result the 2:1 mitigation ratio is appropriate to compensate for the loss of mature riparian habitats.

To determine whether the proposed mitigation amounts were cost effective, a Cost Effective /Incremental Cost Analysis (CE/ICA) was conducted. The CE/ICA report is included with this document as Appendix A. The Mayhew HEP and the Northern oriole HSI model variables were referenced to establish habitat values for the CE/ICA. The cost for mitigation was estimated for five scenarios for the purposes of the CE/ICA for both alternatives. These scenarios included: (1) maximized on- and off-site habitat creation; (2) maximizing the use of credits at a local mitigation bank; (3) a combination of on-site, off-site, and a mitigation bank at a 2:1 ratio; (4) a combination of on-site, off-site, and a mitigation bank at a 1:1 ratio; and (5) a combination of on-site, off-site, and a mitigation bank at a 3:1 ratio. Per the discussion above and the results shown in Table 4, the loss in ecological value associated with on-/off-site mitigation was reduced to an overall 0.8 habitat value. The Recommended Plan is the Alternative 2 Combination Plan with a 2:1 ratio, because it is the smallest mitigation proposal that accomplishes the terms and conditions of the Biological Opinions, and the CE/ICA determined that it was a cost effective plan.

1.8 Proposed Mitigation Measures

The preparation of mitigation plans, including objectives, plan design, determination of success criteria, and monitoring needs would be coordinated with Federal and State resource agencies to the greatest extent practicable. Mitigation objectives are specific actions to be taken to avoid and minimize adverse effects, such as Best Management Practices, compliance with Federal and State regulatory laws, and environmental commitments. Mitigation objectives include the identification of specific amounts of mitigation required to compensate for remaining unavoidable losses.

Items below present a summary of environmental commitments that the Corps would implement as part of the ARCF project to mitigate by avoiding and minimizing impacts and to meet the requirements, terms and conditions specified in the BOs.

- A vegetation variance is being sought by the Sacramento District to comply with ETL 1110-2-583 in order to exempting the Sacramento River and East Side Tributaries from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The ARCF GRR will be complying with the ETL on landside of the levee under a SWIF. This approval process is in alignment with the Corps' Levee Safety Program's goal of maintaining public safety as the primary objective and assuring application of consistent and well documented approaches. As a result, vegetation removed under the ARCF GRR would be limited to the footprint necessary in order to construct the proposed measures. Disturbance or removal of trees or larger woody vegetation would be replaced with native riparian species, outside of the vegetation free zone, as established in the ETL.
- The Corps would use a rock soil mixture to facilitate re-vegetation of the proposed project area. A (70:30) rock to soil ratio would be implemented. The soil-rock mixture would be placed on top of the of the rock revetment to allow native riparian vegetation to be planted to ensure that SRA habitat lost is replaced or enhanced. Alternatively, a rock lined soil trench approach could be taken.
- Vegetation removal, particularly tree removal, would be conducted between September 16 and January 31, to the extent feasible, to minimize potential loss of active bird nests and bat maternity roosts.
- Construction would be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area, approximately May or June through October, depending on the species present on a site-specific basis. If construction needs to extend into the timeframe that species are present, the Corps would coordinate with the resource agencies.

In addition to the mitigation measures described above, the Corps would implement compensatory mitigation, as described below.

The mitigation acreages for ARCF GRR were calculated using a combination of site surveys and aerial photography from Google Earth to determine where the project footprint impacted different habitat types. The habitat types included: riparian, SRA, giant garter snake (GGS), valley elderberry longhorn beetle (VELB), vernal pools, and Delta smelt shallow water. The acreages of each impacted habitat type were then broken up by reach.

Table 7 describes the types and amounts of habitat that would be potentially impacted by the project, the duration of the impacts, the amount of mitigation in total acreage per the USFWS and NMFS BOs and the recommendations of the USFWS Coordination Act Report, and projected costs as estimated according to existing mitigation prices.

Costs are displayed showing the difference between the estimate for on site mitigation or mitigation at a bank. Currently, permanent impacts to GGS uplands and aquatic habitat, vernal pools, Delta smelt spawning and shallow water habitat, and wetlands are proposed to occur at a mitigation bank. Riparian, SRA, elderberry, oak woodland, and green sturgeon are proposed to occur on site.

Table 7. Environmental Effects and Proposed Mitigation for the Recommended Plan.

Habitat Type	Potential Impacts	Duration of Impact	Mitigation (Acres/Linear Feet)	Cost at Mitigation Bank	Cost On- or Off-Site within Study Area
GGS Uplands	30 acres 75 acres	Permanent Temporary	90 acres 75 acres	$4,500,000	N/A*
GGS Aquatic	15 acres	Permanent	45 acres	$2,250,000	
Riparian	150.6 acres	Permanent	301.2 acres		$16,566,000
Shaded Riverine Aquatic Habitat	82,325 lf	Permanent	82,325 lf		$19,020,000**
Elderberry Shrubs	3,292 stems	Permanent	1,715.6 credits 70.89 acres		$6,026,000
Vernal Pools	0.25 acre	Permanent	0.5 acre	$138,000	---
Green Sturgeon	20 acres	Permanent	Restore acres, monitoring, and fish passage features		$16,259,000
Delta Smelt Spawning Habitat	34 acres	Permanent	34 acres	$4,160,000	
Shallow Water Habitat (Delta Smelt)	14 acres	Permanent	42 acres	$5,460,000	
Oak Woodland	2 acres	Permanent	4 acres		$200,000
Wetlands	0.4 acres	Permanent	0.8 acres	$130,000	---
Sub-Total				**$16,775,000**	**$58,341,000**

* 75 acres of temporary effects to GGS habitat from the relocation of the Sacramento Bypass toe drain would consist of standard site restoration erosion control features such as hydroseeding. This is contained within construction costs and is not considered a mitigation cost. It is presented in this plan due to monitoring requirements, as described in Section 2.1 below.
** SRA habitat mitigation is provided in the project's cost estimate as a separate construction cost rather than a mitigation cost, since it is a feature of the bank protection designs and would be included as a part of the construction contract. The cost is displayed under the Fish and Wildlife Facilities account as "Construction" costs and is estimated to be approximately $231 per linear foot.

1.9 Location of Mitigation and Compensation Sites

WRDA 2007 Section 2036(c) directs the Corps to, where appropriate, first consider the use of an approved mitigation bank to compensate for wetland impacts. Credits for additional habitat types, including riparian zones, is also permitted, if credits are available and the use of them is deemed appropriate. As discussed above, the Corps proposes to purchase credits at a mitigation bank for permanent impacts to GGS uplands and aquatic habitat, vernal pools, Delta smelt spawning and shallow water habitat, and wetlands. As a result, these habitat types are not discussed further in this document, because the mitigation bank would be responsible for all site establishment, monitoring, adaptive management measures, and for achieving mitigation success.

The onsite mitigation proposed for the ARCF GRR consists of riparian, SRA, oak woodland, elderberry habitats, all of which are components of the riparian habitat corridor along the Sacramento River. Section 4.a.3 of WRDA 2007 Section 2036(c) implementation guidance states that credits for riparian habitat may be purchased at a mitigation bank, but are not required to be as a first order preference. All of these habitats contribute to the riparian corridor of the Sacramento and American Rivers. As described in Section 1.7 above, the removal of 268 acres of riparian, SRA, oak woodland, and elderberry habitat under the ARCF GRR could adversely affect ESA species within the project area if the function and services provided by riparian habitat is relocated away from the Sacramento River and American River riparian corridors. Additionally, credits are not available for the quantity of riparian habitat being removed for the ARCF project and mitigation requirements would likely increase if the projects proposed all mitigation offsite. As a result, it is appropriate to select on- and off-site mitigation within the study area for these habitat types rather than purchasing credits at a mitigation bank.

Upon completion of construction, sites with preexisting habitat would be restored to pre-construction conditions, where feasible. Sites compatible with on-site mitigation such as the 75 acres of upland GGS habitat and 82,325 linear feet of SRA habitat would be restored in place. Riparian habitat, elderberry compensation, and oak woodland habitat would be mitigated on-and off-site within the project area to the greatest extent practicable. The specific locations for offsite mitigation along the American River would be coordinated with the Sacramento County Department of Parks and Recreation (County Parks) during the design phase of the project.

On-site mitigative features are proposed as part of the bank protection construction to mitigate for impacts to SRA habitat. These features would be designed on a site-specific basis during the design phase and would include a planting berm as shown on Figure 1 above. Riparian vegetation installed on the planting berm would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), and valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo var. californicum*); shrub-scrub species such as elderberry (*Sambucus* spp.), redbud (*Cercis canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitus californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus*

carinatus), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.).

The Corps is committed to implementing project conservation and mitigation as detailed in the BOs, however site selection and real estate coordination has not occurred at this time for onsite and offsite mitigation and would be determined during the design phase of the project. This HMMAMP will accompany the final EIS/EIR, and will be updated throughout the design phase as detailed design efforts allow for finalizing the mitigation plans. The HMMAMP will be coordinated with the Services during the design phase and updated as needed. The Corps would go through the following process in order to determine sites for implementing compensation for impacts to riparian habitat, including VELB compensation sites:

- The Corps would assess opportunities to purchase credits at a mitigation bank as a first option.
- The Corps would assess opportunities for on-site compensation to replace the habitat function and services that would be impacted within the study area. This assessment would include considering site-specific conditions, including whether the site is protected from future erosion by bank protection, or remains at risk of berm and vegetation loss due to the launchable rock trench.
- If on-site compensation is not possible, the Corps would evaluate opportunities to expand existing Corps mitigation sites within the American River Parkway, such as the River Bend Park mitigation site.
- If the Corps requires additional lands for compensation, other opportunities within the American River Parkway would be assessed in coordination with County Parks, USFWS, NMFS, and the American River Flood Control District.

Although much of the mitigation would occur on-site, for riparian, SRA, elderberries, oak woodland, and green sturgeon benthic habitat, some mitigation would be compensated for through the purchase of credits from approved mitigation or conservation banks. Mitigation bank credits are available within the project watershed for riparian habitat, elderberry shrubs, and oak woodland on the Sacramento River.

1.10 Compensation Timing

Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to targeted species from designated compensation sites. For example, compensation time would be the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment to provide habitat for fish species. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to

recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] § 2283). Additionally, ER 1105-2-100, Appendix C states that authorized ecological resource mitigation activities and features should occur before construction of the project, concurrent with the acquisition of lands, or concurrent with the physical construction of the project.

2.0 Mitigation and Management Strategy

The purpose of this HMMAMP is to present conceptual mitigation proposals, establish performance standards, and outline adaptive management tasks and costs. Conceptual mitigation proposals are based on the habitat impacts described above. Performance standards are established below for each habitat type, and monitoring would be conducted with the intent of meeting those standards. Over the 3 to 5 year site establishment period, improvements in field and analytic techniques may lead to changes in the monitoring methodology. While this vegetation and habitat monitoring methodology protocol builds on past years' experiences, it is likely that other opportunities for improvement will be identified in the future that should be incorporated into the protocol. In the future, there may be a determination that specific performance standards have been met and that associated monitoring tasks could cease. Similarly, it could be determined that a monitoring task was not returning useful information, and therefore not worth the expense of continuation.

Monitoring must be closely integrated with adaptive management. The application of adaptive management principles to mitigation projects by modifying mitigation objectives during the monitoring period is a reasonable and foreseeable alternative. Unrealistic expectations or inaccurate assumptions can lead to the establishment of inappropriate project objectives. It is possible that a decision to modify success criteria might be reached based on results after several years of monitoring. In addition to modifying project objectives, there is a potential for changes to or adaptation of management actions based on monitoring results. The purpose of adaptive management is to enable strategic changes to improve the mitigation sites to functioning habitat.

Vegetation and habitat variable monitoring and data collection would occur annually by a qualified biologist, botanist, or habitat restoration specialist using the protocol described below and shown in Table 8 to determine the success of riparian revegetation plantings and overall habitat development.

The project's compensation objective is to directly mitigate for the loss of habitat value that results from construction impacts. This plan focuses on establishing successful and diverse habitats that provide an ecological value consistent with mature existing habitat conditions in the study area. The specific habitats focused on within the sections below are the habitats that would be created by the Corps on-site or off-site, including GGS upland habitat, habitat for VELB, and habitat for green sturgeon. In addition, mitigation sites would be created which present a combination of riparian, oak woodland, and SRA habitats, which are highly related and provide value to a number of listed species, including VELB, Western yellow-billed cuckoo, and fish species.

Table 8. Summary of On-site Habitat Types and Monitoring Recommendations.

Habitat	Monitoring Variable	Method to be Used	Spacing/number of Samples	Data to be Collected	Success Criteria
GGS Upland	Total Herbaceous Species Cover	Visual estimates of cover within 1 square meter (m^2) sampling quadrats	One quadrat randomly located in each planting zone	Herbaceous species composition, total cover, and observation of GGS	Meeting 75% native species present and 95% overall cover onsite within 1 year
Riparian Habitat	Vegetation Species Cover (Ground and Canopy)	Line-intercept estimates of ground and overhead canopy cover with visual estimates of vigor	Monitoring transects; number of transects and spacing dependent on site length	Woody species composition, growth, and natural recruitment	75% vegetative cover after 5 years
SRA Habitat	Shaded Riverine Aquatic (SRA) Cover	Line-intercept estimates of canopy cover overhanging the river	Transect parallel to the shoreline along summer mean water surface elevation (SMWSE); length of transect dependent on site length	Woody species composition and percentage of canopy cover overhanging river (shade)	75% vegetative cover after 5 years
Elderberry	Elderberry and Native Vegetation Health and Vigor (VELB habitat)	Visual assessment of vegetation health and vigor; census of VELB and exit holes	Total census of elderberry shrubs and native vegetation, census of VELB and exit holes	Total survival of elderberry and native vegetation, census of VELB and exit holes	Survivability of 60% shrubs*; 75% vegetative cover after 5 years
Oak Woodland Habitat	Woody Species Overhead Canopy Cover	Line-intercept estimates of overhead canopy cover and visual estimates of vigor	Monitoring transects; number of transects and spacing dependent on site length	Woody species composition, growth, and natural recruitment	75% vegetative cover after 5 years
Green Sturgeon Benthic Habitat	In-water slope and substrate	Substrate sampling and visual assessment of slope/substrate conditions.	Monitoring the width and depth of the river at regular intervals throughout the project area.	Substrate content, percentage of fines, slope defining measurements.	Slope (H:V) of 2:1 with substrate at average of 0-10 inches.

*60% survivability is the established survival criteria for elderberry shrubs in the USFWS Conservation Guidelines for the Valley Elderberry Longhorn Beetle (1999).

2.1 GGS Uplands Mitigation

2.1.1 Objectives and Implementation Strategy

The primary objective of upland habitat mitigation is to restore upland refugia habitat for the giant garter snake (*Thamnophis gigas*) (GGS) in a manner consistent with adjacent equitable habitat. Upland refugia habitat is generally considered native grasslands with space appropriate for basking,

cover, and retreat sites for GGS. Upland refugia is also considered higher elevation areas for cover and refuge from flood waters. Upland refugia restoration would take place on grasslands adjacent to GGS wetland habitat as well as levee slopes for higher elevation refuge. These conservation and restoration measures are taken from the Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat (USFWS, 1997).

Restoring GGS habitat includes minimizing the potential impacts of project activities to the existing habitat. Use of silt fencing and protective mats to prevent runoff and reduce the possibility of individual GGS from entering the project area is recommended. Designation of environmentally sensitive areas and providing worker awareness training is also recommended. Construction activities should be 200 feet from GGS aquatic habitat, and should occur between May 1 and October 1. Project areas should be surveyed for GGS 24 hours prior to ground disturbing activities, and surveys should be repeated if a lapse in construction activity of two weeks or greater has occurred. If aquatic habitat must be removed as part of the construction activities, any dewatering would occur after April 15 and dewatered habitat would be left dry for at least 15 consecutive days.

Upon the completion of construction, the area would be regraded to the preexisting contour. Upland refugia would be hydroseeded with native grasses. USFWS recommends a mix of native grass seeds such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Additional native plant seeds consistent with adjacent habitat may be used at the discretion of USFWS. Permanent irrigation would not need to be established for this habitat type, however the site would require periodic watering in drought conditions.

2.1.2 Success Criteria

Monitoring of GGS upland habitat would focus on: (1) the percentage cover of native species, and (2) the percentage of overall vegetative cover. The restored habitat would be considered successful if 75 percent of the vegetation on site consists of native species. Additionally, the overall vegetative cover on site must be 95 percent.

2.1.3 Mitigation Monitoring Strategy

Restored habitat should be monitored for one year following implementation. Surveys would involve a general overview of the condition of the site, an estimate of ground cover, and a passive (observation only) GGS survey to determine potential habitat use. A ground cover survey would occur to determine the ground cover percent of native and non-native species. Ground cover surveys, if determined by the Corps to be needed to evaluate the success of the mitigation area, would involve the use of a one square meter quadrat placed haphazardly in the restored areas. Once placed, all herbaceous vegetation within the quadrat would be recorded to species level. The percent of cover by native and non-native species would be determined in addition to the percent of total cover.

Monitoring reports documenting the restoration effort would be submitted to USFWS upon completion of the restoration implementation and one year from restoration implementation. Monitoring reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, plantings (if specified), and justification of any substitutions to USFWS recommended guidelines. Monitoring reports would also include recommendations for additional remedial actions, if necessary.

2.1.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent cover of GGS upland habitat.

  Trigger: 95% cover is not achieved within one year.

- Desired Outcome: Decrease percent of non-native invasive species that outcompete natives.

  Trigger: Non-native percent cover of more than 25% within one year.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for GGS upland habitat in order to adaptively manage the site for success.

- If the performance criteria are not met within one year, additional monitoring would be implemented in order to ensure that the site is successful.
- If non-native species are outcompeting the native species, measures would be implemented to manage presence of invasive species, including mowing and selective removal of non-native species at optimal times for native growth.
- If non-native species are outcompeting the native species and targets for overall cover are not being met, then revegetation of native species would occur.
- Supplemental watering if targets for overall cover are not being met.

2.2 Riparian, Oak Woodland, and Shaded Riverine Aquatic Habitat

2.2.1 Objectives and Implementation Strategy

The primary objective of riparian habitat mitigation is to compensate for impacted habitat types and community types, and reduce erosion rates within the alluvial floodplain. Native plant communities and streambank vegetation would be represented in species density appropriate to the surrounding area. As native vegetation matures, it helps to stabilize stream banks and shorelines; provides food, shelter, shade, and access to adjacent habitats; nursery habitat; pathways for movement by resident and nonresident aquatic, semi-aquatic, and terrestrial organisms; and improves and protects water quality by reducing the amount of sediment and other pollutants such as pesticides, organic materials, and nutrients in surface runoff. The long term goal of riparian mitigation is to provide habitat similar to the habitat that was impacted by project construction. These improvements would enhance nesting opportunities for native bird species, and provides opportunities to satisfy VELB compensation. Oak woodland and SRA habitat are considered components of riparian habitat with specific functions within the ecosystem.

Riparian vegetation would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo var. californicum*); shrub-scrub species such as elderberry (*Sambucus spp.*), redbud (*Cercis Canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitus californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Native trees and shrubs provide a buffer to adjacent urban and industrial land uses, and provide habitat structure for wildlife. Leaf litter and large organic debris would create a variety of microhabitats, increasing species diversity and potentially creating a prey base for larger predators.

SRA habitat consists of riparian trees and shrubs growing on the bank and over-hanging the channel that provide instream shade for the water column adjacent to the bank and deposit insects, organic matter, and nutrients into the river. Shade from the vegetation helps to cool water temperatures in the river. SRA is especially important to juvenile salmonids as they migrate down the river to the sea. Terrestrial insects that live on riparian vegetation fall into the river and provide an important food source for fish. Proposed SRA mitigation would occur on the planting berms designed into the bank protection sites along the American and Sacramento Rivers, as shown in Figures 1 and 2 above. Riparian trees and shrubs would be installed in the planting berms, and existing large trees would be protected in place on the lower waterside slope of the levee. Implementation of this SRA habitat mitigation, including protecting large trees in place, is part of the recommended plan and is reliant on the approval of a vegetation variance, which will be sought during the design phase of the project.

The primary objective of oak woodland mitigation, which would occur in the upland zone of the riparian habitat, is the establishment of mature valley oaks and savannah. Planting would generally occur during the late fall when the plants are dormant and soils are moist. Establishment of woody vegetation would likely require multiple techniques including transplants, cuttings, acorn plantings, and seedlings.

Riparian and oak woodland mitigation sites would likely require fencing to protect establishing habitats from recreation, wildlife, and other potential damages. Sites would have irrigation during the establishment period, and would be watered as needed until the vegetation is established and self-sustaining. Mowing would occur periodically to ensure that weed species do not shade out new plantings.

SRA habitat would be established in planting berms along the river. These sites could require beaver fencing. Sites would have temporary irrigation during the summer, and would be watered as needed until the vegetation is established and self-sustaining. A weed eater would be used to ensure that weed species do not shade out new plantings.

2.2.2 Success Criteria

Monitoring of riparian, oak woodland, and SRA habitats would focus on: (1) the percent cover of native plant species; (2) presence of at least five native species contributing to structural diversity; (3) percentage of canopy cover over water; and (4) decrease percent cover of non-native invasive species that out-compete natives. Additionally, an inventory of wildlife species would be recorded during annual monitoring. Table 9 establishes the percentages required to meet these performance standards. If the habitat is meeting these performance standards, conditions should be consistent enough to estimate community composition and general success of planting efforts. Table XX establishes the percentages required to meet these performance standards.

Table 9. Riparian, Oak Woodland, and SRA Habitat Performance Standards.

Performance Standard	Quantitative Measure
Percent cover of native plant species	75%
Structural diversity	At least five native species contributing to 75% canopy and 50% shrub cover
Percent of canopy cover over water per LF	75%
Percent cover of non-native species	Less than 15%

2.2.3 Mitigation Monitoring Strategy

The following monitoring procedures will provide the information necessary to evaluate the success of riparian, oak woodland, and SRA habitat mitigation. Vegetation sampling will occur annually for the duration of the monitoring period. Sampling will occur during spring months, at the peak of growing season, and will consist of permanent field monitoring plots along one or more transects either perpendicular to the river or parallel to the floodplain slope. Plots will be located randomly within each site, and the distance between plots and along transects will be site specific. Woody species with overhead canopy cover that falls along the vegetation monitoring transect, including those that were planted, have recruited naturally to the site, or were existing at the site prior to planting efforts would be recorded. Monitoring will measure percent cover of native and non-native plant species, structural diversity, and percent cover over water. Photograph stations are also important for documenting vegetation conditions. All plots and photograph stations will be documented via Global Positioning System (GPS) coordinates to maintain consistency throughout the monitoring period.

Additionally, field personnel would visually estimate the height (+/- 2 feet) of each tree and shrub that provides overhead canopy cover. Exact heights are not necessary, since there is no tree height criterion included in this protocol. Rather, approximate tree heights would be visually assessed to monitor tree growth over time. Data collected would include species name, location (feet) along the vegetation monitoring transect (upper extent of canopy and lower extent of canopy), whether the tree or shrub is planted (P), recruited (R), or existing (E), height (feet), and vigor as determined using the metric outlined in Table 10, below.

Table 10. Estimation of General Health and Vigor for Plant Species.

Visual Estimate of Foliage	Vigor Category	Value
81 percent (or greater) of foliage appears to be healthy	Excellent	4
51 to 80 percent of foliage appears to be healthy	Good	3
25 to 50 percent of foliage appears to be healthy	Fair	2
Less than 25 percent of foliage appears to be healthy	Poor	1
Dead	Dead	0

General observations, such as fitness and health of plantings, native plant species recruitment, and signs of drought stress would be noted during the surveys. Additionally, potential soil erosion, flood damage, vandalism and intrusion, trampling, and pest problems would be qualitatively identified. A visual check of irrigation infrastructure and fencing would also be conducted. A general inventory of all wildlife species observed and detected using the mitigation site would be documented. Nesting sites and other signs of wildlife use of the newly created habitat would be recorded.

Monitoring reports documenting the restoration effort would be prepared following the first monitoring period and would continue annually until the site has met the success criteria. Monitoring reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, and plantings (if specified). Monitoring reports would also include recommendations for additional adaptive management measures, if necessary. Following this initial establishment period, any subsequent monitoring activities would be the responsibility of the local maintaining agency, and would focus primarily on general and biological inspections for the purposes of fire management and habitat evaluation.

2.2.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent cover of native riparian habitat.

  Triggers: If 50% cover of native riparian habitat is not achieved within 3 years, or 75% cover of native riparian habitat is not achieved within 5 years.

- Desired Outcome: Maintain appropriate structural diversity of native riparian habitats.

  Trigger: Suitable structural diversity is not achieved, if canopy cover and/or shrub cover does not achieve 50% within 5 years.

- Desired Outcome: Increase percent vegetative cover over water per linear foot to support native fish.

  Trigger: If percent cover over water is not 30% within 3 years, and 50% within 5 years.

- Desired Outcome: Decrease percent cover of non-native invasive species that outcompete natives.

  Trigger: If non-native percent cover is greater than 15% during the monitoring period.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for riparian, oak woodland, and SRA habitat in order to adaptively manage the site for success.

- Replanting may be needed if triggers for vegetative cover, vegetative cover over water, and/or structural diversity are being met. Monitoring results should be used to assess the underlying cause of inadequate cover, which may require that additional adaptive management actions be implemented to support successful replanting. Adaptive management actions could include targeted revegetation, such as replanting varieties of species that are exhibiting the greatest growth and survival, or planting at elevations that are exhibiting the greatest growth and survival.
- Nonnative species management may be needed if monitoring results show that the triggers for nonnative species present are met, or if nonnative species are impacting the survival of native species. Adaptive management measures may include adjustments to nonnative control methods, such as plant removal, grading of site to remove nonnative roots, or mowing and selective removal of non-native species at optimal times for native growth.
- Irrigation and/or supplemental water may be needed if vegetation is not meeting success criteria, or if species are exhibiting signs of water stress. Assessment of monitoring results may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and structural diversity.
- Plant protection may be needed if triggers for vegetative cover and/or structural diversity are being met. If monitoring results show that plantings are failing due to predation or trampling from human use, then adaptive management actions would include plant cages or protective fencing that could be installed to protect plantings.

2.3 Elderberry Shrubs

2.3.1 Objectives and Implementation Strategy

The primary objective of elderberry shrub mitigation is to compensate for the adverse effects of the project on habitat important to the Federally listed valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB). Where possible, conservation areas would connect with adjacent habitat in order to prevent isolation of beetle populations. Removal, transplanting, and establishment of elderberry shrubs would be coordinated with USFWS and would follow the USFWS Conservation Guidelines for the valley elderberry longhorn beetle (USFWS, 1999).

Elderberry shrubs with one or more stems measuring one inch or greater in diameter at ground level must be transplanted if they cannot be avoided by the proposed project. Elderberry shrubs should be transplanted when they are dormant, typically from November to the first two weeks in February. Transplanting during the non-growing season would reduce shock to the plant and increase transplantation success. Most transplants require watering through the first summer.

Elderberry stems measuring greater than one inch in diameter are considered habitat for the VELB and trimming or removal of stems would require coordination and mitigation. Each elderberry stem that is adversely affected must be replaced in the conservation area with elderberry seedlings or cuttings as specified by USFWS. Seedlings and cuttings should be obtained from local sources. If the project site is in the vicinity of the conservation area, cuttings may be obtained from elderberry shrubs to be transplanted

Mitigation site planting areas must be at least 1,800 square feet for each elderberry transplant. As many as five additional elderberry plantings (cuttings or seedlings) and up to five associated native species plantings may also be planted within the 1,800 square foot area with the transplant. Studies have found that the VELB is more abundant in dense native plant communities with a mature overstory and a mixed understory. Therefore, a mix of native riparian species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), box elder (*Acer negundo*), white alder (*Alnus rhombifolia*), and California button willow (*Cephalanthus occidentalis californica*) would be planted along with the elderberry shrubs. Stock of saplings, cuttings, and seedlings would be obtained from local sources. Planting or seeding the area with native herbaceous species is also encouraged. Weeds and other non-native plants would be removed by mechanical means at least once a year or at the discretion of USFWS.

No pesticides, herbicides, fertilizers, or other chemical agents would be used in or within 100 feet of the conservation area. Fencing would be placed around the conservation area during the establishment period of the elderberry shrubs. Signs would be posted on the fence stating the status of the VELB and the purpose of the habitat. The conservation area would be protected in perpetuity as habitat for the VELB. Conservation areas may be transferred to resource agencies or appropriate private organizations for long term management. Biologists and law enforcement personnel from the California Department of Fish and Wildlife and USFWS must be given complete access to the project site to monitor transplanting activities. Personnel from these agencies must also be given complete access to the conservation area to monitor the beetle and its habitat in perpetuity.

2.3.2 Success Criteria

After the first year, it is anticipated that the sites would be evaluated to determine the level of project success and apply adaptive management, if necessary. If the habitat meets the below performance standards for three consecutive years, depending on physical site characteristics, conditions should be consistent enough to estimate community composition and general success of planting efforts. Three consecutive years of success should indicate that the project sites are self-sustaining and should not require supplemental irrigation or intensive weed control. Following this initial establishment period, any subsequent monitoring activities would be the responsibility of the local maintaining agency, and would focus primarily on general and biological inspections for the purposes of fire management and habitat evaluation.

Monitoring of elderberry habitats would focus on a minimum survival rate of at least 60 percent of the elderberry shrubs. Within one year of discovery that survival has dropped below 60 percent, additional plantings would be installed to bring survival above this level. Monitoring of associated riparian habitat would focus on: (1) the percent cover of native plant species; (2) presence of at least five native species contributing to structural diversity; and (3) decrease percent cover of non-native invasive species that out-compete natives. Additionally, an inventory of wildlife species would be recorded during annual monitoring. Table 11 establishes the percentages required to meet these performance standards. If the habitat is meeting these performance standards, conditions should be consistent enough to estimate community composition and general success of planting efforts.

Table 11. Elderberry and Associated Riparian Habitat Performance Standards.

Performance Standard	Quantitative Measure
Percent survivability of elderberry shrubs	60%
Percent cover of native riparian species	75%
Structural diversity	At least 5 native species contributing to 75% canopy and 50% shrub cover
Percent cover of non-native species	Less than 15%

2.3.3 Mitigation and Monitoring Strategy

Monitoring would be conducted annually per the USFWS Conservation Guidelines for the valley elderberry longhorn beetle (USFWS, 1999). Two surveys would be conducted by qualified biologists between February 14 and June 30 of each year until the mitigation has met the success criteria. Surveys would include:

1. An evaluation of the elderberry plants and associated native plants on the site, including the number of plants, their size and condition.
2. Presence of the adult beetles, including the number of beetles observed, their condition, behavior, and their precise locations.
3. Presence of beetle exit holes in elderberry stems, noting their locations and estimated ages.
4. An evaluation of the adequacy of the fencing, signs, and weed control efforts in the avoidance and conservation areas.
5. A general assessment of the habitat, including any real or potential threats to the beetle and its host plants, such as erosion, fire, excessive grazing, off-road vehicle use, vandalism, excessive weed growth, etc.

A written report presenting and analyzing the data from the project monitoring would be prepared following the surveys, and would be submitted by December 31 of the same year to USFWS. The report would address the status and progress of the transplanted and planted elderberry shrubs, associated native plants and trees, and any failings of the conservation plan and the steps taken to correct them. Any observations of beetles or fresh exit holes must be noted. Copies of original field notes, raw data, and photographs of the conservation area would be included with the report. A vicinity map of the site and maps showing where the individual adult beetles and exit holes were observed would also be included. The survival rate, condition, and size of the elderberry and associated native plants would be analyzed in the report. Real and likely future threats would be addressed along with suggested remedies and preventative measures (such as limiting public access, more frequent removal of invasive non-native vegetation, etc.).

2.3.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent survivability of elderberry shrubs.

  Triggers: If 60% survivability is not achieved during the monitoring period.

- Desired Outcome: Increase percent cover of native riparian habitat.

  Triggers: If 50% cover of native riparian habitat is not achieved within 3 years, or 75% cover of native riparian habitat is not achieved within 5 years.

- Desired Outcome: Maintain appropriate structural diversity of native riparian habitats.

  Trigger: Suitable structural diversity is not achieved, if canopy cover and/or shrub cover does not achieve 50% within 5 years.

- Desired Outcome: Decrease percent cover of non-native invasive species that outcompete natives including elderberry shrubs.

  Trigger: If non-native percent cover is greater than 15% during the monitoring period.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for VELB habitat in order to adaptively manage the site for success.

- Replanting may be needed if triggers for vegetative cover and/or survivability are being met. Monitoring results should be used to assess the underlying cause of inadequate cover or survival, which may require that additional adaptive management actions be implemented to support successful replanting. Adaptive management actions could include targeted revegetation, such as replanting at elevations that are exhibiting the greatest growth and survival.
- Nonnative species management may be needed if monitoring results show that the triggers for nonnative species present are met, or if nonnative species are impacting the survival of native species including elderberry shrubs. Adaptive management measures may include adjustments to nonnative control methods, such as plant removal, grading of site to remove nonnative roots, or mowing and selective removal of non-native species at optimal times for native growth.
- Irrigation and/or supplemental water may be needed if vegetation is not meeting success criteria, or if species are exhibiting signs of water stress. Assessment of monitoring results may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and structural diversity.
- Plant protection may be needed if triggers for vegetative cover and/or survivability are being met. If monitoring results show that plantings are failing due to predation or trampling from human use, then adaptive management actions would include plant cages or protective fencing that could be installed to protect plantings.

2.4 Green Sturgeon

2.4.1 Objectives and Implementation Strategy

The ARCF GRR project will restore existing or create new habitat to compensate for the quality and quantity of green sturgeon habitat (including soft bottom benthic substrate) permanently impacted by project construction. If possible, this would occur at a mitigation bank, however currently no mitigation banks in the Sacramento area provide credits for green sturgeon habitat.

If onsite mitigation is not possible, and there are no mitigation banks available, then compensation for green sturgeon habitat would occur within the north Delta in as close of a proximity to the study area as possible. The non-Federal sponsor supports green sturgeon mitigation, has the capability to implement the mitigation, and would participate in implementation of this mitigation in coordination with the Corps. Based on current best available science, there are limited opportunities for habitat creation within the study area. Created or restored habitat would be designed in coordination with NMFS and would be based on the primary constituent elements (PCEs) of critical habitat such as food availability, water flow, water quality, migration corridors, and sediment quality. Successful establishment of onsite mitigation or creation of offsite habitat will be determined through the success criteria in Section 2.6.3 below.

2.4.2 Success Criteria

The overall performance standard for green sturgeon habitat is based on the establishment of slope and substrate, with a focus on a suitable range of conditions for rearing juvenile green sturgeon developed from SAM. Slope and substrate are critical components of habitat for rearing juvenile green sturgeon. Slope is used as an indicator of shallow water refuge for juveniles as well as food and resting areas. Substrate size is used as an indicator of juvenile refuge from predators, suitable predator habitat, and food availability for juvenile and adult life stages of focus fish. Table 12 below establishes the suitable range of substrate and slope that must be met for each year of monitoring. Slope and substrate would be monitored yearly along with other potential variables discussed below. The monitoring will continue until all performance standards have been achieved for three consecutive years.

Table 12. Green Sturgeon Habitat Performance Standards.

	Acceptable Range
Slope (H:V)	>2:1
Substrate (average size, inches)	0 – 10

Note: Based on outputs from the SAM model. The Corps, in coordination with NMFS, determined that these outputs from the SAM model are the most likely outputs that would remain relevant to sturgeon with improved baseline condition data.

As stated previously, there is insufficient knowledge of the species' relationship to many habitat attributes; however, there may be opportunities to incorporate additional habitat attributes into the evaluation process. Experts at the Corps Engineering Research and Design Center would be engaged in order to develop a post-construction sampling and monitoring plan that would be refined during PED based on any improvements in the understanding of the species at that time. Potential habitat attributes that could be incorporated into success criteria following preconstruction monitoring and the development of the EFM model include:

- Food Resources – Benthic invertebrates and fishes (various species of shrimp, amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies) can be measured in terms of biomass loss, gain, or recovery rate. The impact on the benthic environment can be quantified within the footprint and adjacent to the footprint. Grab samples would be collected at various points of the river. These samples would be analyzed in order to determine the bed material and any change in presence of benthic food sources (clams, invertebrates, etc.) that resulted from construction.
- Water Flow – Although levee improvement projects are unlikely to impact water flow, there may be some localized increase in flow over revetment that could affect the swimming or foraging habits of green sturgeon. These changes can be assessed through a physical or hydraulic model. This monitoring should be paired with a fish tracking study to assess the species presence/ association with habitat/project features in the project area.
- Water Depth – A diversity of water depth is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages of green sturgeon and salmonids. Water depth impacted by levee construction or bank armoring can be measured impact through a direct physical quantification of changes to shallow and deep water habitat.
- Water Quality –Although levee improvement projects are unlikely to impact long term water quality, sediment quality, or migratory corridors, baseline conditions of these resources could be determined in order to develop a greater understanding of how these resources could impact normal behavior, growth, and viability of all life stages of green sturgeon and other fish species. Water Quality monitoring would involve testing water temperature, salinity, oxygen content, and other chemical characteristics within the project reach.

2.4.3 Mitigation Monitoring Strategy

The mitigation monitoring strategy will focus on the successful establishment of critical habitat elements, including slope and substrate. Post-construction monitoring would continue until the mitigation site has met the success criteria for three consecutive years. Slope would be monitored on an annual basis using range finding technologies. Slope will be sampled in varying distances perpendicular to the shoreline to assess slope ratio and depth. Substrate can vary seasonally and therefore will be monitored bi-annually before and after high flows. Substrate would be evaluated

through direct physical samples. Substrate will be sampled in varying distances perpendicular to the shoreline to assess the content of benthic material.

A post-construction monitoring report would be produced annually following monitoring. The report would summarize and analyze all monitoring activities with overall evaluation of the performance of the success criteria. Additional results, analysis, proposed adaptive management measures, and associated costs would be incorporated into the monitoring report.

2.4.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Maintain slope gradient of greater than 2H:1V.

  Triggers: If slope is less than 2H:1V during the monitoring period.

- Desired Outcome: Maintain acceptable range of substrate conditions to provide benthic habitat.

  Triggers: If average substrate sizes are composed of cobbles larger than 10 inches during the monitoring period.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for green sturgeon benthic habitat in order to adaptively manage the site for success.

- Slope regrading may be needed if monitoring results show that the trigger for slope angle is met. Adaptive management measures may include grading to recontour slope angle to 2H:1V or greater.
- Sediment management measures may be needed if the trigger for substrate is met. If monitoring results show that average substrate composition is larger than 10 inches, then the following measures may be implemented. Measures may include gravel augmentation, sediment catching measures, and/or introduction of fines.

3.0 Adaptive Management Costs

This section outlines the feasibility level adaptive management costs for the American River Common Features (ARCF) General Reevaluation Report (GRR) study. The adaptive management plan for this project reflects a level of detail consistent with the project Feasibility Study. The primary intent is to develop adaptive management costs appropriate for and specific to the project's adaptive management measures and monitoring strategies, as described in Section 2.0 of this document. The specified management actions allow estimation of the adaptive management program costs for the project.

The cost for implementation of this plan are provided at October 2015 price levels and prior to contingency. The cost for implementing the monitoring plan proposed above is approximately $5.05 million and is shown on Table 13 below.

Table 13. Monitoring Costs for the ARCF GRR.

Monitoring	Assumed Tasks for Monitoring	Frequency	Cost Assumptions	Total Cost for 5 Years
Vegetation Monitoring	Assume monitoring of mitigation sites, including transects for percent cover of natives and non-natives, structural diversity, and canopy cover over water using transect/plot monitoring. Assume vegetation mapping, inventories of general wildlife, and observations of damage to habitat would be recorded. Assume monitoring of all parameters would be done concurrently during each monitoring event.	Annually for 5 Years	Monitoring: Cost estimate based on standard establishment contract, including monitoring cost and annual report from contractor. Assume $50,000 per year for 4 biologists to survey mitigation sites	$1,296,000
Green Sturgeon Habitat Monitoring	Assume monitoring of slope and in-channel habitat elements including substrates (i.e., composition and percentage of fines)	Annually for 5 Years	Monitoring: Assume monitoring of 8 reaches for 5 years	$3,750,000
			TOTAL MONITORING	**$5,050,000**

The cost for the adaptive management plan is approximately $5.15 million and is shown on Table 14 below.

Table 14. Adaptive Management Costs for the ARCF GRR.

Adaptive Management Measures	Assumed Tasks for Adaptive Management	Cost Assumptions	Total Cost for 5 Years
Irrigation/Supplemental Water	Apply supplemental irrigation to water stressed plants	Assuming $900 per acre per year for 5 years	$900,000
Re-planting	Assume that assume 25% of vegetation may require replanting over 5 years.	Cost of vegetation was estimated at $5,000 per planted acre	$2,220,000
Plant Protection & Fencing	Assume 10,000 plant cages and 10,000 feet of fencing may be needed.	Assume $10/plant cage; $3/linear foot for fencing; plus $50,000 installation. Costs referenced from existing restoration contracts.	$280,000
Slope Regrading and Sediment Management	Recontouring or existing slopes and gravel augmentation	Assume regarding and gravel augmentation at 25% of mitigation site at $35 per CY	$1,560,000
Annual Report	Produce annual report	Assume $37,500 per report, annually for 5 years	$190,000
		TOTAL ADAPTIVE MANAGEMENT	**$5,150,000**
		TOTAL MONITORING AND ADAPTIVE MANAGEMENT	**$10,200,000**

The combined monitoring and adaptive management costs at October 2015 price levels, as included in the certified total project cost summary under the 06 “fish and wildlife facilities” account, total $10.2 million for the Recommended Plan.

4.0 References

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Appendix A

Cost Effectiveness/Incremental Cost Analysis

Mitigation for ARCF GRR

Development of Compensatory Mitigation Acreages for Alternatives 1 and 2

Mitigation for habitat loss is a requirement to compensate for the loss of habitat due to a Federal action. Section 2036(a) of the Water Resources Development Act of 2007 states that project alternatives must support recommendations with a specific plan to mitigate fish and wildlife losses. Additionally, the Endangered Species Act states that the purpose of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts.

The ARFC GRR study area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Arcade Creek, and the Magpie Creek Diversion Canal (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento.

The mitigation acreages for ARCF GRR were calculated using a combination of site surveys and aerial photography from Google Earth to determine where the project footprint impacted different habitat types. The habitat types included: riparian, shaded riverine aquatic (SRA), oak woodland, wetlands, GGS uplands and aquatic, elderberry shrubs, vernal pools, green sturgeon benthic habitat, and Delta smelt spawning and shallow water. The acreages of each impacted habitat type were then broken up by reach in order to show differences between the two Alternatives. Impacts caused by the construction of this project are shown in Tables 1 and 2.

Table 1: Impacts for ARCF GRR – Alternative 1

	GGS Upland ***	GGS Aquatic ***	Riparian/ Western Yellow-billed Cuckoo **	SRA Habitat ***	Elderberry Shrubs (VELB) **	Vernal Pools **	Delta Smelt Spawning	Shallow Water **	Green Sturgeon Benthic **	Oak Woodland *	Wetlands
American River North											
Reach A (American River)			22 acres	19,000 LF	284 stems						
Reach B (American River)			0.5 acre		183 stems						0.05 acre
Reach C (American River & NEMDC)										1 acre	
Reach D (Arcade Creek)			6 acres								
Reach E (Arcade Creek)			4.5 acres								
Reach F (NEMDC)										1 acre	
Reach G (Dry/Robla Creek)	*No Measures Proposed*										
Reach H (Dry/Robla Creek)	*No Measures Proposed*										
Reach I (Magpie Creek)						0.25 acre					
American River South											
Reach A (American River)			37 acres	6,850 LF	1,437 stems						0.35 acre
Reach B (American River)			2 acres	875 LF	1,144 stems						

	GGS Upland ***	GGS Aquatic ***	Riparian/ Western Yellow-billed Cuckoo **	SRA Habitat ***	Elderberry Shrubs (VELB) **	Vernal Pools **	Delta Smelt Spawning	Shallow Water **	Green Sturgeon Benthic **	Oak Woodland *	Wetlands
Reach C (American River)				3,800 LF	81 stems						
Reach D (Sacramento River)			18.6 acres	9,200 LF	163 stems		10 acres	5 acre			
Reach E (Sacramento River)			13.2 acres	8,850 LF			6 acres	4 acre			
Reach F (Sacramento River)			54.7 acres	21,100 LF			12 acres 1	4 acre			
Reach G (Sacramento River)			25.8 acres	11,150 LF			4 acres	1 acre			
TOTAL (Alt 1)	**0**	**0**	**184.3**	**80,825 LF**	**3,292 stems**	**1 acre**	**32 acres**	**14 acre**	**20 acres**	**2 acre**	**0.40 acre**

*State Listed **Federal Listed ***State and Federal Listed
GGS: Giant garter snake (*Thamnophis gigas*)
LF: linear feet
NEMDC: Natomas East Main Drain Canal
SRA: Shaded Riverine Habitat
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)

Table 2: Impacts for ARCF GRR – Alternative 2

	GGS Upland ***	GGS Aquatic ***	Riparian/ Western Yellow-billed Cuckoo **	SRA Habitat ***	Elderberry Shrubs (VELB) **	Vernal Pools **	Delta Smelt Spawning	Shallow Water **	Green Sturgeon Benthic **	Oak Woodland *	Wetlands
American River North											
Reach A (American River)			22 acres	19,000 LF	284 stems						
Reach B (American River)			0.5 acre		183 stems						0.05 acre
Reach C (American River & NEMDC)										1 acre	
Reach D (Arcade Creek)			6 acres								
Reach E (Arcade Creek)			4.5 acres								
Reach F (NEMDC)										1 acre	
Reach G (Dry/Robla Creek)	*No Measures Proposed*										
Reach H (Dry Robla Creek)	*No Measures Proposed*										
Reach I (Magpie Creek)						1 acre					
American River South											
Reach A (American River)			37 acres	6,850 LF	1,437 stems						0.35 acre 91000
Reach B (American River)			2 acres	875 LF	1,144 stems						

	GGS Upland ***	GGS Aquatic ***	Riparian/ Western Yellow-billed Cuckoo **	SRA Habitat ***	Elderberry Shrubs (VELB) **	Vernal Pools **	Delta Smelt Spawning	Shallow Water **	Green Sturgeon Benthic **	Oak Woodland *	Wetlands
Reach C (American River)				3,800 LF	81 stems						
Reach D (Sacramento River)			10.6 acres	9,200 LF	163 stems		10 acres	5 acre			
Reach E (Sacramento River)			6.2 acres	8,850 LF			6 acres	4 acre			
Reach F (Sacramento River)			41.6 acres	21,100 LF			12 acres	4 acre			
Reach G (Sacramento River)			12.2 acres	11,150 LF			4 acres	1 acre			
Sacramento Weir and Bypass	30	15	8 acres	1,500 LF							See GGS Aquatic
TOTAL (Alt 2)	**30**	**15**	**150.6**	**82,325 LF**	**3,292 stems**	**1 acre**	**32 acres**	**14 acre**	**20 acres**	**2 acre**	**0.40 acre**

*State Listed **Federal Listed ***State and Federal Listed NEMDC: Natomas East Main Drain Canal SRA: Shaded Riverine Habitat

GGS: Giant garter snake (*Thamnophis gigas*) LF: linear feet Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)

Table 3: Mitigation Costs

	GGS Upland ***	GGS Aquatic ***	Riparian	SRA Habitat***	Elderberry Shrubs (VELB)**	Vernal Pools **	Oak Woodland *	Delta Smelt Spawning	Shallow Water **	Green Sturgeon Benthic **	Wetlands
Mitigation Cost at a Bank per acre	$50,000	$50,000	$75,000	$75/LF	$4,500/ credit	$275,000	$75,000	$130,000	$130,000	----	$130,000
Mitigation Created per acre	----	----	$55,000	$231/LF	$85,000	----	$50,000	$55,000	$55,000	$150,000	----

The cost for mitigation was estimated for five scenarios for the purposes of the CE/ICA for both alternatives. These scenarios included: (1) maximized on- and off-site habitat creation; (2) maximizing the use of credits at a local mitigation bank; (3) a combination of on-site, off-site, and a mitigation bank at a 2:1 ratio; (4) a combination of on-site, off-site, and a mitigation bank at a 1:1 ratio; and (5) a combination of on-site, off-site, and a mitigation bank at a 3:1 ratio. The estimated acreage for the first scenario takes into account the feasibility of being able to do this mitigation on-site. For example, Delta smelt mitigation is not likely to be feasible on site due to the limitations of the waterways in the study area and the lack of real estate area to be able to create newly flooded habitat. As a result, Delta smelt mitigation is not assessed under this scenario since it is not implementable. However, it is a requirement of the project's biological opinion; therefore this alternative does not consider all required mitigation. Similarly, the mitigation bank only scenario also does not consider all required mitigation, because some habitat types must occur on-site due to limitations in available mitigation bank credits, and ESA requirements. Projected mitigation costs for both habitat creation and mitigation bank credits are shown in Table 3, above.

The cost for credits at a mitigation bank were obtained by contacting local mitigation banks to determine their prices per acre or credit for each of the habitat types needed for the GRR. These costs were then combined for each reach and Alternative to determine and overall mitigation cost per Alternative. These mitigation costs were included in the overall project cost for each alternative.

The combination alternative is likely the most implementable solution. It takes into account all required mitigation for the project per the NMFS and USFWS Biological Opinions, and assesses the implementation based on a reasonable estimate of on site mitigation, combined with using a mitigation bank. However, due to the temporal loss of habitat while new on site habitat is growing, the ecological value associated with onsite mitigation was reduced to an overall 80% habitat value for all scenarios based on the results of the associated HEP analysis, which was relied on for the purposes of this analysis.

For the purposes of evaluating the impacts of the ARCF GRR on fish and wildlife resources in the project area, with a reliance on existing information in the spirit of SMART Planning, the Habitat Evaluation Procedures (HEP) for the *American River Watershed Investigation, Common Features Modifications, Mayhew Drain Site Project* were relied upon as a reference baseline. The HEP for the Mayhew Drain Site Project was conducted in 2005 to quantify anticipated impacts to fish and wildlife and their habitats, and to determine mitigation needs for the project. This HEP was selected for the ARCF GRR because the Mayhew Drain Site is located within the overall study area for the ARCF GRR, and the habitat type and value at the Mayhew site is consistent with the habitat that occurs throughout the ARCF GRR project area.

The HEP provided information for two general types of wildlife habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same areas at future points in time. By combining the two types of comparisons, the impacts of proposed project on wildlife habitat were quantified and compensation needs (in terms of acreage) for the project were determined. The assumption that habitat for selected wildlife species or communities can be numerically described by a model produces a Habitat Suitability Index (HSI). The HSI, a value from 0.0 to 1.0, provides a measure of habitat quality for a sample area in terms of suitability for the particular species or community being evaluated.

For the Mayhew Drain project, the Northern oriole Riparian woodland model was used because it best suited the habitat type in the project area. The quantity part of the formula is any measure of area which is appropriately sized for the study. The product of these two measures is comparable to "habitat value" which equals habitat quantity multiplied by habitat quality. This formula is expressed as a Habitat Unit (HU).

Habitat Type x Habitat Area = Habitat Value

The Average Annual Habitat Units (AAHUs) over the life of the project can then used to determine mitigation needs. The model, variables measured and data collection methods used for the Mayhew Drain Project are shown below in Table 4. For the ARCF GRR, data was estimated visually and using google earth.

Table 4. HSI model, Variables, and Data Collection Methods.

HSI Model and Cover-Type	HSI Model Variables	Data Collection Method
Northern oriole Riparian Woodland	V1 – Average height of deciduous tree canopy	Visual estimation
	V2- Percent deciduous tree crown cover	Densiometer along belt transects
	V3 – Stand width	Estimated using aerial photos

Since it is not possible to empirically determine habitat quality and quantity for future years, future HSI values were projected. This was accomplished by increasing or decreasing specific baseline variables and/or HSI values for each evaluation element for the Northern oriole based on best professional knowledge of performance at other mitigation sites, literature on plant growth, and conditions at reference sites. To predict changes in the HSI for each future scenario, it was necessary to make assumptions regarding baseline and future values within project impact and compensation areas. The assumptions made for the ARCF GRR with project can be seen in Table 5.

Table 5. HSI Variables for the ARCF GRR Based on Habitat Values.

HEP - FUTURE WITH-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY1	20	25%	2	0.60	1.00	1.00	0.84
TY2	10	25%	2	0.30	1.00	1.00	0.67
TY25	20	75%	2	0.60	0.75	1.00	0.77
TY50	35	75%	2	1.00	0.75	1.00	0.91
HSI = (V1*V2*V3)^1/3						Average	0.80

The HSI value of 0.80 in Table 5 results from a temporal loss of habitat value and function from the removal of existing mature riparian habitat. This is due to the lower values given to mitigation plantings during the establishment period. The recommended plan for mitigation associated with the ARCF GRR is the Alternative 2 combination plan at a 2:1 ratio (the third scenario discussed above). A 2:1 mitigation ratio is a reasonable requirement for implementation of mitigation for this already scarce habitat type, because the proposed project will decrease the connectivity of existing habitat along the Sacramento River system. Additionally, temporal loss of onsite habitat results in a reduction in value and function of the new vegetation within the mitigation areas as it grows to maturity. This also accounts for the loss of other services that riparian vegetation provides, including:

- An essential food source for fish and wildlife, including ESA species;
- Aquatic resting and refugia for resident and migratory fish species;
- Large woody debris recruitment;
- Nesting and rearing habitat for terrestrial wildlife species;

- Nutrients for the ecological system;
- Shade for the river which maintains water temperatures and dissolved oxygen concentrations; and,
- Increased habitat value for VELB.

The above-listed functions and services associated with a newly created acre of habitat are usually expected to be less than those associated with natural habitat. As a result the 2:1 mitigation ratio is appropriate to compensate for the loss of mature riparian habitats.

Tables 6 and 7 below show the environmental effects and proposed mitigation for each of the two alternatives under the recommended plan. Note that some habitat types are adjusted to 1:1 and 3:1 to comply with the terms and conditions of the Biological Opinions.

Table 6. Environmental Effects of and Proposed Mitigation for Alternative 1.

Habitat Type	Potential Impacts	Duration of Impact	Mitigation (Acres/Linear Feet)	Cost at Mitigation Bank	Cost On- or Off-Site within Study Area
GGS Uplands	None	None	None	None	None
GGS Aquatic	None	None	None	None	None
Riparian	184.3 acres	Permanent	368.6 acres		20,273,000
Shaded Riverine Aquatic Habitat	82,325 lf	Permanent	82,325 lf		$19,020,000**
Elderberry Shrubs	3,292 stems	Permanent	1,715.6 credits 70.89 acres		$6,026,000
Vernal Pools	0.25 acre	Permanent	1 acre	$275,000	---
Green Sturgeon	20 acres	Permanent	Restore acres, monitoring, and fish passage features		$16,259,000
Delta Smelt Spawning Habitat	32 acres	Permanent	34 acres	$4,160,000	
Shallow Water Habitat (Delta Smelt)	14 acres	Permanent	42 acres	$5,460,000	
Oak Woodland	2 acres	Permanent	4 acres		$200,000
Wetlands	0.4 acres	Permanent	0.8 acres	$130,000	---
Sub-Total				**$10,025,000**	**$61,778,000**

** SRA habitat mitigation is provided in the project's cost estimate as a separate construction cost rather than a mitigation cost, since it is a feature of the bank protection designs and would be included as a part of the construction contract. The cost is displayed under the Fish and Wildlife Facilities account as "Construction" costs and is estimated to be approximately $231 per linear foot.

Table 7. Environmental Effects and Proposed Mitigation for Alternative 2, the Recommended Plan.

Habitat Type	Potential Impacts	Duration of Impact	Mitigation (Acres/Linear Feet)	Cost at Mitigation Bank	Cost On- or Off-Site within Study Area
GGS Uplands	30 acres 75 acres	Permanent Temporary	90 acres 75 acres	$4,500,000	N/A*
GGS Aquatic	15 acres	Permanent	45 acres	$2,250,000	
Riparian	150.6 acres	Permanent	301.2 acres		$16,566,000
Shaded Riverine Aquatic Habitat	82,325 lf	Permanent	82,325 lf		$19,020,000**
Elderberry Shrubs	3,292 stems	Permanent	1,715.6 credits 70.89 acres		$6,026,000
Vernal Pools	1 acre	Permanent	1 acre	$275,000	---
Green Sturgeon	20 acres	Permanent	Restore acres, monitoring, and fish passage features		$16,259,000
Delta Smelt Spawning Habitat	34 acres	Permanent	34 acres	$4,160,000	
Shallow Water Habitat (Delta Smelt)	14 acres	Permanent	42 acres	$5,460,000	
Oak Woodland	2 acres	Permanent	4 acres		$200,000
Wetlands	0.4 acres	Permanent	0.8 acres	$130,000	---
Sub-Total				**$16,775,000**	**$58,341,000**

* 75 acres of temporary effects to GGS habitat from the relocation of the Sacramento Bypass toe drain would consist of standard site restoration erosion control features such as hydroseeding. This is contained within construction costs and is not considered a mitigation cost. It is presented in this plan due to monitoring requirements, as described in Section 2.1 below.
** SRA habitat mitigation is provided in the project's cost estimate as a separate construction cost rather than a mitigation cost, since it is a feature of the bank protection designs and would be included as a part of the construction contract. The cost is displayed under the Fish and Wildlife Facilities account as "Construction" costs and is estimated to be approximately $231 per linear foot.

In order to establish a basis of comparison for this Cost Estimate, the "Without Project Condition" is assumed to be of such low habitat value that there would be 0 AAHU's without implementing compensatory mitigation. The "With Project Condition" is the completed mitigation as designed. On site costs were estimated using the average of costs for other onsite mitigation the District has constructed for projects in the region. Due to the temporal loss of habitat while new on site habitat is growing, the ecological value associated with onsite mitigation was reduced to an overall 80% habitat value.

The Mitigation Outputs and Cost tables below compare the Average Annual Habitat Units (AAHU's) and costs between the five scenarios.

Table 8. Mitigation Outputs On-/Off-Site for Alternative 1.

Maximized On/Off Site Habitat				
Increment	***Habitat Restored***			
	Acres	***AAHU's Without Project***	***AAHU's With Project***	***Net Change in AAHU's***
Riparian	368.6	0	294.88	294.88
Oak Woodland	4	0	3.2	3.2
Wetlands	0	0	0	0
Delta Smelt	0	0	0	0
SRA	46	0	36.8	36.8
Vernal Pool	0	0	0	0
GGS	0	0	0	0
Green Sturgeon	20	0	20	20
VELB	70	0	56	56
Grand Total:	**508.6**		**410.9**	**410.9**

Table 9. Costs for On-/Off-Site for Alternative 1.

On-/Off-site Cost/Acre			***Cost On-/Off-Site***
$55,000			$20,273,000
$50,000			$200,000
$0			$0
$55,000			$0
$231	$231/lf-80,825lf	80,825	$19,020,000
$0			$0
$0			$0
$150,000			$3,000,000
$85,000			$5,950,000
			$48,443,000

Table 10. Mitigation Outputs at a Mitigation Bank for Alternative 1.

Mitigation Bank				
Increment	***Habitat Restored***			
	Acres	***AAHU's Without Project***	***AAHU's With Project***	***Net Change in AAHU's***
Riparian	368.6	0	368.6	368.6
Oak Woodland	4	0	4	4
Wetlands	1	0	1	1
Delta Smelt	74	0	74	74
SRA	0	0	0	0
Vernal Pool	1	0	1	1
GGS	0	0	0	0
Green Sturgeon	0	0	0	0
VELB	70	0	70	70
Grand Total:	**518.6**	**0**	**518.6**	**518.6**

Table 11. Costs for Mitigation Bank for Alternative 1.

Bank Cost/ Acre			***Cost at a Bank***
$75,000			$27,645,000
$75,000			$300,000
$130,000			$130,000
$130,000			$9,620,000
$0			$0
$275,000			$275,000
$50,000			$0
$0			$0
$4,500	Credit	1715	$7,717,500
			$45,687,500

Table 12. Combination Onsite and Mitigation Bank 2:1 Outputs for Alternative 1.

Combination On/Off-site and Bank					
Increment	***Habitat Restored***				
	Acres on Site	***Acres/Credits at Bank***	***AAHU's Without Project***	***AAHU's With Project***	***Net Change in AAHU's***
Riparian	268.6	100	0	314.88	314.88
Oak Woodland	4	0	0	3.2	3.2
Wetlands	0	1	0	1	1
Delta Smelt	0	74	0	74	74
SRA	46	0	0	36.8	36.8
Vernal Pool	0	1	0	1	1
GGS	0	0	0	0	0
Green Sturgeon	20	0	0	20	20
VELB	70	0	0	56	56
Grand Total:	**408.6**	**176**	**0**	**506.88**	**506.88**

Table 13. Costs for 2:1 Combination Plan for Alternative 1.

Onsite Cost/ Acre	***Bank Cost/ Acre***	***Cost on Site***	***Cost at a Bank***	
$55,000	$75,000	$14,773,000	$7,500,000	
$50,000	$75,000	$200,000	$0	
	$130,000	$0	$130,000	
$55,000	$130,000	$0	$9,620,000	
$231	$75	$19,020,000	$0	
$0	$275,000	$0	$275,000	
$0	$50,000	$0	$0	
$150,000	$0	$3,000,000	$0	
$85,000	$4,500	$5,950,000	$0	
		$42,943,000	**$17,525,000**	**$60,468,000**

Table 14. Combination Onsite and Mitigation Bank 1:1 Outputs for Alternative 1.

Combination On/Off-site and Bank at 1:1					
Increment	***Habitat Restored***				
	Acres on Site	***Acres at Bank***	***AAHU's Without Project***	***AAHU's With Project***	***Net Change in AAHU's***
Riparian	184.3		0	147.44	147.44
Oak Woodland	2	0	0	1.6	1.6
Wetlands	0	0.45	0	0.45	0.45
Delta Smelt	0	46	0	46	46
SRA	46	0	0	36.8	36.8
Vernal Pool	0	0.25	0	0.25	0.25
GGS	0	0	0	0	0
Green Sturgeon	20	0	0	20	20
VELB	70	0	0	56	56
Grand Total:	**322.3**	**46.7**	**0**	**308.54**	**308.54**

Table 15. Costs for 1:1 Combination Plan for Alternative 1.

Onsite Cost/ Acre	***Bank Cost/ Acre***	***Cost on Site***	***Cost at a Bank***	
$55,000	$75,000	$10,136,500	$0	
$50,000	$75,000	$100,000	$0	
$0	$130,000	$0	$58,500	
$55,000	$130,000	$0	$5,980,000	
$231	$75	$19,020,000	$0	
$0	$275,000	$0	$68,750	
$0	$50,000	$0	$0	
$150,000	$0	$3,000,000	$0	
$85,000	$4,500	$5,950,000	$0	
		$38,206,500	**$6,107,250**	**$44,313,750**

Table 16. Combination Onsite and Mitigation Bank 3:1 Outputs for Alternative 1.

Combination Onsite and Bank at 3:1					
Increment	*Habitat Restored*				
	Acres on Site	*Acres at Bank*	*AAHU's Without Project*	*AAHU's With Project*	*Net Change in AAHU's*
Riparian	452.9	100	0	462.32	462.32
Oak Woodland	6	0	0	4.8	4.8
Wetlands	0	1.35	0	1.35	1.35
Delta Smelt	0	138	0	138	138
SRA	46	0	0	36.8	36.8
Vernal Pool	0	0.75	0	0.75	0.75
GGS	0	0	0	0	0
Green Sturgeon	20	0	0	20	20
VELB	70	0	0	56	56
Grand Total:	**594.9**	**240.1**	**0**	**720.02**	**720.02**

Table 17. Costs for 3:1 Combination Plan for Alternative 1.

Onsite Cost/ Acre	*Bank Cost/ Acre*	*Cost on Site*	*Cost at a Bank*	
$55,000	$75,000	$24,909,500	$7,500,000	
$50,000	$75,000	$300,000	$0	
$0	$130,000	$0	$175,500	
$55,000	$130,000	$0	$17,940,000	
$231	$75	$19,020,000	$0	
$0	$275,000	$0	$206,250	
$0	$50,000	$0	$0	
$150,000	$0	$3,000,000	$0	
$85,000	$4,500	$5,950,000	$0	
$395,231		**$53,179,500**	**$25,821,750**	**$79,001,250**

The total outputs and costs for mitigation were further calculated out for Alternative 2, the Recommended Plan. The following tables show the total costs and outputs for the five mitigation scenarios.

Table 18. Mitigation Outputs On-/Off-Site for Alternative 2.

Maximized On/Off Site Habitat Development				
Increment	***Habitat Restored***			
	Acres	***AAHU's Without Project***	***AAHU's With Project***	***Net Change in AAHU's***
Riparian	301.2	0	240.96	240.96
Oak Woodland	4	0	3.2	3.2
Wetlands	0	0	0	0
Delta Smelt	0	0	0	0
SRA	46	0	36.8	36.8
Vernal Pools	0	0	0	0
GGS	0	0	0	0
Green Sturgeon	20	0	20	20
VELB	70	0	56	56
Grand Total:	**441.2**		**357.0**	**357.0**

Table 19. Costs for On-/Off-Site for Alternative 2.

Onsite Cost/ Acre			***Cost All Onsite***
$55,000			$16,566,000
$50,000			$200,000
			$0
$55,000			$0
$231	$231/lf-46,000lf	82,325	$19,020,000
			$0
			$0
$150,000			$3,000,000
$85,000			$5,950,000
			$44,736,000

Table 20. Mitigation Outputs at a Mitigation Bank for Alternative 2.

Mitigation Bank				
Increment	*Habitat Restored*			
	Acres	*AAHU's Without Project*	*AAHU's With Project*	*Net Change in AAHU's*
Riparian	301.2	0	301.2	301.2
Oak Woodland	4	0	4	4
Wetlands	1	0	1	1
Delta Smelt	74	0	74	74
SRA	0	0	0	0
Vernal Pool	1	0	1	1
GGS	135	0	135	135
Gren Sturgeon	0	0	0	0
VELB	70	0	70	70
Grand Total:	**586.2**	**0**	**586.2**	**586.2**

Table 21. Costs for Mitigation Bank for Alternative 2.

Bank Cost/ Acre			*Cost at a Bank*
$75,000			$22,590,000
$75,000			$300,000
$130,000			$130,000
$130,000			$9,620,000
$75/LF			$0
$275,000			$275,000
$50,000			$6,750,000
N/A			$0
$4,500	Credit	1715	$7,717,500
			$47,382,500

Table 22. Combination Onsite and Mitigation Bank 2:1 Outputs for Alternative 2.

Combination Onsite and Bank Per BiOp at Recommended Plan					
Increment	***Habitat Restored***				
	Acres on Site	***Acres at Bank***	***AAHU's Without Project***	***AAHU's With Project***	***Net Change in AAHU's***
Riparian	201.2	100	0	260.96	260.96
Oak Woodland	4	0	0	3.2	3.2
Wetlands	0	1	0	1	1
Delta Smelt	0	74	0	74	74
SRA	46	0	0	36.8	36.8
Vernal Pool	0	1	0	1	1
GGS	0	135	0	135	135
Green Sturgeon	20	0	0	20	20
VELB	70	0	0	56	56
Grand Total:	**341.2**	**311**	**0**	**587.96**	**587.96**

Table 23. Costs for 2:1 Combination Plan for Alternative 2.

Onsite Cost/ Acre	***Bank Cost/ Acre***	***Cost on Site***	***Cost at a Bank***	
$55,000	$75,000	$11,066,000	$7,500,000	
$50,000	$75,000	$200,000	$0	
	$130,000	$0	$130,000	
$55,000	$130,000	$0	$9,620,000	
$231	$75	$19,020,000	$0	
$0	$275,000	$0	$275,000	
	$50,000	$0	$6,750,000	
$150,000	$0	$3,000,000	$0	
$85,000	$4,500	$5,950,000	$0	
		$39,236,000	**$24,275,000**	**$63,511,000**

Table 24. Combination Onsite and Mitigation Bank 1:1 Outputs for Alternative 2.

Combination Onsite and Bank at 1:1					
Increment	*Habitat Restored*				
	Acres on Site	*Acres at Bank*	*AAHU's Without Project*	*AAHU's With Project*	*Net Change in AAHU's*
Riparian	150.6		0	120.48	120.48
Oak Woodland	2	0	0	1.6	1.6
Wetlands	0	0.45	0	0.45	0.45
Delta Smelt	0	46	0	46	46
SRA	46	0	0	36.8	36.8
Vernal Pool	0	0.25		0.25	0.25
GGS	0	45	0	45	45
Green Sturgeon	20	0		20	20
VELB	70	0	0	56	56
Grand Total:	**288.6**	**91.7**	**0**	**326.58**	**326.58**

Table 25. Costs for 1:1 Combination Plan for Alternative 2.

Onsite Cost/ Acre	*Bank Cost/ Acre*	*Cost on Site*	*Cost at a Bank*	
$55,000	$75,000	$8,283,000	$0	
$50,000	$75,000	$100,000	$0	
$0	$130,000	$0	$58,500	
$55,000	$130,000	$0	$5,980,000	
$231	$75	$19,020,000	$0	
$0	$275,000	$0	$68,750	
$0	$50,000	$0	$2,250,000	
$150,000	$0	$3,000,000	$0	
$85,000	$4,500	$5,950,000	$0	
		$36,353,000	**$8,357,250**	**$44,710,250**

Table 26. Combination Onsite and Mitigation Bank 3:1 Outputs for Alternative 2.

Combination Onsite and Bank at 3:1					
Increment	***Habitat Restored***				
	Acres on Site	***Acres at Bank***	***AAHU's Without Project***	***AAHU's With Project***	***Net Change in AAHU's***
Riparian	351.8	100	0	381.44	381.44
Oak Woodland	6	0	0	4.8	4.8
Wetlands	0	1.35	0	1.35	1.35
Delta Smelt	0	138	0	138	138
SRA	46	0	0	36.8	36.8
Vernal Pool	0	0.75	0	0.75	0.75
GGS	0	135	0	135	135
Green Sturgeon	20	0	0	20	20
VELB	70	0	0	56	56
Grand Total:	**493.8**	**375.1**	**0**	**774.14**	**774.14**

Table 27. Costs for 3:1 Combination Plan for Alternative 2.

Onsite Cost/ Acre	***Bank Cost/ Acre***	***Cost on Site***	***Cost at a Bank***	
$55,000	$75,000	$19,349,000	$7,500,000	
$50,000	$75,000	$300,000	$0	
$0	$130,000	$0	$175,500	
$55,000	$130,000	$0	$17,940,000	
$231	$75	$19,020,000	$0	
$0	$275,000	$0	$206,250	
$0	$50,000	$0	$6,750,000	
$150,000	$0	$3,000,000	$0	
$85,000	$4,500	$5,950,000	$0	
$395,231		**$47,619,000**	**$32,571,750**	**$80,190,750**

The following pages include the outputs from the CE/ICA IWR Plan software. The Best Buy plans were shown to be the No Action Plan, the Alternative 1 Combination Plan with a 1:1 ratio, and the Alternative 2 Combination Plan with a 1:1 ratio. However, none of these plans accomplish the terms and conditions of the Biological Opinions and thus cannot be implemented and remain in compliance with the Endangered Species Act. As a result, the Recommended Plan remains the Alternative 2 Combination Plan with a 2:1 ratio, because it accomplishes the terms and conditions of the Biological Opinions, and the CE/ICA did determine that it was a cost effective plan.

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Metadata:

Planning Study Name: American River Common Features

Planning Study Description: ARCF GRR

Planning Set Name: CEICA Analysis 3

Planning Set Description: Planning set generated by Cost Effective/Incremental Cost Analysis.

Parent Set Name: Planning Set 1

CE/ICA Analysis Variables:

Output Variable = Output

Cost Variable = Cost

The following section presents a summary of benefit-cost analyses performed during development of the PlanningStudy2. The Institute for Water Resources Planning Suite version IWR Planning Suite 2.0.8.1 (Uncertainty Beta), release 04 Mar 2013 was used to produce information summarized in the following pages. Likewise, the following are metadata for the file(s) from which the information presented in the following pages was produced:

File Name	File Date	Module	Module Version
PlanningStudy2.mdb	12/5/2015	Plan Editor	2.0.8.1

References:

- Rogers, C., Robinson, M., Skaggs, L., & Heisey, S. (2006, November). IWR Planning Suite User's Guide. Alexandria, VA, United States of America: United States Army Corps of Engineers.
- Brandreth, B., & Skaggs, L. (2002, October). Lessons Learned from Cost Effectiveness and Incremental Cost Analyses. *IWR Report 02-R-5* .Alexandria, Virginia, United States of America: U.S. Army Corps of Engineers.
- Orth, K. (1994, October). Cost Effectiveness Analysis for Environmental Planning: Nine EASY Steps. *IWR Report 94-PS-2* . Alexandria, Virginia, United States of America: U.S. Army Corps of Engineers.
- Robinson, R., Hansen, W., Orth, K., & Franco, S. (1995, May). Evaluation of Environmental Investments Procedures Manual. *IWR Report 95-R-1* . Alexandria, Virginia, United States of America: U.S. Army Corps of Engineers.

Benefit-Cost Analysis Variable Definitions:

The following table provides a summary of the variables used during development of benefit-cost analyses performed during development of the PlanningStudy2. The table provides a summary of variables, units, definitions, and any formulas/computations (where relevant) associated with individual variables that are dependent on values of multiple user-provided values costs or benefits.

Planning Study Variable Properties					
Name	**Units**	**Description**	**Type**	**Derived Function (if applicable)**	**Allowable Range**
Cost	$10	Cost in $10	Currency		Any
Output	HU	Output in Habitat Units	Decimal		Any

Costs and Benefits Summary:

The following table provides a summary of average annual equivalent monetary costs and benefits, and average annual non-monetary costs and benefits considered during development of each mitigation alternative in the American River Common Features Project. In addition to annualized costs and benefits considered during development of cost-benefit analyses, total cost and total benefits associated with each alternative are also shown (reflected as present value) for each mitigation alternative.

Total and Average Cost

12/5/2015 3:35:11PM

All Plan Alternatives **Planning Set:** CEICA Analysis 3

Counter	Name	Output HU	Cost $1000	Average Cost
		0.00	0.00	
		308.54	44,313,750.00	143,624.00
1	No Action Plan	326.58	44,710,250.00	136,904.43
2	Alternative 1 Combo 1:1	357.00	44,736,000.00	125,310.92
3	Alternative 2 Combo 1:1	410.90	48,443,000.00	117,894.86
4	Alternative 2 Max Onsite	506.88	60,468,000.00	119,294.51
5	Alternative 1 Max Onsite	518.60	45,687,500.00	88,097.76
6	Alternative 1 Combo 2:1	586.20	47,382,500.00	80,829.92
7	Alternative 1 Max Mitigation Bank	587.96	63,511,000.00	108,019.25
8	Alternative 2 Max Mitigation Bank			
9	Alternative 2 Combo	720.02	79,001,250.00	109,720.91
	Recommended Plan	774.14	80,190,750.00	103,586.88
10	Alternative 1 Combo 3:1			
11	Alternative 2 Combo 3:1			

Incremental Costs and Benefits Summary:

The following table provides a summary of incremental costs and benefits associated with each mitigation alternative considered during development of the American River Common Features Project. For each of the considered mitigation alternatives, it shows the "added" cost associated with delivery of benefits exceeding the "next-best" cost-effective alternative.

Incremental Cost of Best Buy Plan Combinations (Ordered By Output)

12/5/2015 3:35:14PM

Planning Set: American River Common Features GRR

Counter	Plan Alternative	Output (HU)	Cost ($1000)	Average Cost ($1000 / HU)	Incremental Cost ($1000)	Inc. Output (HU)	Inc. Cost Per Output
1	No Action Plan	0.00	0.00				
2	Alternative 1 Combo 1:1	308.54	44,313,750.00	143,624.0034	44,313,750.0000	308.5400	143,624.0034
3	Alternative 2 Combo 1:1	326.58	44,710,250.00	136,904.4338	396,500.0000	18.0400	21,978.9357
4	Alternative 2 Max Onsite	357.00	44,736,000.00	125,310.9244	25,750.0000	30.4200	846.4826
5	Alternative 1 Max Onsite	410.90	48,443,000.00	117,894.8649	3,707,000.0000	53.9000	68,775.5102
6	Alternative 1 Combo 2:1	506.88	60,468,000.00	119,294.5076	12,025,000.0000	95.9800	125,286.5180
7	Alternative 1 Max Mitigation Bank	518.60	45,687,500.00	88,097.7632	-14,780,500.0000	11.7200	-1,261,134.8123
8	Alternative 2 Max Mitigation Bank	586.20	47,382,500.00	80,829.9215	1,695,000.0000	67.6000	25,073.9645
9	Alternative 2 Combo Recommended Plan	587.96	63,511,000.00	108,019.2530	16,128,500.0000	1.7600	9,163,920.4545
10	Alternative 1 Combo 3:1	720.02	79,001,250.00	109,720.9105	15,490,250.0000	132.0600	117,297.0619
11	Alternative 2 Combo 3:1	774.14	80,190,750.00	103,586.8835	1,189,500.0000	54.1200	21,978.9357

Chart of Alternatives:

This chart provides an illustration of costs and benefits associated with alternatives generated during development of the American River Common Features GRR. Alternatives are charted based on their benefit (x-axis) and cost (y-axis) coordinates.

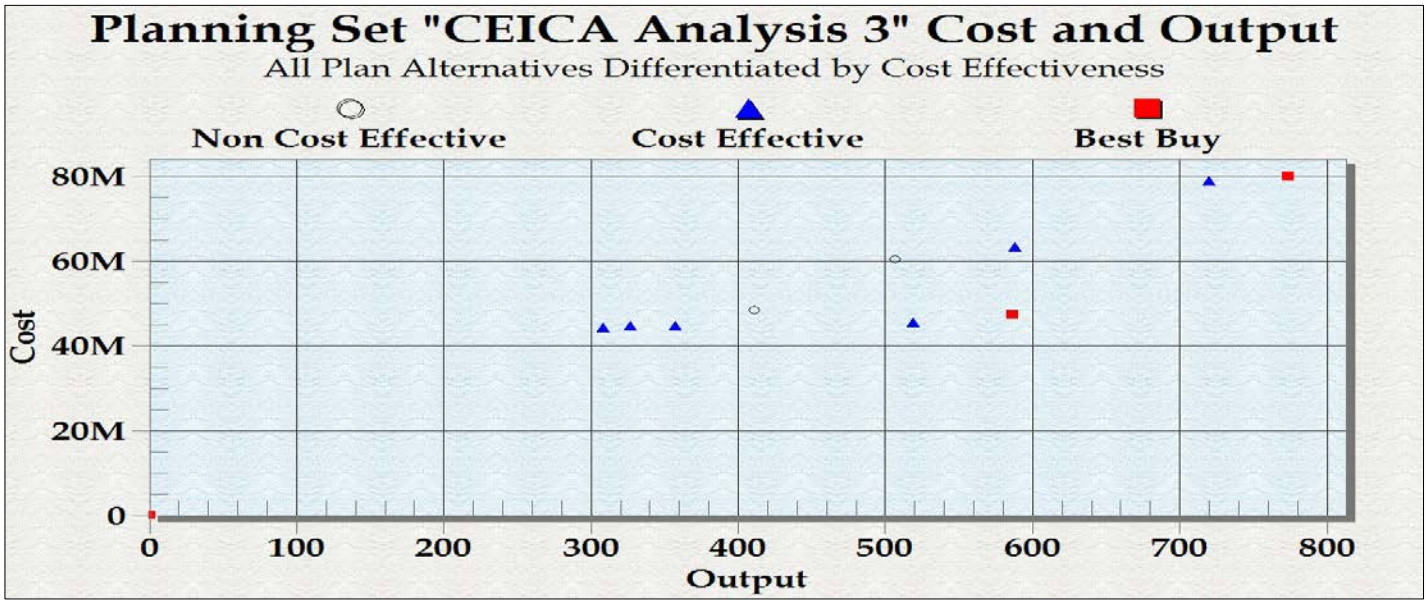


Chart of Cost-Effective Alternatives:

This chart provides an illustration of costs and benefits associated with cost-effective alternatives considered during development of the American River Common Features GRR. Alternatives are charted based on their benefit (x-axis) and cost (y-axis) coordinates. The depicted alternatives have been identified among the most cost-effective of the alternatives considered during development of the study.

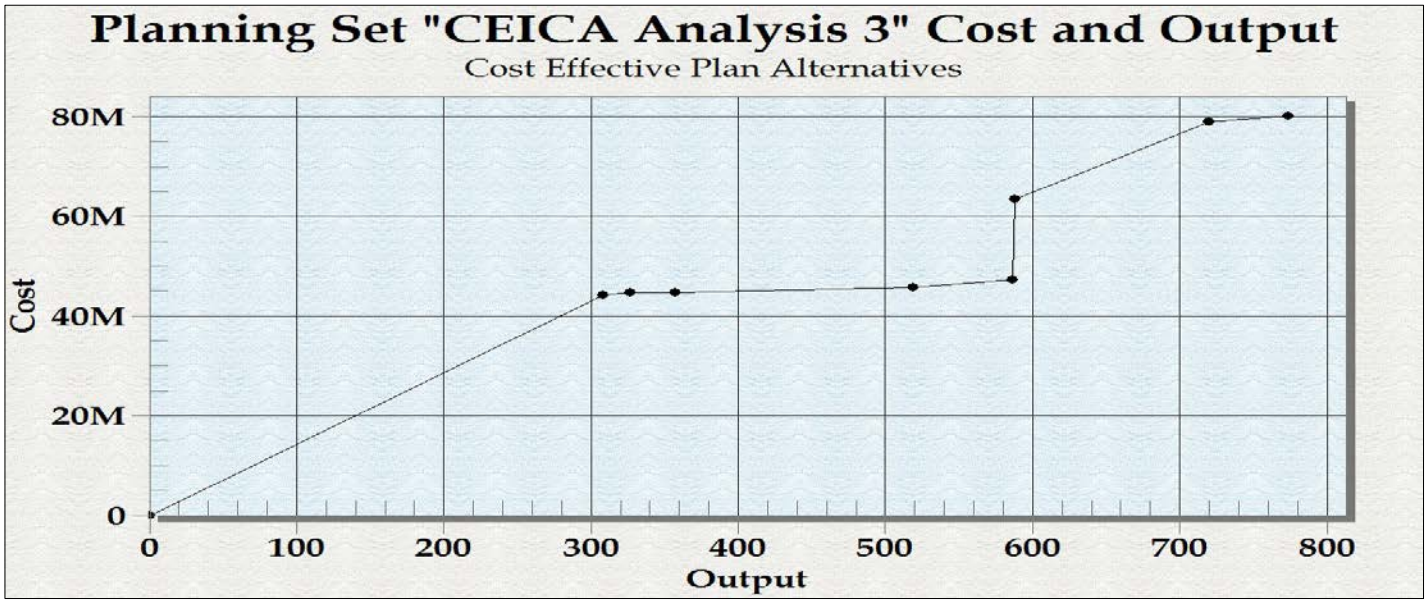
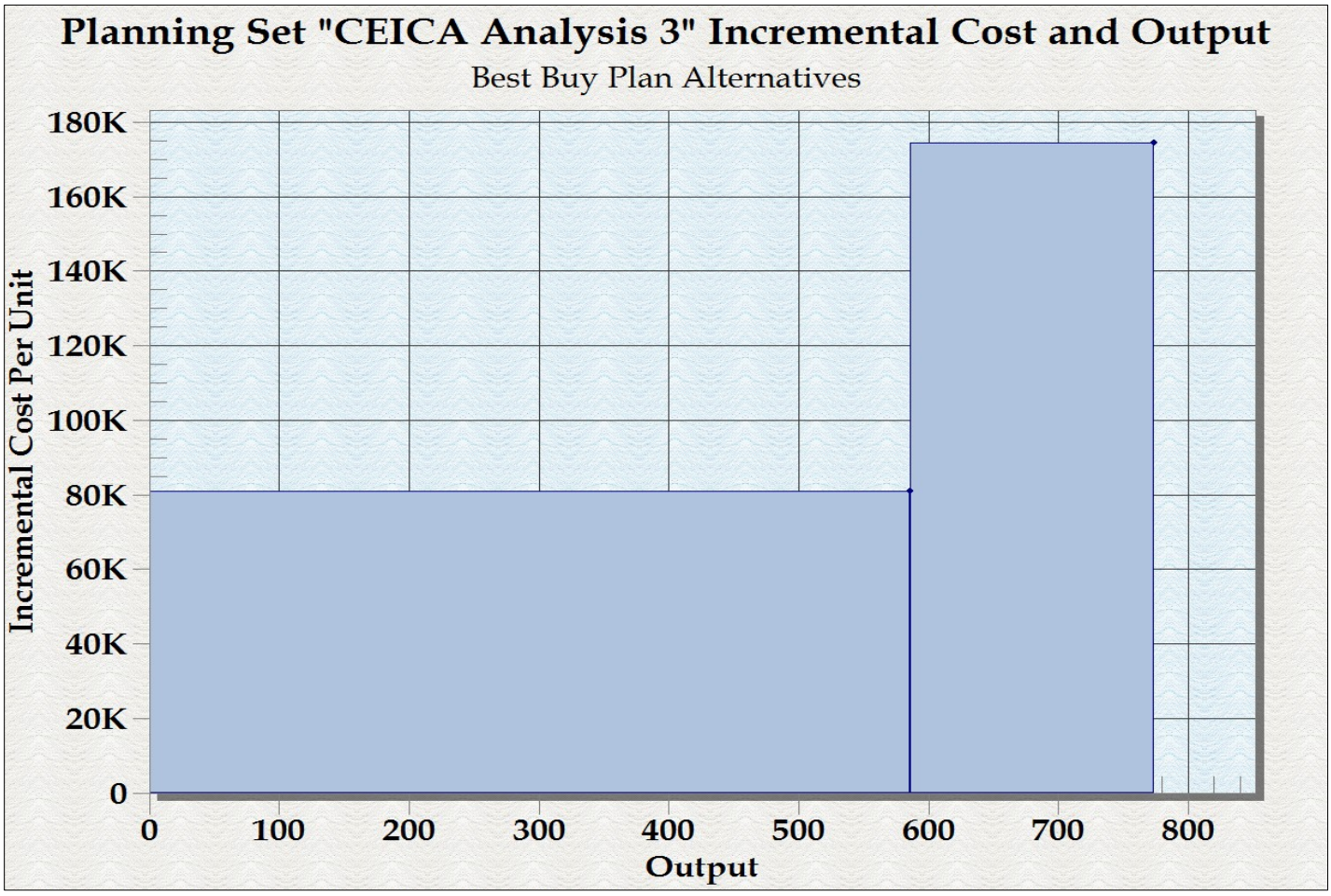


Chart of Incremental Costs and Benefits of Alternatives:

This chart provides an illustration of costs and benefits associated with alternatives considered during development of the American River Common Features GRR. The magnitudes of incremental benefits (width of rectangle) and incremental costs (height of rectangle) are represented to illustrate the relative magnitudes of each alternative's "added" costs associated with benefits exceeding the "next-best" cost-effective alternative.



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825-1846

In Reply Refer to:
08ESMF00-
2014-F-0518

SEP 11 2015

Ms. Alicia E Kirchner
Chief, Planning Division
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814

Subject: Formal Consultation on the American River Common Features (AFRC) Project, Sacramento County, California

Dear Ms. Kirchner:

This letter is in response to the U.S. Army Corps of Engineers (Corps) April 3, 2015, request for consultation with the U.S. Fish and Wildlife Service (Service) on the proposed American River Common Features General Reevaluation Report (ARCF GRR) project in Sacramento County, California. You request was received by the Service on April 7, 2015. The Corps originally initiated consultation on June 30, 2014; however, the Service responded on July 23, 2014, with a request for additional information regarding the project description and the effects analysis the Corps had completed. The April 3, 2015, letter and biological assessment began the formal consultation period. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The Federal action on which we are consulting is the ARCF GRR, which includes levee improvements and bank protection along the Sacramento River, levee improvements along Arcade, Magpie, and Dry/Robla Creeks, widening the Sacramento Bypass and Weir, and bank protection along the lower American River. Pursuant to 50 CFR 402.12(j), you submitted a biological assessment for our review and requested concurrence with the findings presented therein. These findings conclude that the proposed project may affect and is not likely to adversely affect the vernal pool fairy shrimp (*Branchinecta lynchi*) and vernal pool tadpole shrimp (*Lepidurus packardi*); may affect likely to adversely affect the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), delta smelt (*Hypomesus transpacificus)* (smelt) and its critical habitat; the giant garter snake (*Thamnophis gigas*); and the yellow-billed cuckoo (*Coccyzus americanus occidentalis*). The project is outside of critical habitat designated for the valley elderberry longhorn beetle and critical habitat proposed for the yellow-billed cuckoo.

The Corps previously consulted with the Service on the Magpie Creek Flood Control Project and on September 15, 2004 a biological opinion regarding effects to the vernal pool fairy shrimp, vernal pool tadpole shrimp, and giant garter snake (File # 1-1-04-F-0132) was provided. The project described in the 2004 biological opinion is exactly the same as the Magpie Creek portion of the

project description in the Common Features biological assessment. Because the environmental baseline for vernal pool fairy shrimp and vernal pool tadpole shrimp has not changed from the baseline that was analyzed in the 2004 biological opinion and the project description remains the same, effects to and take of vernal pool fairy shrimp and vernal pool tadpole shrimp are addressed in the September 15, 2004, biological opinion. More recent information regarding the status of the habitat along Magpie Creek for giant garter snake has changed from the 2004 biological opinion. This opinion addresses those changes and any potential effects to the giant garter snake.

Seasonal wetlands, which may provide suitable habitat for vernal pool fairy shrimp and vernal pool tadpole shrimp, occur in the vicinity of the Robla Creek woodland mitigation site A, however any vernal pools in this area would be avoided by these activities. The Corps will implement a 250-foot buffer between vernal pools and vegetation planting. Planting activities will be done in the fall when the wetlands are dry and will use best management practices to ensure that sediment does not enter the seasonal wetlands. The Service concurs that with your determination of may affect, not likely to adversely affect vernal pool fairy shrimp and vernal pool tadpole shrimp at the Robla Creek woodland mitigation site A.

This biological opinion is based on information provided in the Corps' letter requesting consultation and the biological assessment. A complete administrative record is on file at the Service's Sacramento Fish and Wildlife Office.

CONSULTATION HISTORY

September 4, 2013: The Service commented on the April 2013 draft biological assessment.

April 8, 2014: The Service commented on the October 2013 draft biological assessment.

June 30, 2014: The Corps initiated section 7 consultation with the Service.

July 23, 2014: The Service sent a letter in response to the Corps initiation requesting additional information.

April 3, 2015: The Corps provided an updated biological assessment with responses to the Service's July 23, 2014, request for additional information.

August 31, 2015: The Corps provided a revised biological assessment that addressed questions the Service had regarding the project description.

BIOLOGICAL OPINION

Description of the Action

Congress directed the Corps to investigate the feasibility of reducing flood risk of the city of Sacramento. The Corps completed feasibility studies in 1991 and 1996, recommending a concrete gravity flood detention dam on the north fork of the American River at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features." Thus, the ARCF Project was authorized in the Water Resources Development Act (WRDA) of 1996 and a decision on Auburn Dam was deferred

to a later date. Major construction components of ARCF in the WRDA 1996 authorization included construction of seepage remediation along about 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas.

Following the 1986 flood, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5. In addition, both the north and south bank of the American River from RM 0 to about RM 11.4 experienced seepage. Seepage on the Sacramento River was so extensive that Congress, soon after the 1986 flood event, funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport.

Shortly thereafter, the Sacramento Valley experienced a flood event in 1997. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was expected because remediation measures had yet to be constructed, but the occurrence of significant seepage on the Sacramento River in the reach remediated as part of the Sac Urban Project was alarming and confirmed that deep underseepage was also of significant concern. As a result, seepage remediation on the American River (then in the late 1990s in the design phase) would need to be designed to remediate both through- and deep underseepage.

In 1999, Congress decided not to authorize Auburn Dam, but instead authorized improvements for Folsom Dam. By doing this, improvements to levees downstream of Folsom Dam could be fine-tuned to work closely with the Folsom improvements being discussed by Congress. Therefore, the ARCF project was modified by WRDA 1999 to include additional necessary features for the American River so that it could safely convey the proposed emergency release of 160,000 cubic feet per second (cfs) from Folsom Dam. Major construction components for the ARCF project in the WRDA 1999 authorization include construction of seepage remediation and levee raise along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of Natomas Cross Canal levee in Natomas. All American River features authorized in WRDA 1996 and 1999 have been constructed or are in design analysis for construction within a year or two.

The purpose of the ARCF project is to reduce the flood risk for the city of Sacramento. The following problems were identified within the Sacramento levee system:

- Seepage and underseepage;
- Levee erosion;
- Levee stability;
- Levee overtopping;
- Access for maintenance and flood fighting;
- Vegetation and encroachments;
- Releases from Folsom Dam;
- Floodplain management; and
- Additional upstream storage from existing reservoirs.

In order to evaluate the effects to listed species, the Corps looked at the largest foreseeable footprint. As the Corps moves into the design phase of the project, footprint changes will likely reduce the effects to listed species.

The project is designed to allow for the release of 160,000 cubic feet per second (cfs) from Folsom Dam. The levees along the American River are unable to withstand these maximum flows for extended periods of time without increased risk of erosion and potential failure. The exact location where erosion will occur and to what extent erosion will occur during any given event is unknown. Erosion within the American River Parkway will be addressed as part of the Folsom Dam Water Control Manual Update currently under evaluation and a biological assessment is being prepared to initiate section 7 consultation with both the Service and National Marine Fisheries Service (NMFS). Therefore, the effects of erosion along the lower American River and effects of increased Yolo Bypass flooding frequency due to changes in operations from Folsom Dam are not analyzed in this project description. This is because construction of the American River and Sacramento Bypass measures, which are dependent on releases from Folsom Dam, will not occur until after a biological opinion is received for the Water Control Manual Update. Sacramento River and East Side Tributaries measures are necessary to improve the flood risk management system in the Sacramento area regardless of the change in operation at Folsom Dam and are not dependent on Folsom Dam operations for their implementation. As a result, construction in these areas could occur regardless of the Folsom Dam Water Control Manual Update schedule.

The Corps' project involves the construction of fix-in-place levee remediation measures to address seepage, stability, erosion, and height concerns identified for the Sacramento River and American River levees, Natomas East Main Drainage Canal (NEMDC), Arcade, Dry/Robla, and Magpie Creeks (Figure 1). Most height concerns along the Sacramento River will be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass. Due to the urban nature and proximity of existing development within the American River North and South basins the Corps is planning fix in place remediation. This would improve the flood damage reduction system to safely convey flows to a level that maximizes net benefits. Table 1 summarizes the levee problems discussed above and the proposed measure for each waterway.

Sacramento Area Flood Control Agency (SAFCA), the project's local sponsor, will complete some portions of the Federal project. SAFCA is seeking permission from the Corps pursuant to 33 USC §408 (Section 408) for alteration of the Federal levees along the NEMDC and Arcade Creek.

In addition to the proposed levee improvements measures shown in Table 1, the following measures and policies would be addressed during construction:

- The non-Federal (Department of Water Resources (DWR)) will bring the levees into compliance with the Corps' standard levee footprint using a System Wide Implementation Framework (SWIF) process. A SWIF is a plan developed by the levee sponsor(s) and accepted by the Corps to implement system-wide improvements to a levee system (or multiple levee systems within a watershed) to address system-wide issues, including correction of unacceptable inspection items, in a prioritized way to optimize flood risk reduction. The standard levee footprint consists of a 20 foot crown width, 3:1 waterside

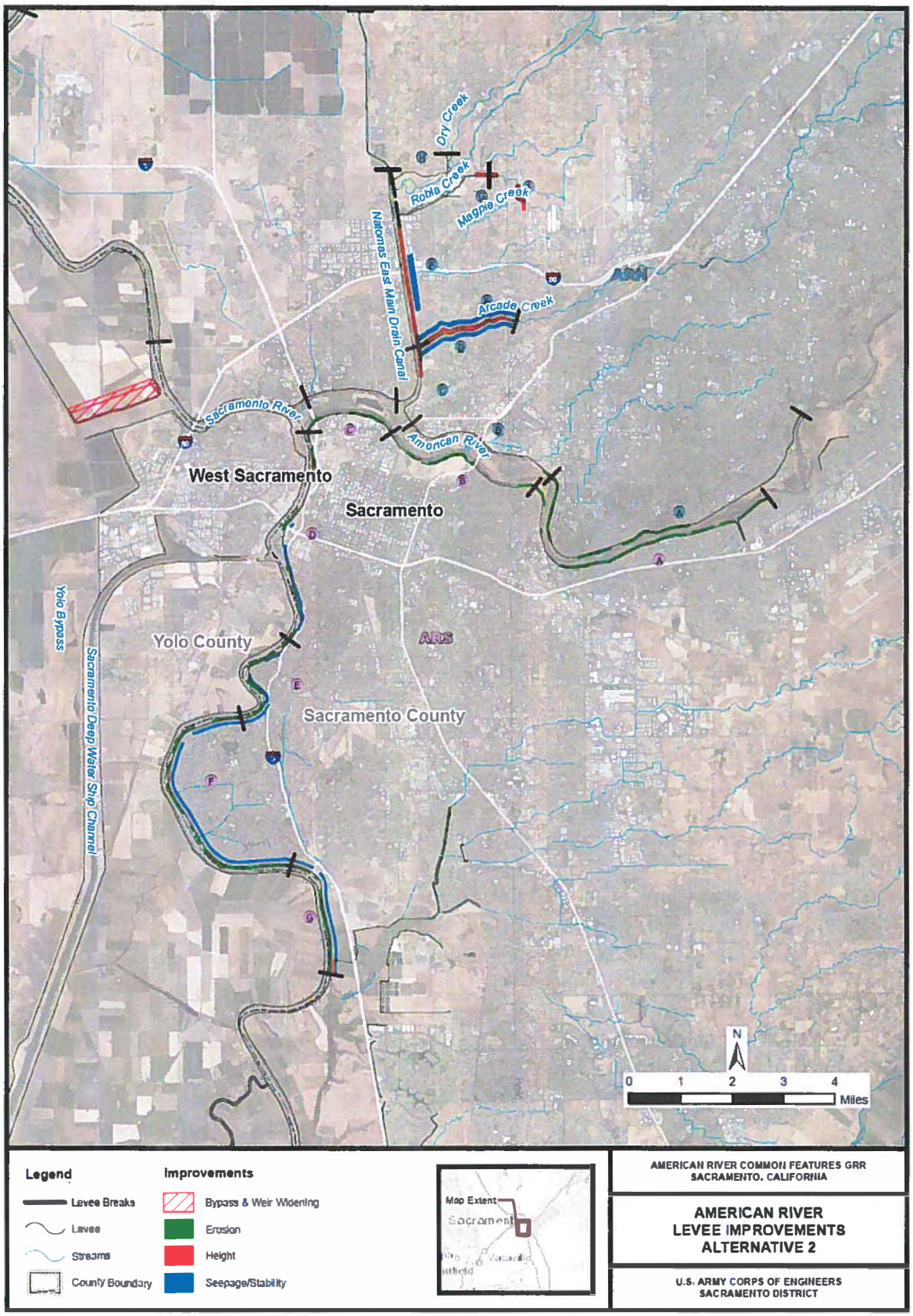


Figure 1. American River Common Features Project Area

Table 1. Remediation by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench (31,000 linear feet)	---
Sacramento River	Cutoff Wall (50,300 linear feet)	Cutoff Wall (50,300 linear feet)	Bank Protection (50,300 linear feet)	Sacramento Bypass and Weir Widening, Levee Raise (1,500 feet)
NEMDC	Cutoff Wall (6,000 linear feet)	Cutoff Wall	---	Floodwall (15,600 linear feet)
Arcade Creek	Cutoff Wall (22,000 linear feet)	Cutoff Wall	---	Floodwall (22,000 linear feet)
Dry/Robla Creeks	---	---	---	Floodwall (2,500 linear feet)
Magpie Creek[2]	---	---	---	Floodwall, Levee Raise

[1]American River seepage, stability, and overtopping measures were addressed in a previous construction project.

[2]In addition to the floodwall, Magpie Creek will include construction of a new levee (3,100 linear feet) along Raley Boulevard south of the creek, and construction of a detention basin on both sides of Raley Boulevard (79 acres). In addition, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek Bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

slope and 2:1 landside slope, when possible. If the 3:1 waterside slope is not possible, then a minimum 2:1 waterside slope would be established instead.

- Engineering Technical Letter 1110-2-583 (ETL) vegetation compliance would occur under a SWIF by the local maintaining agency (LMA). The intent of the SWIF is to collaboratively work with the resource agencies and levee sponsors to transition existing levees to Corps standards while maintaining Public Law (PL) 84-99 rehabilitation assistance and adhering to the Act and other environmental laws. The SWIF is a two-step process completed by the applicant that is composed of a letter of intent, which is followed by submission of a SWIF plan. The SWIF process allows eligible local sponsors to implement levee improvements in a prioritized "worst first" way to optimize the achievement of risk reduction. The Corps acknowledges that implementing system-wide improvements will need to be done within a collaborative intergovernmental framework and that it will take time to develop and implement improvements in complex situations. Challenges including ensuring that both environmental and levee safety considerations are adequately served.
- The vegetation requirements for the SWIF include a 15-foot waterside, landside, and vertical vegetation-free zone. Trees that pose an unacceptable risk to levee integrity will be removed and the root balls and roots will be remediated. Trees that do not pose a threat will not be removed. Vegetation on the landside slope would only be removed within the construction

footprint (up to ½ levee degrade) and the remaining vegetation would be dealt with under the SWIF process.

- Utility encroachments will be brought into compliance with Corps policy. Utilities that penetrate the levee would be removed and replaced with one of two fixes: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.
- Private encroachments shall be removed by the non-Federal sponsor prior to construction.
- The Sacramento District of the Corps will pursue a vegetation variance which will allow vegetation on the lower ½ of the levee slope to 15 feet waterward of the waterside levee toe to remain in place. The Sacramento District has conducted an evaluation which examined the safety, structural integrity, and functionality of the levees that will be retained and not compromised if a tree were to fall and result in scouring of the root ball area. The results show that the tree fall and scour did not significantly affect levee performance, and the levee meets Corps seepage and slope stability criteria assuming the entire project is constructed.

American River

Levees along the American River require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion to the river bank and levee, which could potentially undermine the levee foundation. There are two measures proposed for the American River levees: (1) a maximum of 31,000 linear feet (LF) of bank protection, and (2) a maximum of 65 acres/45,000 LF of launchable rock trench. Both of these measures are described in detail in the subsections below. These numbers are maximized because there is some overlap identified to account for the uncertainty of site-specific conditions. For example, for some reaches both bank protection and launchable rock trench impacts were estimated even though both measures will not be constructed in the same reach.

Bank Protection

This measure consists of placing rock revetment on the river's bank to prevent erosion. It entails installing revetment along the stream bank based on site-specific analysis (Figure 2). When necessary, the eroded portion of the bank will be filled and compacted prior to the rock placement. The sites will be prepared by clearing and stripping of loose material and understory growth prior to construction. In most cases, large vegetation will be permitted to remain at these sites. Temporary access ramps will be constructed, if needed, using imported borrow material that would be trucked on site.

The placement of rock onto the bank will occur from a land based staging area using long reach excavators and loader. The loader brings rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the waterside of the levee.

The revetment will be placed on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a planting berm will be constructed in the rock to allow for revegetation of the site. The planting berm varies in width from 5 to 15 feet. In all cases the planting will occur outside the vegetation free zone as required by the ETL.

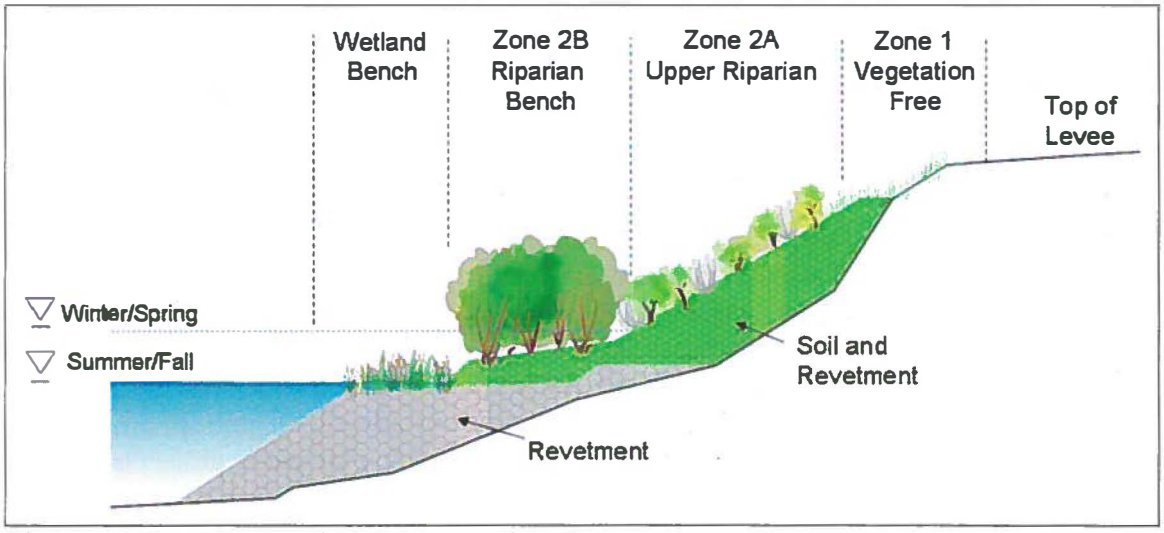


Figure 2. Bank Protection with Planting Bench.

Launchable Rock Trench

For the purposes of this project description, it is assumed that 65 acres of the lower American River will have a launchable rock trench fix. The remainder will be the bank protection described above. This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it (Figure 3). All launchable rock trenches will be constructed outside of the natural river channel. The vegetation will be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration will include a 2:1 landside slope and 1:1 waterside slope and will be excavated at the toe of the existing levee. All soil removed during trench excavation will be stockpiled for potential reuse. The bottom of the trench will be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench will be filled with revetment that will be imported from an offsite commercial location. After rock placement the trench will be covered with a minimum of 3 feet of the stockpiled soil for a planting berm. Rock placed on the levee slope will be covered with 2 feet of stockpiled soil. All disturbed areas will be reseeded with native grasses and small shrubs where appropriate. Trees and shrubs could be permitted on the trench if planted outside the specified vegetation free zone as required by the ETL.

Sacramento River

Levees along the Sacramento River require improvements to address seepage, stability, and erosion. About 50,300 LF of bank protection and cutoff wall or slope stability work is proposed for the Sacramento River. In addition, these levees require a total of one mile of intermittent height improvements in order to convey additional flows that exceed current design levels.

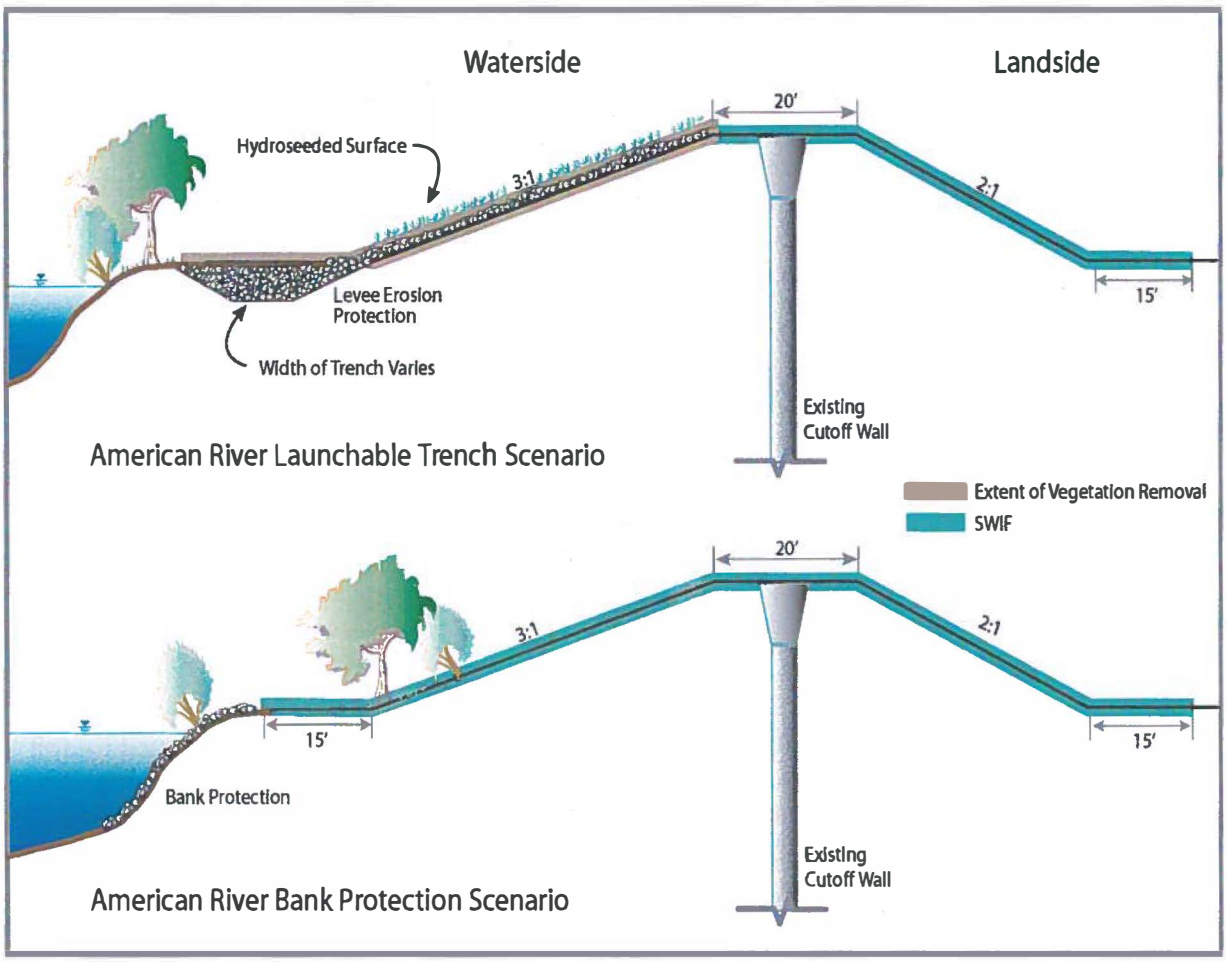


Figure 3. Launchable Rock Trench and Bank Protection.

Where the existing levee does not meet the levee design requirements, as discussed above, slope flattening, crown widening, and/or a minimal amount of levee raise is required. This improvement measure addresses problems with slope stability, geometry, height and levee crest access and maintenance. To begin levee embankment grading, loose material and vegetation understory will be cleared, grubbed, stripped, and where necessary, portions of the existing embankment will be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) will be stockpiled at staging areas. Haul trucks and front end loaders will bring borrow materials to the site, which will then be spread evenly and compacted according to levee design plans.

The levee will be raised about 1 to 2 feet resulting in the levee footprint extending out a maximum of 5 feet on the landside from the existing levee. The levee crown patrol road will be re-established at the completion of construction.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown. The cutoff wall will be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach will depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of about 85 feet. For cutoff walls of greater depth the DSM method will be utilized.

Prior to any cutoff wall construction method, the construction site and any staging areas will be cleared, grubbed, and stripped. The levee crown will be degraded up to half the levee height to create a large enough working platform (about 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. This method of slurry wall installation will also reduce the risk of slurry mixture following seepage paths and leaking into the river or into landside properties.

Open Trench Cutoff Wall

Under the open trench method, a trench about 3 feet wide will be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it is filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry was hardened, it will be capped and the levee embankment will be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of about 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout will be injected through the augers and mixed with the native soils. An overlapping series of mixed columns will be drilled to create a continuous seepage cutoff barrier. A degrade of up to one half the levee height will be required for construction of the DSM wall. For both methods, once the slurry has hardened it will be capped and the levee embankment will be reconstructed with impervious or semi-impervious soil.

Bank Protection

Proposed bank protection along the Sacramento River will address erosion concerns. Studies have shown that the Sacramento River levees have a medium to high risk of breach due to erosion. Bank protection will be addressed by standard bank protection with planting berm. The standard bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, where necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. Large trees on the lower half of the waterside slope will be protected in place to retain shaded riverine aquatic (SRA) habitat. The sites will be prepared by removing vegetation along the levee slopes at either end of the site for construction of a temporary access ramp, if needed. The ramp will then be constructed using imported commercial borrow material that will be trucked on site.

The placement of rock onto the levee slope will occur from atop the levee and/or from the waterside by means of barges. Rock required within the channel, both below and slightly above the water line at the time of placement, will be placed by an excavator located on a barge. Construction will require two barges: one barge would carry the excavator, while the other barge will hold the stockpile of rock to be placed on the channel slopes. Rock required on the upper portions of the slopes will be placed by an excavator located on top of the levee. Rock placement from atop the levee will require one excavator and one loader for

each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the waterside of the levee.

The revetment will be placed via the methods discussed above on existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a small planting berm will be constructed in the rock to allow for some revegetation of the site.

Natomas East Main Drain Canal

The east levee of the NEMDC requires 6,000 LF of improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A cutoff wall will be constructed at this location to address the seepage and stability problems. The cutoff wall will be constructed by one of the methods described in the Sacramento River section above. SAFCA is proposing to construct 1,700 LF of cutoff wall beginning just south of the confluence of Arcade Creek and extending south along the NEMDC. The Corps will construct the remaining 4,300 LF of cutoff wall.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A centerline cutoff wall will be constructed to address seepage along 22,000 LF of the Arcade Creek levees. Levees from Rio Linda Boulevard to Marysville Boulevard will have a cutoff wall constructed at the waterside toe of the levee. Construction of the waterside toe cutoff wall will require constructing a work bench along the toe of the levee. Excavation for the bench will extend deep enough below existing grade to remove organic material and soft, unsuitable foundation soils. Bench excavation will also extend into the existing waterside slope of the levee as needed. Riprap will be placed on the waterside benches after construction of the waterside toe cutoff wall. Some portions of the Arcade Creek north levee will require more substantial excavation and reconstruction of the waterside slope to provide a low permeable seepage levee slope barrier. Bench fill material will be integrated with the slope reconstruction fill to provide an integral seepage barrier with the cutoff wall over the full height of the levee slope. A small section of levee will have a sheet pile cutoff wall at the centerline of the levee, rather than the waterside toe cutoff wall.

There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path, and could affect the stability of the levee. The ditch will be replaced with a conduit or box culvert and then backfilled. This will lengthen the seepage path and improve the stability of the levee. Additionally, pressure relief wells will be installed along the landside toe of the levee along the north levee west of Norwood Avenue.

The majority of the Arcade Creek levees have existing floodwalls, however there remains a height issue in this reach. A 1 to 4-foot floodwall will allow the levees to pass flood events greater than the current design level. The floodwall will be placed on the waterside hinge point of the levee and will be designed to disturb a minimal amount of waterside slope and levee crown for construction. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with aggregate base.

Dry and Robla Creeks

The Dry and Robla Creeks levees require improvements to address overtopping when flood events exceed the design level. Height improvements will be made with a new floodwall constructed to a height of 4 to 6 feet along 2,500 LF of the south levee. The floodwall will be placed at the waterside hinge point of the levee and will be designed to disturb a minimal amount of waterside slope and levee crown for construction. Construction of the floodwall will be consistent with the description for Arcade Creek above. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with aggregate base.

Magpie Creek Diversion Canal

The Magpie Creek Diversion Canal project description is the same as was described in the September 15, 2004 biological opinion.

Sacramento Weir and Bypass

The Sacramento Weir was completed in 1916. It is the only weir in the Sacramento River Flood Control Project that is manually operated; all others overflow by gravity on their own. It is located along the right bank of the Sacramento River about 4 miles upstream of the Tower Bridge, and about 2 miles upstream from the confluence with the American River. Its primary purpose is to protect the city of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The weir limits flood stages (water surface elevations) in the Sacramento River to project design levels through the Sacramento/West Sacramento area. Downstream of the Sacramento Weir, the design flood capacity of the American River is 5,000 cfs higher than that of the Sacramento River. Flows from the American River channel during a major flood event often exceed the capacity of the Sacramento River downstream of the confluence. When this occurs, floodwaters flow upstream from the mouth of the American River to the Sacramento Weir.

The project design capacity of the weir is 112,000 cfs. It is currently 1,920 feet long and consists of 48 gates to divert floodwaters to the west through the mile-long Sacramento Bypass to the Yolo Bypass. Each gate has 38 vertical wooden plank "needles" (4 inches thick by 1 foot wide by 6 feet long).

Though the weir crest elevation is 24.75 feet, the weir gates are not opened until the river reaches 27.5 feet at the I Street gage with a forecast to continue rising. This gage is about 1,000 feet upstream from the I Street Bridge and about 3,500 feet upstream from the mouth of the American River. The number of gates to be opened is determined by the National Weather Service/DWR river forecasting team to meet either of two criteria: (1) to prevent the stage at the I Street gage from exceeding 29 feet, or (2) to hold the stage at the downstream end of the weir to 27.5 feet (DWR 2010). The weir gates are then closed as rapidly as practicable once the stage at the weir drops below 25 feet. This provides "flushing" flows to re-suspend sediment deposited in the Sacramento River between the Sacramento Weir and the American River during the low flow periods when the weir is open during the peak of the flood event (DWR 2010).

The Sacramento Weir and Bypass will be expanded to roughly twice their current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass will be degraded and a new levee would be constructed 1,500 feet to the north. The existing Sacramento Weir will be expanded to match the wider bypass. At this time, it is not known whether the new segment of weir will be constructed consistent with the 1916 design described above, or whether it

will be designed to be a gravity-type weir. The new north levee of the bypass will be designed to be consistent with the existing Sacramento Bypass north levee; however, it will also include a 300-foot-wide seepage berm on the landside with a system of relief wells. A hazardous, toxic, and radiological waste site near the existing north levee will be remediated by the non-Federal sponsor prior to construction.

Operation of the new segment of the Sacramento Weir will occur during high water situations only, when the American River flows exceed 115,000 cfs. The existing Sacramento Weir will be operating at the pre-existing conditions described above. There are not expected to be any water quality impacts, though this has not been specifically modeled. The approximate change in water diversions, which are shown in Table 2, will vary based on the size of the flood event. The frequency of water diversion is expected to be the same, dependent on the stream gage at the I Street Bridge reaching 27.5 feet.

The widened portion of the Sacramento Weir will only be operated when the release from Folsom Dam is above 115,000 cfs. With the Folsom Dam improvements in place, releases from Folsom Dam will be above 115,000 cfs for flood events greater than the 100-year event. Therefore, for events up to and including the 100-year event, only the existing weir will be operated per the criteria previously established. For events greater than the 100-year event, when the release from Folsom Dam will go above 115,000 cfs, the new weir will be opened. Therefore, for events up to the 100-year event there will be no change in flow conditions in the Sacramento and Yolo Bypasses.

Table 2. Comparison of 10-, 100-, and 200-year Frequency Flows under Various Conditions

10-Year Event	Existing Condition	Future Without Project Condition	Future With Project Condition
American River	43,000 cfs	72,000 cfs	72,000 cfs
Sacramento Bypass	50,000 cfs	66,000 cfs	66,000 cfs
Yolo Bypass below Sacramento Bypass	270,000 cfs	296,000 cfs	296,000 cfs
100-Year Event	Existing Condition	Future Without Project Condition	Future With Project Condition
American River	145,000 cfs	115,000 cfs	115,000 cfs
Sacramento Bypass	131,000 cfs	115,000 cfs	115,000 cfs
Yolo Bypass below Sacramento Bypass	555,000 cfs	535,000 cfs	535,000 cfs
200-Year Event	Existing Condition	Future Without Project Condition	Future With Project Condition
American River	320,000 cfs	160,000 cfs	160,000 cfs
Sacramento Bypass	183,000 cfs	149,000 cfs	164,000 cfs
Yolo Bypass below Sacramento Bypass	656,000 cfs	631,000 cfs	643,000 cfs

For the 200-year event, there will be an increase in flows in the Sacramento Bypass of about 15,000 cfs. In the Yolo Bypass, this equates to an increase of about 0.10-foot of water surface elevation. During the 200-year event, the Yolo Bypass is already flooded from levee to levee. The addition of these flows will equate to about 0.5-foot of additional width on the Yolo Bypass levee slopes.

High Hazard Levee Encroachment and Vegetation Removal

The National Flood Insurance Program (NFIP) standards for levee accreditation and the State's ULDC both require removal or modification of encroachments that pose an unacceptably high risk to the performance and safety of a levee either by undermining its structural integrity or by interfering with necessary inspection, operation, and maintenance activities. To address this requirement, SAFCA has identified and evaluated all of the encroachments in the NEMDC, Robla Creek, and Arcade Creek area. Each of these encroachments has been evaluated and based on this evaluation the encroachments have been classified as either:

- High-risk – poses a threat to levee integrity, removable prior to the levee being accredited;
- High-risk – impedes operation, maintenance, and inspection, removable within 3 years after the levee is accredited; or
- Low-risk – not identified as high hazard.

High-risk encroachments to be removed are limited to residential landscaping located at 10 locations along the landside of the south and north levees of Arcade Creek and along the Robla Creek south levee.

Vegetation on levees must be modified or removed if it presents an unacceptable risk to the structural integrity or impedes operation and maintenance of the levee. Eight high-risk trees along Arcade Creek have been identified for removal. All of the trees are either nonnative (7) or snags (1). Five are located on the waterside of the levees. These trees are in addition to any trees that will be removed as a result of implementation of levee improvements in the Arcade Creek area.

Utility Relocation

Existing encroachments and penetrations within the NEMDC and Arcade Creek have been inventoried by SAFCA. Many utilities will be avoided, however some utilities may need to be temporarily removed or relocated prior to construction. Temporary bypass pumping may be required for sanitary sewers. SAFCA and the construction contractors will coordinate with utility owners to manage the utilities in advance of construction. Disturbed utilities will be restored after construction consistent with Central Valley Flood Protection Board requirements.

Stormwater Pollution Prevention

Temporary erosion/runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. These temporary control measures may include implementing construction staging in a manner that minimizes the amount of area disturbed at any one time; secondary containment for storage of fuel and oil; and the management of stockpiles and disturbed areas by means of earth berms, diversion ditches, straw wattles, straw bales, silt fences, gravel filters, mulching, revegetation, and temporary covers as appropriate. Erosion and stormwater pollution control measures will be consistent with National Pollutant Discharge Elimination System (NPDES) permit requirements and included in a Stormwater Pollution Prevention Plan (SWPPP).

After completion of construction activities, the temporary facilities (construction trailers and batch plants) will be removed and the site would be restored to pre-project conditions. Site restoration activities for areas disturbed by construction activities, including borrow areas and staging areas, will

include a combination of regrading, reseeding, constructing permanent diversion ditches, using straw wattles and bales, and applying straw mulch and other measures deemed appropriate.

Borrow Sites, Haul Routes, and Staging Areas

Borrow Sites - It is estimated that a maximum of 1 million cubic yards (cy) of borrow material will be needed to construct the project. Detailed studies of the borrow needs have not been completed. Actual volumes exported from any single borrow site will be adjusted to match demands for fill. Borrow sites will be selected that avoid effects to endangered species or their habitat.

To identify potential locations for borrow material soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. Except as discussed below for Arcade Creek and NEMDC, eventual borrow site selection will include the following criteria: avoid threatened and endangered species effects and habitat, current land use patterns, and soil types.

Excavation limits on the borrow sites will provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation will be no steeper than 3:1. Excavation depths from the borrow sites will be determined based on available suitable material. The borrow sites will be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites will be returned to their existing use whenever possible, or these lands could be used to mitigate for project effects, if appropriate.

Because SAFCA has completed more detailed design and studies for work along NEMDC and Arcade Creek the borrow site has been selected. Borrow site 2 is located along the east side of the NEMDC north of where the levee repairs will occur. About 27,000 cubic yards of material will be excavated from the 5.5-acre borrow site in order to construct levee improvements along the NEMDC and Arcade Creek. Following borrow activities the site will be contoured to create about 0.5 acre of tule bench, set an elevation the will provide aquatic habitat all year, 1.0 acre of higher bench with seasonal wetlands, that will flood in the winter and spring, and 3.5 acres of native grassland.

Clean rock will be commercially acquired in order to construct the American and Sacramento River bank protection sites. For the Sacramento River, rock will be acquired from a commercial source in the Bay Area and barged up the Sacramento River to the construction sites. Rock for the American river sites will be acquired from a commercial source within a 50-mile radius and will be hauled in trucks to the construction sites.

Haul Routes – Haul routes will be determined during the design phase and will depend on what borrow sites and staging areas are selected. Haul routes will be selected based on existing commercial routes and levee roads. Haul routes will be selected that avoid effects to federally listed species.

For Arcade Creek and NEMDC, haul trucks will leave borrow site 2 and use East Levee Road from the borrow site down to a point just north of the existing Del Paso/Main Avenue Bridge over NEMDC. Temporary bridges crossing the NEMDC and Arcade Creek will be used to allow haul trucks to reach repair sites. Railroad car undercarriages on temporary abutment supports will be one option for temporary bridge crossings.

Staging Areas – Staging areas will be selected that do not require the removal of vegetation or habitat that is used by threatened or endangered species or effect threatened or endangered species. Four potential staging areas have been identified for improvements along Arcade Creek. All four

areas will require little preparation other than surface striping and temporary connection roads and ramps to the levee crown. The primary use of staging areas will be for temporary trailers, parking, and material staging. Additionally, there will need to be space to process material and an area where excavated soils and imported soils will be spread out and processed material. Importing, processing, and exporting material for levee reconstruction will be continuous activities once the work flow is established during the start of the construction season. Staging areas will be returned to pre-project conditions following construction activities unless the owner agrees to some grade raising to help dispose of excess construction soils.

Operation and Maintenance

Operation and maintenance (O&M) of the levees in the Sacramento area are the responsibility of the local maintaining agencies, including the American River Flood Control District, the DWR, and the City of Sacramento. The applicable O&M Manual for the Sacramento area levees is the Standard Operation and Maintenance Manual for the Sacramento Flood Control Project. Typical levee O&M in the Sacramento in the Sacramento area currently includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.
- Post-construction, groundwater levels will be monitored using the piezometers.

The Corps will work with local maintaining agencies to develop the maintenance activities necessary for long-term operations and maintenance. This will occur during the preconstruction engineering and design phase of the project. The Corps will evaluate if these maintenance activities will affect any Federally-listed species and reinitiate section 7 consultation if there will be adverse effects to listed species. Currently, the Corps only has a project description for activities that will affect valley elderberry longhorn beetle habitat. This is included below.

Following construction, the O&M manual for these reaches will be adjusted to reflect the vegetation variance and the SWIF plan. Under the adjusted O&M manual, large trees that are protected in place under the variance will be allowed to remain on the waterside slopes and additional vegetation will be planted on the planting benches.

Vegetation maintenance includes keeping maintenance roads clear of overhanging branches. Some of the vegetation along the levees includes elderberry shrubs. As part of long-term O&M, elderberry shrubs will be trimmed by the three levee maintenance districts. Table 3 describes the maximum amount of elderberry acreage that will be trimmed each year as a result of O&M. Trimming consists of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. Up to a third of a shrub will be trimmed in a single season. Trimming will occur between November 1 and March 15. Loss of habitat will be offset through the development of a conservation area as described in the conservation measures below. Each year the local maintaining agency will document the amount of valley elderberry longhorn beetle habitat that they have trimmed and report that number to the Corps to ensure compliance with this biological opinion. If the local maintaining agency has a need to exceed the amount of valley elderberry longhorn beetle

habitat which needs to be trimmed or affected due to routine maintenance, then they will request the Corps reinitiate consultation on this biological opinion for those actions.

Table 3. O&M by Maintaining Agency

Local Maintaining Agency	Levee Systems Covered	Annual Acreage of Trimmed Elderberry Shrubs*	Total Acreage of Elderberry Shrubs Trimmed over the 50 Year Life of the Project
American River Flood Control District	Lower American River, Dry/Robla Creek, Arcade Creek, NEMDC	0.5	25
Maintenance Area 9	Sacramento River east levee between Sutterville Road and the Beach Lake Levee	0.2	10
City of Sacramento	Sacramento River East Levee between the confluence of the American River and Sutterville Road	0.1	5

*acreage based on an estimated average shrub of 0.027 acre and no more than 1/3 of a shrub trimmed any given year.

Valley Elderberry Longhorn Beetle Habitat

Valley elderberry longhorn beetles are closely associated with elderberry shrubs. In 2011, the Corps conducted surveys and mapped all of the elderberry shrubs on the levees and 15 feet on either side of the levee. Elderberry shrubs were located along the American River and Sacramento River. The Corps counted shrub clusters and used elderberry stem counts from previous projects in the area to estimate a standard number and size of elderberry stems per shrub cluster. Tables 4 and 5 list the stem counts for shrubs along the American River and Sacramento River respectively. While shrubs exist along Arcade Creek or Magpie Creek, the Corps and SAFCA will avoid effects to the beetle by following the conservation measures below.

Table 4. American River Elderberry Shrub Effects and Compensation

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios	Elderberry Plantings	Associated Native Planting	Associated Native Ratios
riparian	> or = 1" & < or = 3"	no	1,998	2	3,996	3,996	1
		yes	0	4	0	0	2
riparian	> 3" & < 5"	no	790	3	2,370	2,370	1
		yes	16	6	96	192	2
Riparian	> or = 5"	no	312	4	1,248	1,248	1
		yes	23	8	184	368	2
TOTAL			**3,139**		**7,894**	**8,174**	
				total basins or credits=	1,606.8		
				total acres for compensation	66.40		

Table 5. Sacramento River Elderberry Shrub Effects and Compensation

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios	Elderberry Plantings	Associated Native Plantings	Associated Native Ratios
riparian	> or = 1" & < or = 3"	no	104	2	208	208	1
		yes	0	4	0	0	2
riparian	> 3" & < 5"	no	40	3	120	120	1
		yes	1	6	6	12	2
riparian	> or = 5"	no	16	4	64	64	1
		yes	2	8	16	32	2
TOTAL			**163**		**414**	**436**	
				total basins or credits=	85		
				total acres need for compensation	3.51		

Delta Smelt Habitat

The American River lacks suitable turbidity making it unsuitable for delta smelt. Due to the higher temperatures within Arcade Creek, Magpie Creek, and NEMDC it is also unlikely that delta smelt will use these tributaries. Therefore, suitable delta smelt habitat occurs within the Sacramento River in the reach where erosion protection will occur. The Corps has calculated that there will be a complete loss of 14 acres of shallow water habitat due to the placement of riprap and a change of substrate from natural soil to riprap on 32 acres.

Giant Garter Snake Habitat

Giant garter snakes are not known to use large rivers such as the American and Sacramento Rivers. Given the close proximity to urban development, high level of human disturbance, presence of riparian vegetation along the banks of most channel reaches, and lack of extensive marsh or rice to the east, giant garter snakes are unlikely to occur in Arcade Creek, Dry Creek, Robla Creek, Magpie Creek, or the southern section of the NEMDC (south of where Dry Creek enters). North of Dry Creek, the NEMDC has less woody vegetation, less urban development, and large areas of open grassland along the landside of the levee with rice farming occurring to the west of the grasslands. Therefore, there is potential for the snake to occur either in the upland or within the NEMDC north of where Dry Creek enters. Work in this location will involve removal of borrow material at borrow site 2 (5.5 acres of upland habitat).

Habitat for the giant garter snake also exists north of the existing Sacramento Bypass north levee. The land north of the Sacramento Bypass is currently agricultural fields producing row crops and nut orchards. Existing giant garter snake aquatic habitat occurs in drainage ditches and farm canals and the surrounding upland habitat. About 15 acres of aquatic habitat will be filled making it and the associated 30 acres of upland habitat unavailable to the giant garter snake. The Sacramento Bypass also has a toe drain along the levee with 25 acres of aquatic and 50 acres of upland habitat that will be relocated to the toe of the new Sacramento Bypass levee.

Yellow-billed Cuckoo Habitat

Yellow-billed cuckoos use riparian habitat for foraging and nesting. Suitable habitat occurs within the lower American River. The project will affect 65 acres of riparian habitat that could be used by the yellow-billed cuckoo. While riparian habitat occurs along Arcade Creek, Magpie Creek, and NEMDC it is very narrow and cuckoos are not likely to use these areas. Riparian habitat occurs along the Sacramento River and in some areas may be of such a width that a cuckoo could stop and use it during migration, but it is not wide enough to support a nesting pair of cuckoos. The Corps will remove 110 acres of riparian habitat along the Sacramento River and disturb an additional 50 acres of riparian habitat by removing the understory and placing rock around the large trees. The Sacramento Bypass does not have suitable habitat for the yellow-billed cuckoo. But riparian habitat does exist north of the existing Sacramento Weir along the Sacramento River (8 acres). Cuckoos have been observed in the Yolo Bypass in recent years (Ebird 2015).

Conservation Measures

Valley Elderberry Longhorn Beetle

- The Corps assumes complete avoidance of the valley elderberry longhorn beetle when a 100-foot (or wider) buffer is established and maintained around elderberry shrubs.
- When work will occur within the 100-foot buffer, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.
- During construction activities, all areas to be avoided will be fenced and flagged.
- Contractors will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs will be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area will be restored.
- Buffer areas will continue to be protected after construction.
- No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Elderberry shrubs that cannot be avoided would be transplanted to an appropriate riparian area at least 100 feet from construction activities.
- Elderberry shrubs will be surveyed prior to construction to ensure that the actual effects match the estimated effects of this biological opinion. If the Corps will effect more valley elderberry longhorn beetle habitat than estimated than they will reinitiate consultation with the Service.
- If possible, elderberry shrubs would be transplanted during their dormant season (November through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation will apply.
- Elderberry compensation will be planted in the American River Parkway. The Corps has six existing sites which are offsetting previous Corps flood control projects along the lower American River and near Folsom Dam. The Corps will find areas within the lower American River parkway which will either expand existing compensation areas or provide for connectivity between conserved valley elderberry longhorn beetle habitat. Sites within the lower American River parkway will be coordinated with Sacramento County Parks and the Service during the design phase of the project. Sites will be designed and developed prior to any effects to valley elderberry

longhorn beetle habitat. The Corps will create 69.91 acres of riparian habitat which supports valley elderberry longhorn beetle within the lower American River parkway for the transplantation of elderberry shrubs. In addition, the local sponsors will create an additional 40 acres of land to benefit the valley elderberry longhorn beetle or purchase 40 acres of credits at a Service approved conservation bank to offset the loss of habitat due to trimming of elderberry shrubs along the lower American River, Sacramento River, Dry/Robla Creeks, Arcade Creek, Magpie Creek, and NEMDC.

- Management of these lands will include all measures specified in the Service's conservation guidelines (1999a) related to weed and litter control, fencing, and the placement of signs.
- Monitoring will occur for 10 consecutive years or for 7 non-consecutive years over a 15-year period. Annual monitoring reports will be submitted to the Service.
- Compensation areas will be protected in perpetuity and have a funding source for maintenance (endowment).

Giant Garter Snake

- Unless approved otherwise by the Service, construction will be initiated only during the giant garter snakes' active period (May 1–October 1, when they are able to move away from disturbance).
- Construction personnel will be given a Service-approved worker environmental awareness program.
- A survey for giant garter snakes will be conducted within 24 hours prior to construction beginning in potential giant garter snake habitat. Should there be any interruption in work for greater than 2 weeks, a biologist will resurvey the area within 24 hours prior to the restart of construction.
- Giant garter snakes encountered during construction will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from giant garter snake aquatic habitat.
- Giant garter snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.
- Habitat temporarily affected for one season (the 5.5 acre borrow site along the NEMDC and the 75 acres along the toe drain of the Sacramento Bypass levee) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants. If for any reason construction extends into another active season the Corps will replace the habitat on-site and purchase credits at a ratio of 1:1 at a Service approved conservation bank.
- Habitat temporarily affected for more than three or more seasons will be restored and twice as much habitat will be created.
- Habitat permanently affected in the Sacramento Bypass in the form of drainage ditches and irrigation canals will be compensated for through the purchase of 135 acres of credits at a Service approved conservation bank.
- One year of monitoring will be conducted for the 80.5 acres that are temporarily affected.

- The Corps will purchase credits at a conservation bank prior to any permanent disturbance of giant garter snake habitat.
- A biological monitor will be on-site during all ground disturbing activities at borrow site 2.
- Exclusionary fencing will be placed, at least 10 days prior to the beginning of ground disturbing activities after May 1, to exclude giant garter snakes from entering areas where upland disturbance (borrow site 2 and Sacramento Bypass) will occur during the active season (May 1 to October 1). Prior to fencing installation, the fence line will be mowed (with a minimum height of 6 inches) in order to conduct a surface survey of potential burrows. Fencing will be installed with a minimum of 6 inches buried in the ground and a minimum of 24 inches above ground. Fence staking will be installed on the inside of the exclusion area. One-way escape funnels will be installed every 50 to 100 feet and sealed along the fence line to provide an escape for any giant garter snake that may be within the exclusion area. The fencing will enclose the entirety of the site, or additional exclusionary fencing can be extended 200 to 400 feet beyond the proposed entrance area. The fencing will be inspected before the start of each work day and maintained by the contractor until completion of the project. The fencing will be removed only when project activities are completed.

Yellow-Billed Cuckoo

- Prior to construction, surveys will be conducted to determine the presence of yellow-billed cuckoos within the project area in accordance with any required Service survey protocols and permits at the time of construction.
- If surveys find cuckoos in the area, vegetation removal will be done outside of the cuckoo nesting season.
- Riparian habitat that is removed due to project construction along the American River will be replanted within the American River parkway. The Corps intends to expand existing conserved riparian lands within the parkway that could support the yellow-billed cuckoo. The design of replacement riparian areas will be coordinated with the Service to ensure that the habitat benefits both valley elderberry longhorn beetles and yellow-billed cuckoos.

Fisheries Conservation Measures

- In-water construction activities (e.g., placement of rock revetment) will be limited to the work window of August 1 through November 30. If the Corps wants to work outside of this window they will consult with National Marine Fisheries Service (NMFS) and/or the Service.
- The Corps will purchase 42 acres of delta smelt credits from a Service-approved conservation bank to off-set the loss of 14 acres of shallow water habitat.
- The Corps will purchase an additional 32 acres of delta smelt credits from a Service-approved conservation bank to off-set the loss of spawning habitat due to the placement of riprap on the river bed.
- Erosion control measures (BMPs), including Storm Water Pollution Prevention Program and Water Pollution Control Program, that minimize soil or sediment from entering the river shall be installed, monitored for effectiveness, and maintained

throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.

- Screen any water pump intakes, as specified by NMFS and the Service screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.
- The Corps shall include as part of the project, a Riparian Corridor Improvement Plan with the overall goal of maximizing the ecological function and value of the existing levee system within the Sacramento Metropolitan area.

Additional Minimization and Conservation Measures

- Obtain an ETL approved vegetation variance exempting sites from vegetation removal prior to final design and construction phase for the Sacramento River.
- Construction will be scheduled when listed terrestrial and aquatic species will be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present, then coordination/reinitiation with the Service will occur.
- Compensation for impacts to native riparian habitat will occur on a 2:1 basis on-site or in close proximity to the impact area. Riparian vegetation impacted under the SAFCA 408/404 actions will be replaced on a 3:1 canopy cover acreage basis.
- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110% containment system.
- Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetland areas.
- Implement BMPs to prevent slurry from seeping out to the river and require piping systems on the landside of the levee.
- Project related vehicles will observe a 20-mile-per-hour speed limit within construction areas, except on County roads and on State and federal highways.
- Site access will be limited to the smallest area possible in order to minimize disturbance. Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
- Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
- Designating a Service approved biologist as a point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of the effects assessment, the action area encompasses the Sacramento River from the Sacramento Bypass downstream to River Mile 45, the Yolo Bypass south the confluence of the Sacramento Bypass, the lower American River from Arden Way to the confluence of the Sacramento River, Arcade Creek from Marysville Boulevard to the confluence of the NEMDC, the NEMDC from the south Dry

Creek levee to just south of the NEMDC Arcade Creek confluence, the southern Dry Creek levee between Dry Creek Road and Rose Street, the borrow site along the NEMDC, and any borrow sites. Additionally, we are including a buffer of 300 feet from construction to account for effects to listed species due to dust and noise.

Analytical Framework for the Jeopardy Analysis

The following analysis relies on four components to support the jeopardy determination for the giant garter snake, valley elderberry longhorn beetle, yellow-billed cuckoo, and delta smelt: (1) the *Status of the Species*, which evaluates the species' range-wide condition, the factors responsible for that condition, and their survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the role of the action area in the species' survival and recovery; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on these species; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on these species.

In accordance with the implementing regulations for section 7 and Service policy, the jeopardy determination is made in the following manner: the effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the current status of the delta smelt, valley elderberry longhorn beetle, giant garter snake, and yellow-billed cuckoo. Additionally, for non-Federal activities in the action area, we will evaluate those actions likely to affect the species in the future, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both its survival and recovery in the wild.

The following analysis places an emphasis on using the rang-wide survival and recovery needs of the delta smelt, valley elderberry longhorn beetle, giant garter snake, and yellow-billed cuckoo, and the role of the action area in providing for those needs as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Analytical Framework Adverse Modification

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.2. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the *Status of the Critical Habitat*, which evaluates the range-wide condition of critical habitat for the delta smelt in terms of primary constituent elements (PCE)s, the factors responsible for that condition, and the intended recovery function of the critical habitat at the provincial and range-wide scale; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units and; (4) *Cummulative Effects,* which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on the delta smelt critical habitat are evaluated in the context of the range-wide condition of the critical habitat at the provincial and range-wide scales, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the delta smelt.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of delta smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species and Environmental Baseline

Valley Elderberry Longhorn Beetle Status of the Species

Please refer to the *Withdrawl of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife* (Service 2014) for the current status of the species. Ongoing threats to the valley elderberry longhorn beetle include habitat loss due to flood control projects, development projects, and invasive species. While these threats continue to affect the valley elderberry longhorn beetle throughout its range, to date no project has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the valley elderberry longhorn beetle.

Valley Elderberry Longhorn Beetle Environmental Baseline

The project footprint along both the Sacramento River and the American River contain riparian vegetation. The beetle is known in numerous locations along the American River parkway (CNDD 2015). Suitable habitat for the beetle in the form of elderberry shrubs occurs within the action area along the Sacramento River, the American River, and Arcade Creek.

Sacramento River - Riparian habitat along the Sacramento River, south of the city of Sacramento, occurs in narrow bands along the riverbank and levee. Generally an overstory layer is present composed of cottonwood, sycamore, and oak trees. Shrubs occur as a mid-story layer including buttonbush, blue elderberry, white alder, and Oregon ash. Elderberry shrubs occur randomly along the reach of river proposed for improvements. The Corps has documented at least 73 elderberry shrubs along the Sacramento River reach where construction is proposed. Natural river processes of erosion and accretion effect elderberry shrubs which is the host plant of the valley elderberry longhorn beetle by eroding away bank and potentially elderberry shrubs. Levee maintenance can adversely affect elderberries within this stretch of the Sacramento River either by pruning or drift of herbicides used along the levee slope.

American River – The valley elderberry longhorn beetles have been identfied along the lower American River Parkway in the CNDDB (2015). Additionally, the Corps has designed and built six sites along the lower American River as habitat for the valley elderberry longhorn beetle. These sites extend from RM 0.9 up to RM 21. Levee maintenance can adversely affect elderberry shrubs, though the largest threat to valley elderberry longhorn beetle is fires that have been started in the parkway and burned habitat that supports valley elderberry longhorn beetles.

Delta Smelt Status of Species

Listing Status: The Service proposed to list the delta smelt as threatened with proposed critical habitat on October 3, 1991 (56 FR 50075). The Service listed the delta smelt as threatened on March 5, 1993 (58 FR 12854), and designated critical habitat for this species on December 19, 1994 (59 FR 65256). The delta smelt was one of eight fish species addressed in the *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (Service 1996). This recovery plan is currently under revision. A 5-year status review of the delta smelt was completed on March 31, 2004 (Service 2004). The 2004 review affirmed the need to retain the delta smelt as a threatened species. A 12-month finding on a petition to reclassify the delta smelt was completed on April 7, 2010 (75 FR 17667). After reviewing all available scientific and commercial information, the Service determined that re-classifying the delta smelt from a threatened to an endangered species was warranted, but precluded by other higher priority listing actions (Service 2010).

Distribution: The delta smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The delta smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary.

Description: Live delta smelt are nearly translucent with a steely-blue sheen to their sides and have been characterized to have a pronounced odor reminiscent of cucumber (Moyle 2002). Although delta smelt have been recorded to reach lengths of up to 120 millimeters (mm) (4.7 in) (Moyle 2002), mean fork length of the delta smelt from 1974 to 1991 was measured to be 64.1 ± 0.1 mm. Since then, catch data from 1992 - 2004 showed mean fork length decreased to 54.1 ± .01 mm (Bennett 2005; Sweetnam 1999). Delta smelt are also identifiable by their relatively large eye to head size (Moyle 2002). Delta smelt have a small, translucent adipose fin located between the dorsal and caudal fins.

The delta smelt is one of six species currently recognized in the *Hypomesus* genus (Bennet 2005). Genetic analyses have confirmed that *H. transpacificus* presently exists as a single intermixing population (Stanley *et al.* 1995; Trenham *et al.* 1998; Fisch *et al.* 2011). Within the genus, delta smelt is most closely related to surf smelt (*H. pretiosis*), a species common along the western coast of North America. Despite morphological similarities, the delta smelt is less-closely related to the wakasagi (*H. nipponensis*), an andadromous western Pacific species introduced to Central Valley reservoirs in 1959, and may be seasonally sympatric with delta smelt in the estuary (Trenham *et al.* 1998). Allozyme studies have demonstrated that wakasagi and delta smelt are genetically distinct and presumably derived from different marine ancestors (Stanley *et al.* 1995).

Life History and Biology

Adult-Spawning: Adult delta smelt spawn during the late winter and spring months, with most spawning occurring during April through mid-May (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta. Delta smelt spawning has also been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most spawning occurs at temperatures between 12-18°C. Although spawning may occur at temperatures up to 22°C, hatching success of the larvae is very low (Bennett 2005).

Fecundity of females ranges from about 1,200 to 2,600 eggs, and is correlated with female size (Moyle 2002). Moyle *et al.* (1992) considered delta smelt fecundity to be "relatively low." However,

based on Winemiller and Rose (1992), delta smelt fecundity is fairly haigh for a fish its size. Captive delta smelt can spawn up to 4-5 times. While most adults do not survive to spawn a second season, a few (<5 percent) do (Moyle 2002; Bennett 2005). Those that do survive are typically larger (90-110 mm Standard Length[sdl]) females that may contribute disproportionately to the population's egg supply (Moyle 2002 and references therein). Two-year-old females may have 3-6 times as many ova as first year spawners.

Most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the California Department of Fish and Wildlife Spring Kodiak Trawl (SKT) and 20-mm Survey, respectively. In the laboratory, delta smelt spawned at night (Baskerville-Bridges *et al.* 2000; Mager *et al.* 2004). Other smelts, including marine beach spawning species and estuarine populations and the landlocked Lake Washington longfin smelt, are secretive spawners, entering spawning areas during the night and leaving before dawn. If this behavior is exhibited by delta smelt, then delta smelt distribution based on the SKT, which is conducted during daylight hours in offshore habitats, may reflect general regions of spawning activity, but not actual spawning sites.

Delta smelt spawning has only been directly observed in the laboratory and eggs have not been found in the wild. Consequently, what is known about the mechanics of delta smelt spawning is derived from laboratory observations and observations of related smelt species. Delta smelt eggs are 1 mm diameter and are adhesive and negatively buoyant (Moyle 1976, 2002; Mager *et al.* 2004; Wang 1986, 2007). Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the bottom over substrates of sand and/or pebble in current (DWR and Reclamation 1994; Brown and Kimmerer 2002; Lindberg *et al.* 2003; Wang 2007). Spawning over gravel or sand can also aid in the oxygenation of delta smelt eggs. Eggs that may have been laid in silt or muddy substrates might get buried or smothered, preventing their oxygenation from water flow (Lindberg pers. comm. 2011). The eggs of surf smelts and other beach spawning smelts adhere to sand particles, which keeps them negatively buoyant but not immobile, as the sand may move ("tumble") with water currents and turbulence (Hay 2007). It is not known whether delta smelt eggs "tumble incubate" in the wild, but tumbling of eggs may moderately disperse them, which might induce predation risk within a localized area.

The locations in the Delta where newly hatched larvae are present, most likely indicates spawning occurrence. The 20-mm trawl has captured small (~5 mm sdl) larvae in Cache Slough, the lower Sacramento River, San Joaquin River, and at the confluence of these two rivers (e.g., 20-mm trawl survey 1 in 2005). Larger larvae and juveniles (size > 23 mm sdl), which are more efficintly sampled by the 20-mm trawl gear, have been captured in Cache Slough and the Sacramento Deep Water Ship Channel in July (e.g. 20-mm trawl survey 9 in 2008). Because they are small fish inhabiting pelagic habitats with strong tidal and river currents, delta smelt larval distribution depends on both the spawning area from which they originate and the effect of transport processes caused by flows. Larval distribution is further affected by water salinity and temperature. Hydrodynamic simulations reveal that tidal action and other factors may cause substantial mixing of water with variable salinity and temperature among regions of the Delta (Monson *et al.* 2007). This could result in rapid dispersion of larvae away from spawning sites.

The timing of spawning may affect delta smelt population dynamics. Lindberg (2011) has suggested that smelt larvae that hatch early, around late February, have an advantage over larvae hatched during late spawning in May. Early season larvae have a longer growing season and may be able to grow larger faster during more favorable habitat conditions in the late winter and early spring. An early growing season may result in higher survivorship and a stronger spawning capability for that

generation. Larvae hatched later in the season have a shorter growing season which effectively reduces survivorship and spawning success for the following spawning season.

Larval Development: Mager *et al.* (2004) reported that embryonic development to hatching takes 11-13 days at 14-16° C for delta smelt, and Baskerville-Bridges *et al.* (2000) reported hatching of delta smelt eggs after 8-10 days at temperatures between 15-17° C. Lindberg *et al.* (2003) reported high hatching rates of delta smelt eggs in the laboratory at 15° C, and Wang (2007) reported high hatching rates at temperatures between 14-17° C. Hatching success peaks near 15°C (Bennett 2005) and swim bladder inflation occurring at 60-70 days post hatch at 16-17°C (Mager *et al.* 2004). At hatching and during the succeeding three days, larvae are buoyant, swim actively near the water surface, and do not react to bright direct light (Mager *et al.* 2004). As development continues, newly hatched delta smelt become semi-buoyant and sink in stagnant water. However, larvae are unlikely to encounter stagnant water in the wild.

Growth rates of wild-caught delta smelt larvae are faster than laboratory-cultured individuals. Mager *et al.* (2004) reported growth rates of captive-raised delta smelt reared at near-optimum temperatrues (16-17°C). Their fish were about 12 mm long after 40 days and about 20 mm long after 70 days. In contrast, analyses of otoliths indicated that wild delta smelt larvae were 15-25 mm, or nearly twice as long at 40 days of age (Bennett 2005). By 70 days, most wild fish were 30-40 mm long and beyond the larval stage. This suggests there is a strong selective pressure for rapid larval growth in nature, a situation that is typical for fish in general (Houde 1987). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges *et al.* 2000; Mager *et al.* 2004; Baskerville-Bridges *et al.* 2004). The food available to larval fishes is constrained by mouth gape and status of fin development. Larval delta smelt cannot capture as many kinds of prey as larger individuals, but all life stages have small gapes that limit their range of potential prey. Prey availability is also constrained by habitat use, which affects what types of prey are encountered. Larval delta smelt are visual feeders. They find and select individual prey organisms and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges *et al.* 2004). Thus, delta smelt diets are largely comprised of small crustacea that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval delta smelt have particularly restricted diets (Nobriga 2002). They do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods, *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding delta smelt larvae are largely restricted to the larval stages of these copepods; older, larger life stages of the copepods are increasingly targeted as the delta smelt larvae grow, their gape increases, and they become stronger swimmers.

The triggers for and duration of delta smelt larval movement from spawning areas to rearing areas are not known. Hay (2007) noted that eulachon larvae are probably flushed into estuaries from upstream spawning areas within the first day after hatching, but downstream movement of delta smelt larvae occurs much later. Most larvae gradually move downstream toward the two parts per thousand (ppt) isohaline (X2). X2 is scaled as the distance in kilometers from the Golden Gate Bridge (Jassby *et al.* 1995).

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow (above normal to wet water years), delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish versus the degree to which they originate upstream and are transported by tidal currents to the bay and marsh is uncertain.

Juveniles: Young-of-the-year delta smelt rear in the low-salinity zone (LSZ) from late spring through fall and early winter. Once in the rearing area growth is rapid, and juvenile fish are 40-50 mm sdl long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). They reach adult size (55-70 mm sdl) by early fall (Moyle 2002). Delta smelt growth during the fall months slows considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al.* 1950; Radtke 1966).

Delta Smelt Population Dynamics and Abundance Trends

As a consequence of channelization, water operations, and agriculture in the Delta there has been a change to the physical appearance, water salinity, water clarity, and hydrology in the Delta such that most life stages of the delta smelt are now distributed across a smaller area than historically (Arthur *et al.* 1996; Feyrer *et al.* 2007). Wang (1991) noted in a 1989 and 1990 study of delta smelt larval distribution that, in general, the San Joaquin River was used more intensively for spawning than the Sacramento River. Nobriga *et al.* (2008) found that delta smelt capture probabilities in the Summer Townet Survey (TNS) are highest at specific conductance levels of 1,000 to 5,000 $\mu S\ cm^{-1}$ (approximately 0.6 to 3.0 practical salinity unit [psu]). Similarly, Feyrer *et al.* (2007) found a decreasing relationship between abundance of delta smelt in the Fall Midwater Trawl (FMWT) and specific conductance during September through December. The location of the low salinity zone (LSZ) and changes in delta smelt habitat quality in the San Francisco Estuary can be indexed by changes in X2. The LSZ historically had the highest primary productivity and is where zooplankton populations (on which delta smelt feed) were historically most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). However, this has not always been true since the invasion of the overbite clam (Kimmerer and Orsi 1996). The abundance of many local aquatic species has tended to increase in years when winter-spring outflow has high and Z2 was pushed seaward (Jassby *et al.* 1995), implying that the quantity and quality (overall suitability) of estuarine habitat increases in years when outflows are high. However, delta smelt is not one of the species whose abundance has statistically covaried with winter-spring freshwater flows (Stevens and Miller 1983; Moyle *et al.* 1992; Kimmerer 2002a; Bennett 2005).

The distribution of juvenile delta smelt has also changed over the last several decades. During the years 1970 through 1978, delta smelt catches in the TNS survey declined rapidly to zero in the Central and South Delta and have remained near zero since. A similar shift in FMWT catches occurred after 1981 (Arthur *et al.* 1996). This portion of the Delta has also had a long-term trend increase in water clarity during July through December (Arthur *et al.* 1996; Feyrer *et al.* 2007; Nobriga *et al.* 2008).

The CDFW has conducted several long-term monitoring surveys that have been used to index the relative abundance of delta smelt. The 20-mm Survey has been conducted every year since 1995. This survey targets late-stage delta smelt larvae. Most sampling has occurred April-June. The TNS has been conducted nearly every year since 1959. This survey targets 38-mm striped bass, but collects similar-sized juvenile delta smelt. Most sampling has occurred June-August. The Fall Midwater Trawl Survey has been conducted nearly every year since 1967. This survey also targets age-0 striped bass, but collects delta smelt > 40 mm in length. The FMWT samples monthly, September-December. The relative abundance index data and maps of the sampling stations used in these surveys are available at http://www.CDFW.ca.gov/delta/. The methods that underlie the surveys have been described previously (Stevens and Miller 1983; Moyle *et al.* 1992; Dege and Brown 2004). The delta smelt catch data and relative abundance indices derived from these sampling programs have been used in numerous publications (e.g., Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995; Kimmerer 2002b; Dege and Brown 2004; Bennett 2005; Feyrer *et al.* 2007; Sommer *et al.* 2007; Kimmerer 2008; Newman 2008; Nobriga *et al.* 2008; Kimmerer *et al.* 2009; Mac

Nally *et al.* 2010; Thomson *et al.* 2010; Feyrer *et al.* 2011; Maunder and Deriso 2011). These abundance index time series document the long-term decline of the delta smelt.

Early statistical assessments of delta smelt population dynamics concluded that at best, the relative abundance of the adult delta smelt population had only a very weak influence on subsequent juvenile abundance (Sweetnam and Stevens 1993). Thus, early attempts to describe abundance variation in delta smelt ignored stock-recruit effects and researchers looked for environmental variables that were directly correlated with interannual abundance variation (e.g., Stevens and Miller 1983; Moyle *et al.* 1992; Sweetnam and Stevens 1993; Herbold 1994; Jassby *et al.* 1995). Because delta smelt live in a habitat that varies in size and quality with Delta outflow, the authors cited above searched for a linkage between Delta outflow (or X2) and the TNS and FMWT indices. Generally, these analyses did not find strong support for an outflow-abundance linkage. These analyses led to a prevailing conceptual model that multiple interacting factors had caused the delta smelt decline (Moyle *et al.* 1992; Bennett and Moyle 1996; Bennett 2005). It has also recently been noted that delta smelt's FMWT index is partly influenced by explanation for why few analyses could consistently link springtime environmental conditions to delta smelt's fall index.

One published exception to the multi-factor hypothesis was proposed by Gilbert (2010), who posited that nutrient pollution was the root cause of all the food web and fish assemblage changes that caused the decline of delta smelt and other pelagic fishes. However, the statistical approach she used to support her hypothesis was not appropriate and the untransformed data sets do not support this hypothesized chain of consequences stemming solely from wastewater inputs to the Delta (Jassby *et al.* in press). It is now recognized that delta smelt abundance plays an important role in subsequent abundance (Bennett 2005; Maunder and Deriso 2011). Bennett (2005) assessed (1) the influence of adult stock as indexed by the FMWT versus the next generation of juveniles indexed by the following calendar year's TNS; (2) the influence of the juvenile stock indexed by the TNS versus the subsequent adult stock indexed a few months later in the FMWT; (3) the influence of the FMWT on the following year's FMWT and on the FMWT two years later, and (4) he did the same for the TNS data. He concluded that (1) two-year-old delta smelt might play an important role in delta smelt population dynamics, (2) it was not clear wheter juvenile production was a density-independent or density-dependent function of adult abundance, and (3) adult production was a density-dependent function of juvenile abundance and the carrying capacity of the estuary to support this life-stage transition had declined over time. These conclusions are also supported by Maunder and Deriso (2011).

The concept of density-dependence and how it has affected the delta smelt is important because it may be used as a reason not to protect particular life stages from sources of mortality. Bennet (2005) concluded it was (statistically) unclear whether density-dependence occurs between generations. He also noted that the delta smelt indices strongly suggest that density-dependence has occurred, at least over the long-term, during the juvenile stage. The uncertainty about density-dependence between generations results because statistical assessments of the relationship between the adult stock and the next generation of recruits (juveniles_ result in similar fits for linear (density-independent) and nonlinear (density-dependent) relationships (Bennett 2005; Maunder and Deriso 2011).

One reason for this is that delta smelt population dynamics may have changed over time. Previous papers have reported a delta smelt step-decline during 1981-1982 (Kimmerer 2002a; Thomson *et al.* 2010). Prior to this decline, the stock-recruit data are consistent with "Ricker" type density-dependence where increasing adult abundance resulted in decreased juvenile abundance. Since the decline, recruitment has been positively and essentially linearly related to prior adult abundance, suggesting that reproduction has been basically density-independent for about the past 30 years.

This means that since the early 1980s, more adults translates into more juveniles and fewer adults translates into fewer juveniles without being 'compensated for' by density-dependence. In contrast to the transition among generations, the weight of scientific evidence strongly supports the hypothesis that, at least over the history of Interagency Ecological Program (IEP) fish monitoring, delta smelt has experienced density-dependence during the juvenile stage of its life cycle, i.e., between the summer and fall (Bennett 2005; Maunder and Deriso 2011). This has been inferred because, statistically, the FMWT index does not increase linearly with increases in the summer townet index. Rather, the best-fitting relationships between the summer townet index and the FMWT index show that the FMWT indices approach an asymptote as the summer townet increases or possibly even declines at the highest summer townet indices.

From a species conservation perspective, the most relevant aspect of this juvenile density dependence is that the carrying capacity of the estuary for delta smelt has declined (Bennett 2005). Thus, the delta smelt population decline has occurred for two basic reasons. First, the compensatory density-dependence that historically enabled juvenile abundance to rebound from low adult numbers stopped happening. This change had occurred by the early 1980s as described above. The reason is still not known, but the consequence of the change is that for the past several decades, adult abundance drives juvenile production in a largely density-independent manner. Thus, if numbers of adults or adult fecundity decline, juvenile production will also decline (Kimmerer 2011). Second, because juvenile carrying capacity has declined, juvenile production hits a 'ceiling' at a lower abundance than it once did. This limits adult abundance and possibly per capita fecundity, which cycles around and limits the abundance of the next generation of juveniles. The mechanism causing carrying capacity to decline is likely due to the long-term accumulation of deleterious habitat changes, both physical and biological, during the summer-fall (Bennett *et al.* 2008; Feyrer *et al.* 2007; 2011; Maunder and Deriso 2011).

Habitat

The existing physical appearance and hydrodynamics of the Delta have changed substantially from the environment in which native fish species like delta smelt evolved. The Delta once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Delta from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002a). For instance, in the early 1900s, the location of maximum salinity intrusion into the Delta during dry periods varied from Chipps Island in the lower Delta to Stockton along the San Joaquin River and Merritt Island in the Sacramento River. Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows (Knowles 2002), though Delta outflows have been tightly constrained during late summer-fall for several decades. The following is a brief description of the changes that have occurred to delta smelt's habitat that are relevant to the environmental baseline for this consultation.

Changes to the LSZ: There have been documented changes to the delta smelt's LSZ habitat that have led to present-day, baseline habitat conditions. The close association of delta smelt with the San Francisco estuary LSZ has been known for many years (Stevens and Miller 1983; Moyle *et al.* 1992). Peterson (2003) developed a conceptual model that hypothesized how, "stationary and dynamic components of estuarine habitats" interacted to influence fisheries production in tidal river estuaries.

Peterson's model suggests that when the dynamic and static aspects of estuarine habitat sufficiently overlap, foraging, growth, density, and survival are all high, and that enables fish production to outpace losses to predators. The result is high levels of successful recruitment of new individuals. The model also hypothesizes that when the dynamic and static aspects of an estuarine habitat do not sufficiently overlap, foraging, growth, density, and survival are impaired such that losses to predators increase and recruitment of new individuals decreases. This model was developed specifically for species spawned in marine environments that were subsequently transported into estuaries. However, the concept of X2, which was developed in the San Francisco estuary to describe how freshwater flow affected estuarine habitat (Jassby *et al.* 1995), played a role in the intellectual development of Peterson's model. The Peterson model also provides a useful framework to conceptualize delta smelt's LSZ habitat.

Currently available information indicates that delta smelt habitat is most suitable for the fish when low-salinity water is near 20°C, highly turbid, oxygen saturated, low in contaminants, supports high densities of calanoid copepods and mysid shrimp (Moyle *et al.* 1992; Lott 1998; Nobriga 2002), and occurs over comparatively static 'landscapes' that support sandy beaches and bathymetric variation that enables the fish and their prey to aggregate (Kimmerer *et al.* 2002a; Bennett *et al.* 2002; Hobbs *et al.* 2006). Almost every component listed above has been degraded over time (see below). The Service has determined that this accumulation of habitat change is the fundamental reason or mechanism that has caused delta smelt to decline.

Alterations to estuarine bathymetry and salinity distribution (~ 1850-present): The position of the LSZ, where delta smelt rear, has changed over the years. The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Moyle *et al.* 2010). The ancestral Delta was a large tidal marsh-floodplain habitat totaling approximately 700,000 acres. Most of the historic wetlands within the system were diked and reclaimed for agriculture or other human uses by 1920 (Atwater *et al.* 1979). Channels were dredged deep (~12 meters[m]) to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the confluence of the Sacramento-San Joaquin Rivers as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995). However, the deepened channels created to support shipping and flood control, requires more freshwater outflow to maintain the LSZ in the large Suisun Bay and River confluence than was once required (Gartrell 2010). The construction of the CVP and SWP not only provided water supply for urban, agricultural and industrial users, but also provided water needed to combat salinity intrusion into the Delta, which was observed by the early 20th century. California's demand for freshwater (keeps) continues to increase, thus seasonal salinity intrusion perpetually reduces the temporal overlap of the LSZ (indexed by X2) within the Suisun Bay (region), especially in the fall (Feyrer *et al.* 2007; 2011). Consequently, the second major habitat change in the Delta has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation. There was a step-decline in the LSZ in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer *et al.* 2011).

Summer and fall environmental quality has decreased overall in the Delta because outflows are lower and water transparency is higher. These changes may be due to increased upstream water diversions for flooding rice fields (Kawakami *et al.* 2008). The confluence of the Sacramento and San Joaquin Rivers has, as a result, become increasingly important as a rearing location for delta smelt, with physical environmental conditions constricting the species range to a relatively narrow area (Feyrer *et al.* 2007; Nobriga *et al.* 2008). This has increased the likelihood that most of the

juvenile population is exposed to chronic and cyclic environmental stressors, or catastrophic events. For instance, all seven delta smelt collected during the September 2007 FMWT survey were captured at statistically significantly higher salinities than what would be expected based upon historical distribution data generated by Feyrer *et al.* (2007). During the same year, the annual bloom of toxic cyanobacteria (Microcystis aeruginosa) spread far downstream to the west Delta and beyond during the summer (Peggy Lehman, pers comm). This has been suggested as an explanation for the anomaly in the distribution of delta smelt relative to water salinity levels (US Bureau of Reclamation 2008).

Bank Protection (Levees): The placement of riprap bank protection has led to the loss of riparian habitat, large woody debris, shallow water habitat, and natural channel migration. Bank stabilization and riprapping has been shown to change natural river processes such as erosion and accretion which reduces habitat complexity; creates a smooth, hydraulically enhanced surface that is not conducive to the habitat requirements of fish including delta smelt; stops woody vegetation from entering the river and reduces the long-term recruitment of large woody debris; inhibits plant growth through a change is substrate; lowers the amount of outside food sources because of the lack of riparian and wetland vegetation for aquatic invertebrates; and increases stream edge velocities which decreases available refuge areas for fish (Service 2000). More than half of the Sacramento River's lower 194 miles have been riprapped, mostly under the Corps Sacramento River bank Protection Project. Today most of the riparian forests and wetlands have been removed and the Sacramento River has been constrained to not allow natural erosion and accretion to occur.

Turbidity: From 1999 to present, the Delta experienced a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). For decades, the turbidity of the modified estuary had been sustained by very large sediment deposits resulting mainly from gold mining in the latter 19th century. Sediments continued to accumulate into the mid-20th century, keeping the water relatively turbid even as sediment loads from the Sacramento River basin declined due to dam and levee construction (Wright and Schoellhamer 2005). The flushing of the sediment deposits may also have made the estuary deeper overall and thus a less suitable nursery from the 'static' bathymetric perspective (Schroeter 2008).

Delta smelt are associated with highly turbid waters; there is a negative correlation between the frequency of delta smelt occurrence in survey trawls during the summer, fall and early winter and water clarity. For example, the likelihood of delta smelt occurrence in trawls at a given sampling station decreases with increasing Secchi depth at the stations (Feyrer *et al.* 2007, Nobriga *et al.* 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). Few daylight trawls catch delta smelt at Secchi depths over 0.5 m and capture probabilities for delta smelt are highest at 0.40 m depth or less. First-feeding delta smelt larvae require relatively turbid (muddy) waters to capture prey, but older fish do not require turbidity to capture prey and very high turbidity may even have some inhibitory effect on prey consumption (Hasenbein *et al.* 2013). Delta smelt may also use turbidity as cover from predators; this was hypothesized based on long-term monitoring of the distribution of fish in the wild (e.g., Feyrer *et al.* 2007) and recently supported by a laboratory experiment (Ferrari *et al.* 2014).

Temperature: Temperature also affects delta smelt distribution. Swanson and Cech (1995) and Swanson *et al.* (2000) indicate delta smelt tolerate temperatures (<8° C to >25° C), however warmer water temperatures >25° C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the water is well oxygenated and temperatures are usually less than 25° C in summer (Nobriga *et al.* 2008). Currently, delta smelt are subjected to thermally stressful temperatures every summer, and all available regional climate change projections

predict central California will be warmer still in the coming decades (Dettinger 2005). We expect warmer estuary temperatures to be yet another significant conservation challenge based on climate change models. Warmer water temperatures would increase delta smelt mortality and constrict suitable habitat throughout the Delta during the summer months. Higher temperatures would shrink delta smelt distribution into the fall, limiting their presence to Suisun Bay and in waters with less than optimal salinities (Brown *et al.* 2013). Water temperatures are presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding the nominal lethal limit of 25°C for short periods. Coldwater fishes begin to have behavioral impairments (Marine and Cech 2004) and lose competitive abilities (Taniguchi *et al.* 1998) prior to reaching their thermal tolerance limits. Thus, the estuary can already be considered thermally stressful to delta smelt and can only become more so if temperatures warm in the coming decades.

Foraging Ecology: Delta smelt feed primarily on small planktonic crustaceans, and occasionally on insect larvae (Moyle 2002). Juvenile-stage delta smelt prey upon copepods, cladocerans, amphipods, and insect larvae (Moyle 2002). Historically, the main prey of delta smelt was the euryhaline copepod *Eurytemora affinis* and the euryhaline mysid *Neomysis mercedis*. The slightly larger *Pseudodiaptomus forbesi* has replaced *E. affinis* as a major prey source of delta smelt since its introduction into the Bay-Delta, especially in summer, when it replaces *E. affinis* in the plankton community (Baxter *et al.* 2008; Moyle 2002). The most common copepod in the estuary now is a small nonnative species, *Limnoithona tetraspina*. It has been suggested that *L. tetraspina* may be an inferior food for pelagic fishes including delta smelt because of its small size and generally sedentary behavior (Bouley and Kimmerer 2006). Experimental studies addressing this issue have suggested that smelt larvae will attack *L. tetraspina* until they grow large enough to successfully capture larger copepods; also, growth rate of delta smelt fed *L. tetraspina* was lower than that of smelt fed the larger copepods (Sullivan *et al.*, unpublished). *L. tetraspina* is sometimes consumed in large numbers by juvenile delta smelt during late summer when this copepod is abundant in the LSZ (Slater and Baxter 2014). *Acartiella sinensis*, a calanoid copepod species that invaded the Delta at the same time as *L. tetraspina*, also occurs at high densities in Suisun Bay and in the western Delta over the last decade. Delta smelt eat these newer copepods, but *Pseudodiaptomus* remains their dominant prey (Baxter *et al.* 2008).

River flows influence estuarine salinity gradients and water residence times and thereby affect both habitat suitability for benthos and the transport of pelagic plankton upon which delta smelt feed. High tributary flow leads to lower residence time of water in the Delta, which generally results in lower plankton biomass (Kimmerer 2004). In contrast, higher residence times, which result from low tributary flows, can result in higher plankton biomass but water diversions, overbite clam grazing (Jassby *et al.* 2002) and possibly contaminants (Baxter *et al.* 2008) remove a lot of plankton biomass when residence times are high. These factors all affect food availability for planktivorous fishes that utilize the zooplankton in Delta channels. Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga *et al.* 2008). Thus, there is the potential for mismatches between regions of high zooplankton abundance in the Delta and delta smelt distribution now that the overbite clam has decimated LSZ zooplankton densities.

The delta smelt compete with and are prey for several native and introduced fish species in the Delta. The introduced Mississippi silverside may prey on delta smelt eggs and/or larvae and compete for copepod prey (Bennett and Moyle 1996; Bennett 2005). Young striped bass also use the LSZ for rearing and may compete for copepod prey and eat delta smelt. Centrarchid fishes and coded wire tagged Chinook salmon smolts released in the Delta for survival experiments since the early 1980s may potentially also prey on larval delta smelt (Brandes and McLain 2001; Nobriga and Chotkowski 2000). Studies during the early 1960s found delta smelt were only an occasional prey fish for striped bass, black crappie and white catfish (Turner and Kelley 1966). However, delta smelt

were a comparatively rare fish even then, so it is not surprising they were a rare prey. Striped bass appear to have switched to piscivorous feeding habits at smaller sizes than they historically did, following severe declines in the abundance of mysid shrimp (Feyrer *et al.* 2003). Nobriga and Feyrer (2008) showed that Mississippi silverside, which is similar in size to delta smelt, was only eaten by subadult striped bass less than 400-mm fork length. While largemouth bass are not pelagic, they have been shown to consume some pelagic fishes (Nobriga and Feyrer 2007).

Other Stressors

Aquatic Macrophytes: For many decades, the Delta's waterways were turbid and growth of submerged plants was apparently unremarkable. That began to change in the mid-1980s, when the Delta was invaded by the non-native plant, *Egeria densa*, a fast-growing aquatic macrophyte that has now taken hold in many shallow habitats throughout the Delta (Brown and Michnuik 2007; Hestir 2010). *Egeria densa* and other non-native species of submerged aquatic vegetation (SAV) grow most rapidly in the summer and late fall when water temperatures are warm (> 20°C) and outflow is relatively low (Hestir 2010). The large canopies formed by these plants have physical and biological consequences for the ecosystem (Kimmerer *et al.* 2008). First, the dense nature of SAV promotes sedimentation of particulate matter from the water column, which increases water transparency that then limits the amount of habitat available for delta smelt (Feyrer *et al.* 2007; Nobriga *et al.* 2008). Second, dense SAV canopies provide habitat for a suite of non-native fishes that occupy the littoral and shallow habitats of the Delta, displacing native fishes (Nobriga *et al.* 2005; Brown and Michniuk 2007). Finally, the rise in SAV colonization over the last three decades has led to a shift in the dominant trophic pathways that fuel fish production in the Delta. Until the latter 1980s, the food web of most fishes was often dominated by mysid shrimp (Feyrer *et al.* 2003) that were subsidized by phytoplankton food sources (Rast and Sutton 1989). Now, most littoral and demeral fishes of the Delta have diets dominated by the epibenthic amphipods that eat SAV detritus or the epiphytic algae attached to SAV (Grimaldo *et al.* 2009).

E. densa and other non-native submerged aquatic vegetation (e.g., *Myriophyllum spicatum*) can affect delta smelt in direct and indirect ways. Directly, submerged aquatic vegetation can over whelm littoral habitats (inter-tidal shoals and beaches) where delta smelt may spawn making them unsuitable for spawning. Indirectly, submerged aquatic vegetation decreases turbidity (by trapping suspended sediment) which has contributed to a decrease in both juvenile and adult smelt habitat (Feyrer *et al.* 2007; Nobriga *et al.* 2008). Increased water transparency may delay feeding and may also make delta smelt more susceptible to predation pressure.

Predators: Delta smelt is a rare fish and has been a rare fish (compared to other species) for at least the past several decades (Nobriga and Herbold 2008). Therefore, it has also been rare in examinations of predator stomach contents. Delta smelt were occasional prey fish for striped bass, black crappie, and white catfish in the early 1960s (Turner and Kelly 1966) but went undetected in a recent study of predator stomach contents (Nobriga and Feyrer 2007). The predator with the highest historical documentation of predation on delta smelt is striped bass (*Morone saxatilis*; Stevens 1963; 1966; Thomas 1967). In these studies, striped bass were confirmed to prey on both juvenile and adult delta smelt. Striped bass are widely distributed in pelagic areas of the San Francisco Bay-Delta and parts of its watershed, and thus striped bass distribution fully encompasses the distribution of delta smelt juveniles and adults (Nobriga *et al.* 2013). Striped bass also tend to aggregate in the vicinity of water diversion structures, where delta smelt are frequently entrained (Nobriga and Feyrer 2007). No inverse correlations between the abundance of striped bass and the relative abundance of delta smelt have been found to date using a variety of statistical approaches (Mac Nally et al 2010; Thomson *et al.* 2010; Maunder and Deriso 2011; Miller *et al.* 2012; Nobriga et al 2013). Although the relative rarity of delta smelt in the estuary food web would presumably make

them an incidental prey item for striped bass, it is possible that striped bass abundance and demand for prey are always high enough to limit delta smelt population growth rate (Nobriga *et al.* 2013).

Fish eggs and larvae can be opportunistically preyed upon by many invertebrate and vertebrate animals. There has always been a very long list of potential predators of delta smelt's eggs and larvae. One of these is the nonnative Mississippi silverside (*Menidia audens*), which like delta smelt is and annual fish with a maximum length near 100 mm (4 inches). Mississippi silversides may be both predators and competitors of delta smelt (Bennett 2005). Mississippi silversides were first introduced to the San Francisco Bay-Delta in the mid-1970s, and have increased dramatically in numbers since the mid-1980s. They forage in schools around the shoreline habitats and tidal marsh channels of the San Francisco Bay-Delta, where they are exceptionally common (Matern *et al.* 2002); Nobriga *et al.* 2005; Gewant and Bollens 2012). They readily consume delta smelt larvae in aquarium tests Bennett (20025_ concluded that "delta smelt are at high risk of eggs or larvae co-occur with schools of foraging silversides."

Another known predator is the largemouth bass are freshwater fish that prefer clear waters along shorelines (littoral habitat) with relatively dense water plants (Nobriga and Feyrer 2007; Brown and Michniuk 2007; Baxter *et al.* 2008). This is a suite of habitat characteristics that is distinctly different from those described above for delta smelt. Thus, unlike delta smelt and striped bass, delta smelt and largemouth bass have different habitat requirements (e.g., Nobriga *et al.* 2005) and their distributions do not strongly overlap. However, there has been a major increase in the Delta's largemouth bass population since the early 1990's that is believed to have been facilitated by the spread of the introduced plant *Egeria densa*, which provides rearing habitat for the bass (Baxter *et al.* 2008). Despite increases in largemouth bass populations and habitat, Nobriga and Feyrer (2007) did not find delta smelt as largemouth bass prey. Nor have more recent and extensive surveys of largemouth bass stomach contents. In captivity however, even young juvenile largemouth bass will attempt to consume delta smelt (Ferrari *et al.* 2014) so they presumably represent a predation threat when the species closely co-occur in the wild. In contrast to the situation for striped bass, several researchers have found inverse correlations between the relative abundance of largemouth bass or multi-species indices that included largemouth bass and the relative abundance of delta smelt (MacNally *et al.* 2010; Thomson *et al.* 2010; Maunder and Deriso 2011). At this time however, there is no way to determine whether these correlations are causative (predation by largemouth bass caused delta smelt to decline) or not (delta smelt simply use different habitats than largemouth bass and delta smelt habitat has decreased whil largemouth bass habitat has increased).

Other potential predators of eggs and larvae of smelt in littoral habitats are yelllowfin goby, entrarchids, and Chinook salmon. Potential native predators of juvenile and adult delta smelt would also have included numerous bird and fish species and this may be reflected in delta smelt's annual life-history. Annual fish species, also known as "opportunistic strategists", are adapted to high mortality rates in the adult stage (Winemiller and Rose 1992). This high mortality is usually due to predation or highly unpredictable environmental conditions, both of which could have characterized the ancestral niche of delta smelt.

Predation is a common source of density-dependent mortality in fish populations (Rose *et al.* 2001). Thus, it is possible that predation was a mechanism that historically generated the density-dependence observable in delta smelt population dynamics that has been noted by Bennett (2005) and Maunder and Deriso (2011). As is the case with other fishes, the vulnerability of delta smelt to predators may be influence primarily by habitat suitability. It is widely documented that pelagic fishes, including many smelt species, experience lower predation risks under turbid water conditions (Thetmeyer and Kils 1995; Utne-Palm 2002; Horpilla *et al.* 2004). Growth rates, a result of feeding

success plus water temperature, are also well known to affect fishes' cumulative vulnerability to predation (Sogard 1997).

Competition: It has been hypothesized that delta smelt are adversely affected by competition from other introduced fish species that use overlapping habitats, including Mississippi silversides, (Bennett and Moyle 1995) striped bass, and wakasagi (Sweetnam 1999). Laboratory studies show that delta smelt growth is inhibited when reared with Mississippi silversides (Bennett 2005) but there is no empirical evidence to support the conclusion that competition between these species is a factor that influences the abundance of delta smelt in the wild. There is some speculation that the overbite clam competes with delta smelt for copepod nauplii (Nobriga and Herbold 2008). It is unknown how intensively overbite clam grazing and delta smelt directly compete for food, but overbite clam consumption of shared prey resources does have other ecosystem consequences that appear to have affected delta smelt indirectly.

Microcystis: Large blooms of toxic blue-green algae, *Microcystis aeruginosa*, were first detected in the Delta during the summer of 1999 (Lehman *et al.* 2005). Since then *M. aeruginosa* has bloomed each year, forming large colonies throughout most of the Delta and increasingly down into eastern Suisun Bay. Blooms typically occur between late spring and early fall (peak in the summer) when temperatures are above 20°C. *M. aeruginosa* can produce natural toxins that pose animal and human health risks if contacted or ingested directly. It is unclear whether microcystins and other toxins produced by local blooms are acutely toxic to fishes at current concentrations; however, the toxins accumulate in fish and their prey. During the summer of 2005, Age-0 striped bass and Mississippi silversides that were co-occurring with the *Microcystis* bloom showed various forms of liver damage (Lehman *et al.* 2010). When ingested with food, microcystins have been experimentally shown to cause substantial impairment of health in threadfin shad (Acuna *et al.* 2012). In addition, the copepods that delta smelt eat are particularly susceptible to these toxins (Ger 2008; Ger *et al.* 2010). An investigation of food web effects and fish toxicity concluded that even at low abundances, *M. aeruginosa* may impact estuarine fish productivity through both toxicity and food web impacts (Lehman *et al.* 2010). *M. aeruginosa* is most likely to affect juvenile delta smelt during summer blooms. Microcystis blooms may also decrease dissolved oxygen to lethal levels for fish (Saiki *et al.* 1998), although delta smelt do not strongly overlap the densest *Microcystis* concentrations, so dissolved oxygen is not likely a problem. *Microcystis* blooms are a symptom of eutrophication and high ammonia to nitrate ratios in the water.

Contaminants: Contaminants can change ecosystem functions and productivity through numerous pathways. However, contaminant loading and its ecosystem effects within the Delta are not well understood. Although a number of contaminant issues were first investigated during the Pelagic Organism Decline (POD) years, concern over contaminants in the Delta is not new. There are long-standing concerns related to mercury and selenium levels in the watershed, Delta, and San Francisco Bay (Linville *et al.* 2002; Davis *et al.* 2003). Phytoplankton growth rate may, at times, be inhibited by high concentrations of herbicides (Edmunds *et al.* 1999). New evidence indicates that phytoplankton growth rate is chronically inhibited by ammonium concentrations in and upstream of Suisun Bay (Wilkerson *et al.* 2006, Dugdale *et al.* 2007). Contaminant-related toxicity to invertebrates has been noted in water and sediments from the Delta and associated watersheds (e.g., Kuivila and Foe 1995, Giddings 2000, Werner *et al.* 2000, Weston *et al.* 2004). Undiluted drain water from agricultural drains in the San Joaquin River watershed can be acutely toxic (quickly lethal) to fish and have chronic effects on growth (Saiki *et al.* 1992).

Evidence for mortality of young striped bass due to discharge of agricultural drainage water containing rice herbicides into the Sacramento River (Bailey *et al.* 1994) led to new regulations for

water discharges. Bio assays using caged Sacramento sucker (Catostomus occidentalis) have revealed deoxyribonucleic acid strand breakage associated with runoff events in the watershed and Delta (Whitehead *et al.* 2004). Kuivila and Moon (2004) found that peak desities of larval and juvenile delta smelt sometimes coincided in time and space with elevated concentrations of dissolved pesticides in the spring. These periods of co-occurrence lasted for up to 2-3 weeks, but concentrations of individual pesticides were low and much less than would be expected to cause acute mortality. However, the effects of exposure to the complex mixtures of pesticides actually present are unknown.

Current science suggests the possible link between contaminants and the POD may be the effects of contaminant exposure on prey items, resulting in an indirect effect on the survival of POD species (Johnson *et al.* 2010). The POD investigators initiated several studies beginning in 2005 to address the possible role of contaminants and disease in the declines of Delta fish and other aquatic species. Their primary study consists of twice-monthly monitoring of ambient water toxicity at fifteen sites in the Delta and Suisun Bay. In 2005 and 2006, standard bioassays using the amphipod *Hyalella azteca* had low (<5 percent) frequency of occurrence of toxicity (Werner *et al.* 2008). The results indicated that 2007, a dry year, showed a higher incidence of toxic events than in the previous (wetter) year, 2006 (Werner *et al.* 2010). Parallel testing with the addition of piperonyl butoxide, an enzyme inhibitor, indicated that both organophosphate and pyrethroid pesticides may have contributed to the pulses of toxicity. Most of the tests that were positive for *H. azteca* toxicity have come from water samples from the lower Sacramento River.

Pyrethroids are of particular concern because of their widespread use, and their tendency to be genotoxic (DNA damaging) to fishes at low doses (in the range of micrograms per liter) (Campana *et al.* 1999). The pyrethroid esfenvalerate is associated with delayed spawning and reduced larval survival of bluegill sunfish (*Lepomis macrochirus*) (Tanner and Knuth 1996) and increased susceptibility of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) to disease (Clifford *et al.* 2005). In addition, synthetic pyrethroids may interfere with nerve cell function, which could eventually result in paralysis (Bradbury and Coats 1989; Shafer and Meyer 2004). Weston and Lydy (2010) found the largest source of pyrethroids flowing into the Delta to be coming from the Sacramento Regional Waste water Treatment Plant, where only secondary treatment occurs. Their data not only indicate the presence of these contaminants, but the concentrations found exceeded acute toxicity thresholds for the amphipod *Hyalella azteca.* This is of substantial concern because the use of insecticides flowing into the Delta. Furthermore, this was not the case for the Stockton Wastewater Treatment facility, where tertiary treatment occurs, suggesting that different treatment methods may remove or etain pyretroids differently (Baxter *et al.* 2010).

In conjunction with the POD investigation, larval delta smelt bioassays were conducted simultaneously with a subset of the invertebrate bioassays. The water samples for these tests were collected from six sites within the Delta during May-August of 2006 and 2007. Results from 2006 indicated that delta smelt are highly sensitive to high levels of ammonia, low turbidity, and low salinity. There is some preliminary indication that reduced survival may be due to disease organisms (Werner *et al.* 2008). No significant mortality of larval delta smelt was found in the 2006 bioassays, but there were two instances of significant mortality in June and July of 2007. In both cases, the water samples were collected from sites along the Sacramento River and had relatively low turbidity and salinity levels and moderate levels of ammonia. It is also important to note that no significant *H. azteca* mortality was detected in these water samples. While H. Azteca tests are very useful for detecting biologically relevant levels of water column toxicity for zooplankton, interpretation of the *H. azteca* test results with respect to fish should proceed with great caution. The relevance of the bioassay results to field conditions remains to be determined. Werner *et al.* (2010b) conducted *in situ* testing in the laboratory and compared contaminant sensitivity of delta smelt to common bioassay organisms, including *H. azteca.* The investigations included contaminants commonly observed in the

Delta, such as organophosphate and pyrethroid insecticides, copper, and total ammonia. In the laboratory, delta smelt were 1.8 to >11 times more sensitive thatn fathead minnow to ammonia, copper and all insecticides tested (except permethrin). The invertebrates tested were more sensitive to contaminants than delta smelt or fathead minnows. *Eurytemora affinis* and *Ceriodaphnia dubia* were the most sensitive to total ammonia. *C. dubia* was the most sensitive to copper and organophosphates pesticides. *H. azteca* was the most sensitive test organism to pyrethroids. Toxicity was not detected for the Sacramento River at Hood or the San Joaquin River at Rough and Ready Island during the 2009 in situ testing period. Delta smelt survival was low in treatment and control waters. Werner *et al.* (2010b) concluded that larval smelt may be too sensitive to salinity, temperature and transport stress for *in situ* exposures and recommended using surrogate species in future tests.

Persistent confinement of the spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawners will be affected by a catastrophic event or localized chronic threat. For instance, large volumes of highly concentrated ammonia released into the Sacramento River from the Sacramento Regional County Sanitation District may affect embryo survival or inhibit prey production. Further, agricultural field in the Yolo Bypass and surrounding areas are regularly sprayed by pesticides, and water samples taken from Cache Slough sometimes exhibited toxicity to *H. azteca* (Werner *et al.* 2008; 2010). The thresholds of toxicity for delta smelt for most of the known contaminants have not been determined, but the exposure to a combination of different compounds increases the likelihood of adverse effects. The extent to which delta smelt larvae are exposed to contaminants varies with flow entering the Delta. Flow pulses during spawning increase exposure to many pesticides (Kuivila and Moon 2004) but decrease ammonia concentrations from wastewater treatment plants.

The POD investigations into potential contaminant effects also include the use of biomarkers that have been used previously to evaluate toxic effects on POD fishes (Bennett and Moyle 1996, Bennett 2005). The results to date have been mixed. A pathogen survey of 105 adult delta smelt, sampled from January through May, at several sites in the Delta, found that disease did not appear to overtly influence the health of the surveyed population for that year (Foott and Bigelow 2010). Histopathological and viral evaluation of young longfin smelt collected in 2006 indicated no histological abnormalities associated with exposure to toxics or disease (Foott *et al.* 2006). There was also no evidence of viral infection or high parasite loads. Similarly, young threadfin shad showed no histological evidence of contaminant effects or of viral infections (Foott *et al.* 2006). Parasites were noted in threadfin shad gills at a high frequency but the infections were not considered severe. Both longfin smelt and threadfin shad were considered healthy in 2006. Adult delta smelt collected from the Delta during the winter of 2005 also were considered healthy, showing little histopathological evidence for starvation or disease (Teh 2007). However, there was some evidence of low frequency endocrine disruption. In 2005, nine of 144 (six percent) of adult delta smelt males sampled were intersex, having immature oocytes in their testes (Teh 2007). Bennett (2005) reported that about 10 percent of the delta smelt analyzed for histopathological anomalies in 1999-2000 showed evidence of deleterious contaminant exposure. In contrast, 30-60 percent of these fish had liver glycogen depletion consistent with food limitation.

In contrast, preliminary histopathological analyses have found evidence of significant disease in other species and for POD species collected from other areas of the estuary. Massive intestinal infections with an unidentified myxosporean were found in yellowfin goby (*Acanthogobius flavimanus*) collected from Suisun Marsh. Severe viral infection was also found in Mississippi silverside and juvenile delta smelt collected from Suisun Bay during summer 2005. Lastly, preliminary evidence suggests that contaminants and disease may impair survival of age-0 striped bass. Baxter *et al.* 2008 found high occurrence and severity of parasitic infections, inflammatory conditions, and muscle

degeneration in young striped bass collected in 2005; levels were lower in 2006. Several biomarkers of contaminant exposure including P450 activity (i.e., detoxification enzymes in liver), acetylcholinesterase activity (i.e., enzyme activity in brain), and vitellogenin induction (i.e., presence of egg yolk protein in blood of males) were also reported from striped bass collected in 2006 (Ostrach 2008).

Delta smelt can also be exposed to other toxic substances. Recent toxicological research has provided dose-response curves for several contaminants (Connon *et al.* 2009; 2011). This research has also shown that gene expression changes and impairment of delta smelt swimming performance occur at contaminant concentrations lower than levels that cause mortality.

Climate Change: Climate change is likely already impacting the delta smelt. Climate change may affect the delta smelt directly by creating physiological stress, the primary impacts of climate change on the species are expected to be through changes in the availability and distribution of delta smelt habitat.

The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years of being a typical period for such measurements (IPCC 2013a). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (for example, temperature or precipitation) that persists for an extended period, whether the change is due to natural variability or human activity (IPCC 2013a). Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has increased since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions.

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has increased since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions (for these and other examples, see Solomon *et al.* 2007;; IPCC 2013b;; IPCC 2014). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (Solomon *et al.* 2007; IPCC 2013b). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011), whom concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (Meehl *et al.* 2007, entire; Ganguly *et al.* 2009; Prinn *et al.* 2011). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increasing global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be

influenced substantially by the extent of GHG emissions (Meehl *et al.* 2007; Ganguly *et al.* 2009; Prinn *et al.* 2011; IPCC 2013b). See IPCC 2013b (entire), for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation.

Current Drought Conditions and Relative Abundance: California is experiencing its fourth consecutive dry water-year due to low rainfall and low snowpack. On January 17, 2014, the Governor of California declared a State of Emergency due to the drought and directed state officials to take all necessary actions to make water immediately available (Office of the Governor 2014). As of June 2015, the Governor's drought declaration remains in place and the current drought conditions are comparable to the driest years on record in California. The severity of California's drought has been exacerbated by record warm temperatures and below-normal precipitation in 2015, resulting in a severely reduced snowpack. During the last two years, Federal and state governments (Bureau of Reclamation and California Department of Water Resources) have taken actions to ensure the reduced water quality and supply does not reach a level of concern for human health and safety, while complying with biological opinions. The actions taken include the 2015 placement of a salinity rock barrier on West False River and numerous Temporary Urgency Change Orders to modify requirements under Decision 1641 to meet certain water quality objectives, reduction of river flows caused by low reservoir storage, and river temperature requirements.

Drought conditions and some drought management actions have decreased suitable and available aquatic habitat in the Delta for delta smelt breeding and survival, thereby reducing the overall population in the Delta. Fish surveys indicate that the relative abundance of delta smelt is very low. In the last five years, the FMWT, TNS, and 20mm survey results have produced some of the lowest adult and larval delta smelt abundance indexes on record (CDFW 2013, 2014, 2015). The 2014 FMWT abundance index which determines the relative population status for the delta smelt was set at 9, which is the lowest index on record. The low index numbers and relatively few occurrences represent the additive impact of drought to the delta smelt and its habitat.

Status of the Delta Smelt Critical Habitat

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code) (Service 1994).

Conservation Role of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful spawning, larval and juvenile transport, rearing, and adult migration. Delta smelt are endemic to the Bay-Delta and the vast majority only live one year. Thus, regardless of annual hydrology, the Delta must provide suitable habitat all year, every year. Different regions of the Delta provide different habitat conditions for different life stages, but those habitat conditions must be present when needed, and have sufficient connectivity to provide migratory pathways and the flow of energy, materials and organisms among the habitat components. The entire Delta and Suisun Bay are designated as critical habitat; over the course of a year, the entire habitat is occupied.

Description of the Primary Constituent Elements

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements (PCEs) essential to the conservation of the species:

Primary Constituent Element 1: "Physical habitat" is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary's low-salinity zone (LSZ) (Bennett *et al.* 2002, Hobbs *et al.* 2006).

Primary Constituent Element 2: "Water" is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.

Primary Constituent Element 3: "River flow" is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and Old and Middle Rivers flow influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones. River flow interacts with the fourth primary constituent element, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.

Primary Constituent Element 4: "Salinity" is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5-6.0 psu (parts per thousand salinity) (Kimmerer 2004). The 2 psu isohaline is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby *et al.* 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu isohaline to the Golden Gate Bridge (X2); X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby *et al.* 1995, Kimmerer 2002a). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from San Pablo Bay (45 kilometers) to as far upstream as Rio Vista on the Sacramento River (95 kilometers). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete their life cycle. In general, delta smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish the more frequently and further the LSZ moves upstream, toward the confluence.

Overview of Delta Smelt Habitat Requirements and the Primary Constituent Elements

Delta smelt live their entire lives in the tidally-influenced fresh- and brackish waters of the San Francisco Estuary (Moyle 2002). Delta smelt are an open-water, or pelagic, species. They do not associate strongly with structure. They may use nearshore habitats for spawning (PCE #1), but free-swimming life stages mainly occupy offshore waters (PCE #2). Thus, the distribution of the population is strongly influenced by river flows through the estuary (PCE #3) because the quantity of fresh water flowing through the estuary changes the amount and location of suitable low-salinity,

open-water habitat (PCE #4). This is true for all life stages. During periods of high river flow into the estuary, delta smelt distribution can transiently extend as far west as the Napa River and San Pablo Bay. Delta smelt distribution is highly constricted near the Sacramento-San Joaquin river confluence during periods of low river flow into the estuary (Feyrer *et al.* 2007). In the 1994 designation of critical habitat, the best available science held that the delta smelt population was responding to variation in spring X2.

Alterations to Estuarine Bathymetry (PCE # 1) (~ 1850-present)

The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Nichols *et al.* 1986). The ancestral Delta was a large tidal marsh-floodplain habitat totaling approximately 300,000 acres. Most of the wetlands were diked and reclaimed for agriculture or other human use by the 1920s. The physical habitat modifications of the Delta and Suisun Bay were mostly due to land reclamation and urbanization. Water conveyance projects and river channelization have had some influence on the regional physical habitat by armoring levees with riprap, building conveyance channels like the Delta Cross Channel, storage reservoirs like Clifton Court Forebay, and by building and operating temporary barriers in the south Delta and permanent gates and water distribution systems in Suisun Marsh.

In the 1930s to 1960s, the shipping channels were dredged deeper (~12 m) to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the Sacramento-San Joaquin river confluence region as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995). However, the deeper landscape created to support shipping and flood control requires more freshwater outflow to maintain the LSZ in the large Suisun Bay/river confluence region than was once required (Gartrell 2010).

Seasonal salinity intrusion reduces the temporal overlap of the LSZ (indexed by X2) with the Suisun Bay region, especially in the fall (Feyrer *et al.* 2007, 2010). Thus, the second major change has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation. This metric showed a step-decline in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer *et al.* 2011). As such this alteration of PCE # 1 also affects the other PCEs, particularly PCE # 4. The major landscape factor affecting this interaction was the dredging of shipping channels.

Spawning delta smelt require all four PCEs, but spawners and embryos are the life stage that is believed to most require a specific structural component of habitat. Spawning delta smelt require sandy or small gravel substrates for egg deposition (Bennett 2005). The major invasive species effect on physical habitat is the dense growth of submerged aquatic vegetation in the Delta. These plants carpet large areas in parts of the Delta such as Frank's Tract. The vegetation beds act as mechanical filters removing turbidity and possibly other water quality components as the tides and river flows move water over them (Hestir 2010). Thus, the proliferation of submerged aquatic plants has likely also reduced the area of nearshore habitat suitable for delta smelt spawning.

Alterations to Water (PCE # 2)

PCE # 2 is primarily referring to a few key water quality components (other than salinity) that influence spawning and rearing habitat suitability for delta smelt. Research to date indicates that water quality conditions are more important than physical habitat conditions for predicting where

delta smelt occur (Feyrer *et al.* 2007; Nobriga *et al.* 2008) probably because delta smelt is a pelagic fish except during its egg/embryo stage. However, the interaction of water quality and bathymetry is thought to generally affect estuarine habitat suitability (Peterson 2003) and there is evidence that delta smelt habitat is optimized when appropriate water quality conditions overlap the Suisun Bay region (Moyle *et al.* 1992; Hobbs *et al.* 2006; Feyrer *et al.* 2011). This is discussed further in the section about PCE # 4 (salinity).

Changing predation pressure (1879 to present): Noting is known about the historical predators of delta smelt or their possible influence on delta smelt. Fish eggs and larvae can be opportunistically preyed upon by many invertebrate and vertebrate animals so there has always been a very long list of potential predators of delta smelt's eggs and larvae. Potential native predators of juvenile and adult delta smelt would also have included numerous bird and fish species and this may be reflected in delta smelt's annual life-history. Annual fish species, also known as "opportunistic strategists", are adapted to high mortality rates in the adult stage (Winemiller and Rose 1992). This high mortality is usually due to predation or highly unpredictable environmental conditions, both of which could have characterized the ancestral niche of delta smelt.

The introduction of striped bass into the San Francisco Estuary in 1879 added a permanently resident, large piscivorous fish to the low-salinity zone: a habitat that is not known to have had an equivalent predator prior to the establishment of striped bass (Moyle 2002). This likely changed predation rates on delta smelt, but there are no data available to confirm this hypothesis. For many decades the estuary supported higher striped bass and delta smelt numbers than it does currently. This is evidence that delta smelt is able to successfully coexist with striped bass.

The current influence of striped bass and other predators on delta smelt population dynamics is also not known mainly because quantitative descriptions of predator impacts on rare prey are extremely difficult to generate. Delta smelt were observed in the stomach contents of striped bass and other fishes in the 1960s (Stevens 1963; Turner and Kelley 1966), but have not been observed in more recent studies (Feyrer *et al.* 2003; Nobriga and Feyrer 2007). Predation is a common source of density-dependent mortality in fish populations (Rose *et al.* 2001). Thus, it is possible that predation was a mechanism that historically generated the density-dependence observed in delta smelt population dynamics (Bennett 2005; Maunder and Deriso 2011). Because it is generally true for fishes, the vulnerability of delta smelt to predators is influenced primarily by habitat conditions. Turbidity may be a key mediatory of delta smelt's vulnerability to predators (Nobriga *et al.* 2005; 2008). Growth rates, an interactive outcome of feeding success and water temperature, are also well known to affect fishes' cumulative vulnerability to predation (Sogard 1997). Thus, predation rate is best characterized as an aspect food web function linked to PCE # 2.

Food web alterations attributable to the overbite clam (1987-present): The next major change to PCE #2 occurred following the invasion of the estuary by overbite clam (*Corbula amurensis*). The overbite clam was first detected in 1986 and from 1987-1990 its influence on the ecosystem became evident. Since 1987, there has been a step-decline in phytoplankton biomass (Alpine and Cloern 1992; Jassby *et al.* 2002). Phytoplankton in the LSZ is an important component of the pelagic food web that delta smelt are a part of because a key part of the diet of delta smelt's prey is phytoplankton. Not only does the overbite clam reduce food for delta smelt's prey, it can also graze directly on the larval stages of the copepods eaten by delta smelt (e.g., Kimmerer *et al.* 1994). The grazing pressure applied by the overbite clam rippled through the historical zooplankton community that fueled fishery production in the LSZ (Kimmerer and Orsi 1996; Orsi and Mecum 1996; Kimmerer 2002b; Feyrer *et al.* 2003). This major change in the way energy moved through the ecosystem has likely facilitated the numerous invasions of the estuary by suppressing the production of historically

dominant zooplankton, which increases the opportunity for invasion by other species that are less dependent on high densities of LSZ phytoplankton.

The distribution and abundance of several LSZ fishes have changed since 1987 (Kimmerer 2002b; Kimmereer 2006; Rosenfield and Baxter 2007; Mac Nally *et al.* 2010). Surprisingly, the changes in phytoplankton and zooplankton production have not been as evident for delta smelt as for other organisms (Kimmer 2002b; Kimmerer 2006; Sommer *et al.* 2007; Mac Nally *et al.* 2010). Nonetheless, delta smelt collected in the FMWT have been persistently smaller since the overbite clam invasion (Sweetnam 1999; Bennett 2005). This is evidence for reduced growth rates that could have been caused by food web changes stemming from overbite clam grazing. The Service considers the prey density aspect of the estuarine food web to be a component of PCE #3 ("Water"). The Central Valley Project and State Water Project entrain some food web production (about 4.5 percent on a daily average basis was attributed to all water diversions in the Delta; Jassby *et al.* 2002). However, prey densities have been most strongly affected by clam grazing (Kimmerer *et al.* 1994; Jassby *et al.* 2002). Urban wastewater input, *Microcystis* blooms, and pesticide loads may also impair the production of zooplankton eaten by delta smelt or eaten by delta smelt's prey (Wilkerson *et al.* 2006; Dugdale *et al.* 2007; Jassby 2008; Ger *et al.* 2009; Werner *et al.* 2010).

Proliferation of submerged aquatic vegetation (1980s to present): For many decades, the Delta's waterways were turbid and the growth of submerged plants was apparently unremarkable. That began to change in the mid-1980s, when the Delta was invaded by non-native plant *Egeria densa*, a fast-growing aquarium plant that has taken hold in many shallow habitats (Brown and Michnuik 2007; Hestir 2010). *Egeria densa* and other non-native species of submerged aquatic vegetation (SAV) grow most rapidly in the summer and late fall when water temperatures are warm (>20°C) and outflow is relatively low (Hestir 2010). The large canopies formed by these plants have physical and biological consequences for the ecosystem (Kimmerer *et al.* 2008). First, dense SAV promotes water transparency. Increased water transparency leads to a loss of habitat for delta smelt (Feyrer *et al.* 2007; Nobriga *et al.* 2008). Second, dense SAV canopies provide habitat for a suite of non-native fishes, including largemouth bass, which now dominate many shallow habitats of the Delta and displace native fishes (Nobriga *et al.* 2005; Brown and Michniuk 2007). Finally, SAV colonization over the last three decades has led to a shift in the dominant freshwater food web pathways and that fuel fish production (Grimaldo *et al.* 2009b). It is noteworthy that SAV-dominated habitats are comparatively productive (Nobriga *et al.* 2005; Grimaldo *et al.* 2009b), but most of the productivity they generate remains in the nearshore environment and therefore does not contribute much to pelagic fish production (Grimaldo *et al.* 2009b).

Reduced turbidity (1999-present): The next major change was a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). For decades, the turbidity of the modified estuary had been sustained by very large sediment deposits resulting mainly from gold mining in the latter 19th century. The sediments continued to accumulate into the mid-20th century, keeping the water relatively turbid even as sediment loads from the Sacramento River basin declined due to dam and levee construction (Wright and Schoellhamer 2004). The flushing of the sediment deposits may also have made the estuary deeper overall and thus a less suitable nursery from the 'static' bathymetric perspective (Schroeter 2008). Delta smelt larvae require turbidity to initiate feeding (Baskerville-Bridges *et al.* 2004), and as explained above, older fish are thought to use turbidity as cover from predators. Thus, turbidity is an aspect of PCE # 2 which is a necessary water quality aspect of delta smelt's critical habitat.

Dams and armored levees have contributed to the long-term decline in sediment load to the estuary (Wright and Schoellhamer 2004) and to the clearing of estuary water. This is a long-term effect that stemmed from building and maintaining infrastructure. Opportunities to substantively address this

change are limited due to the extreme Central Valley flood and water supply risks that will result from decommissioning dams or removing levees.

Changing water temperature (present through long-term climate forecasts): Delta smelt is already subjected to thermally stressful temperatures every summer in the Delta. Water temperatures are presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding the nominal lethal limit of 25°C for short periods. Coldwater fishes begin to have behavioral impairments (Marine and Cech 2004) and lose competitive abilities (Taniguchi *et al.* 1998) prior to reaching their thermal tolerance limits. Thus, the estuary can already be considered thermally stressful to delta smelt and can only become more so if temperatures warm in the coming decades.

All available regional climate change projections predict central California will be warmer still in the coming decades (Dettinger 2005). It is expected that warmer estuary temperatures will be yet another significant conservation challenge (Brown *et al.* 2013; Cloern *et al.* 2011). This is true because they will limit abiotic habitat suitability further than indicated by flow-based projection (e.g., Feyrer *et al.* 2011). In addition, warmer water temperatures mean that higher prey densities will be required just to maintain present-day growth rates, which are already lower than they once were (Sweetnam 1999; Bennett 2005). Water temperature is mainly affected by climate variation, both as air temperature and as flood and drought scale flow variation (Kimmer 2004; Wagner *et al.* 2011).

Sensitivities to contaminants (ongoing): Delta smelt's spawning migration coincides with early winter rains (Sommer *et al.* 2011). This 'first-flush' of inflow to the Delta brings sediment-bound pesticides with it (Bergamaschi *et al.* 2001), and peak densities of larvae and juveniles can co-occur with numerous pesticides (Kuivila and Moon 2004). Bennett (2005) reported that about 10 percent of the delta smelt analyzed for histopathological anomalies in 1999-2000 showed evidence of deleterious contaminant exposure, but this was low compared to the 30-60 percent of these fish that appeared to be food-limited.

Delta smelt can also be exposed to other toxic substances. Recent toxicological research has provided dose-response curves for several contaminants (Connon *et al.* 2009; 2011). This research has also shown the gene expression changes and impairment of delta smelt swimming performance occur at contaminant concentrations lower than levels that cause mortality. Climate scale flow variation (e.g., flood versus drought scale variation) affects the amount of methyl mercury (Darryl Slotton presentation) entering the ecosystem and may have some influence on the meaningful dilution of ammonium from urban wastewater inputs (Dick Dugdale presentation).

Invasive species may also affect PCE #2 by changing contaminant dynamics. For instance, *Microcystis* blooms generate toxic compounds that can kill delta smelt prey (Ger *et al.* 2009) and accumulate in the estuarine food web (Lehman *et al.* 2010). A second example is the biomagnification of selenium in the food web by *Corbula* (Stewart *et al.* 2004). This has been considered a potential issue for the clam's predators – namely sturgeon, splittail, and diving ducks (Richman and Lovvorn 2004; Stewart *et al.* 2004). However, it is not known whether this change in selenium dynamics negatively affects delta smelt and other fishes that do not directly prey on the clams.

Alterations of River Flows (PCE # 3)

This PCE refers to the transport flows that help guide young delta smelt from spawning habitats to rearing habitats, and to flows that guide adult delta smelt from rearing habitats to spawning habitats. Delta outflow also has some influence on delta smelt's supporting food web (Jassby *et al.* 2002; Kimmerer 2002a) and it affects abiotic habitat suitability as well (Feyrer *et al.* 2007; 2011). The latter

is expanded upon in the discussion of PCE # 4. The environmental driver with the strongest influence on PCE # 3 is highly dependent on the time-scale being considered. The tide has the largest influence on flow velocities and directions in delta smelt's critical habitat at very short timescales (minutes to days), whereas interannual variation in precipitation and runoff has the largest influence on flows into and through the Delta at very long timescales (years to decades), and sometimes at shorter time scales (days to weeks) during major storm events. Changes to flow regimes can have the largest influence on PCE #3 at timescales of weeks to seasons. This is particularly true during periods of low natural inflow, for instance during the fall and during droughts, and in the south Delta where Old and Middle River flows are often managed using changes in export flow rates.

Entrainment into water export diversions (1951 to present): The amount of water diverted from the estuary has generally increased over time, and most of the increase during the 1950s and 1960s was due to CVP exports and since the latter 1960s, SWP exports. There are two basic potential fishery impacts that result from water diversion from the Delta: ecosystemic impacts and direct entrainment. From the ecosystemic perspective, water diversions are unnatural 'predators' because they 'consume' organisms at every trophic level in the ecosystem from phytoplankton (Jassby *et al.* 2002) to fish (Kimmerer 2008). Unlike natural predators which typically shift their prey use over time in association with changes in prey fish density (Nobriga and Feyrer 2008), fractional entrainment losses of fishes to diversions are functions of water and demand (e.g., Grimaldo *et al.* 2009). Thus, water diversions not only elevate 'predation' mortality in an aquatic system, but they can do so in an atypical, density-independent manner. Diversions and fish collection facilities in the south Delta are very large structures which attract large aggregations of actual predatory fish and prey on smaller species like delta smelt before they reach the fish salvage facilities and within these facilities (Gingras 1997).

Estimated entrainment losses of delta smelt to SWP and CVP diversions can be substantial in some years (Kimmerer 2008). Given the delta smelt's current density-independent population dynamics, even a statistically indiscernible entrainment effect on the population is likely to cause the species to continue to decline (Kimmerer 2011). The entrainment losses of delta smelt are not generally observed until they reach the early juvenile stage (~20-30 mm in length), but combinations of 20-mm Survey distribution data and hydrodynamic modeling provide evidence that their risk of entrainment into the CVP and SWP diversions can be described by any of several indices that integrate Delta inflow and export flow (Kimmerer and Nobriga 2008; Kimmerer 2008; Service 2008; Grimaldo *et al.* 2009).

Delta smelt entrainment losses estimated from survey data and hydrodynamics can also be substantial in some years (Kimmerer 2008), though it is possible that Kimmerer may have overestimated them (Miller 2011). Nonetheless, increasing higher outflow (or lower X2) moves the bulk of the larval population increasingly west, which results in fewer larvae distributed in the south Delta where they are at highest risk of entrainment. At the same time, indices like the export to inflow ratio or Old and Middle river flow are useful metrics for gauging the effect of exports on the south Delta.

The risk of delta smelt entrainment into smaller agricultural irrigation diversions used mainly to irrigate crops within the Delta is also related to flow conditions. These in-Delta irrigation diversions generally have mean flow rates less than 1 cubic meter per second (Nobriga *et al.* 2004). The lower the Delta outflow, the higher the proportion of the young delta smelt population that overlaps the array of irrigation diversions in the Delta (Kimmerer and Nobriga 2008). However, the irrigation diversions are not currently considered to represent a substantial source of mortality because they individually draw small quantities of water relative to channel volumes (Nobriga *et al.* 2004).

In Suisun Marsh, water diversions are largely made to support waterfowl production. Some Suisun Marsh diversions are larger for the size of channels they are in than most of the agricultural irrigation diversions in the Delta. Based on hydrodynamic simulations, proximity to water diversions in the marsh is expected to correlate strongly with entrainment (Culberson *et al.* 2004), and substantial delta smelt losses have been reported when these diversions are not screened (Pickard *et al.* 1982). Entrainment risk for delta smelt in western Suisun Marsh is considered low because the habitat surrounding the diversions is often too saline (Enos *et al.* 2007).
Salinity PCE # 4

The core delta smelt habitat, is the LSZ (Moyle *et al.* 1992; Bennett 2005). The LSZ is where freshwater transitions into brackish water; the LSZ is defined as the area of the estuary where salinity ranges from 0.5-6.0 psu (Kimmerer 2004). This area is always moving due to tidal and river flow variation. The 2 psu isohaline is a specific location within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby *et al.* 1995). By local convention, changes in the location of the LSZ are described in terms of the distance from the Golden Gate Bridge to the 2 psu isohaline (X2); X2 is an indicator of habitat suitability for many of the estuary's organisms and it is associated with variance in abundance of diverse components of the ecosystem (Jassby *et al.* 1995; Kimmerer 2002b; Kimmerer *et al.* 2009). The LSZ expands and moves downstream when river flows into the estuary are high (Kimmerer *et al.* 2009). Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from as far downstream of San Pablo Bay (45 km) to as far upstream as Rio Vista on the Sacramento River (95 km).

Larval delta smelt tend to reside somewhat landward (upstream) of X2 (Dege and Brown 2004), but the center of juvenile distribution tends to be very near X2 until the fish start making spawning migrations in the winter (Feyrer *et al.* 2011; Sommer *et al.* 2011). Because of this association between the distribution of salinity in the estuary and the distribution of the delta smelt population, the tidal and river flows that comprise PCE # 3 affect PCE # 4.

The expansion and contraction of the LSZ affects the areal extent of abiotic habitat for delta smelt, both during spring (Kimmerer *et al.* 2009) and fall (Feyrer *et al.* 2007; 2011). In the spring, most delta smelt are larvae or young juveniles and the LSZ is typically maintained over the expansive Suisun Bay region. Thus, abiotic habitat "limitation" is unlikely and no consistent influence of spring X2 variation on later stage abundance estimates has been reported to date (Jassby *et al.* 1995; Bennett 2005; Kimmerer *et al.* 2009). In fact, historical maxima in juvenile abundance according to CDFW's TNS occurred in low outflow years when abiotic habitat area was comparatively low (Kimmerer 2002a; Kimmerer *et al.* 2009).

In contrast, during fall delta smelt are late stage juveniles and for the past decade or more, the LSZ has been persistently constricted by low Delta outflow. Fall habitat conditions affect delta smelt distribution and the concurrent FMWT abundance index (Feyrer *et al.* 2007; 2011). However, the quantitative life cycle models developed to date have not found evidence for a year over year effect of fall LSZ location on delta smelt population dynamics (Mac Nally *et al.* 2010; Thompson *et al.* 2010; Maunder and Deriso 2011).

It is now recognized that some delta smelt occur year-round in the Cache Slough region including the Sacramento Deep Water Shipping Channel and Liberty Island (Kimmerer 2011; Miller 2011; Sommer *et al.* 2011). The latter has been a consistently available habitat only since 1997. This region is often lower in salinity than 0.6 psu, the lower formal limit of the LSZ as defined by Kimmerer (2004). Delta smelt likely use it because it is one of the most turbid habitats remaining in the Delta (Nobriga *et al.* 2005). A recent population genetic study found no evidence that delta smelt inhabiting this region are unique compared to delta smelt using the LSZ-proper (Fisch *et al.*

2011), therefore it is likely that individual delta smelt migrate between the LSZ and the Cache Slough region. This is consistent with the high summer water temperatures observed there, which might compel individual delta smelt to seek out cooler habitats within and outside the Cache Slough region.

Delta Smelt Environmental Baseline

The portions of the Action Area that fall within the range of delta smelt include the Sacramento River east levee, south of Sacramento and the Sacramento Weir. Delta smelt typically migrate up into this area as early as December and move out in the spring and summer. The proposed project contains habitat components that can be used for feeding, spawning, rearing, and movement. Some amount of erosion protection has already occurred within the action area. Additionally, the Corps has a project which will place rock along 31,000 linear feet of the right bank of the Sacramento River immediately across the river and extending upstream from the proposed project footprint. Compensation for the placement of this rock will be through the development of a setback levee that will provide 118 acres of newly created shallow water habitat.

Giant Garter Snake Status of the Species

For the most recent assessment of the species' range-wide status please refer to the *Giant Garter Snake (Thamnophis gigas) 5-year Review: Summary and Evaluation* (Service 2012) for the current status of the species. Ongoing threats to giant garter snake include habitat loss from water transfers, rice fallowing due to drought conditions, habitat disturbance and loss from irrigation and drainage ditch maintenance, climate change, and invasive species. While these threats continue to effect the giant garter snake throughout its range, to date no project has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the giant garter snake.

Giant Garter Snake Environmental Baseline

The *Draft Recovery Plan for the Giant Garter Snake* (Service 1999b) subdivides the range of the species into four recovery units. Each recovery unit includes populations. The action area for the proposed project is located within the Yolo Basin-Willow Slough unit and the American Basin unit. According to the 2012, 5-year review (Service 2012) the abundance and distribution of giant garter snakes has not changed significantly. Within the Action Area habitat loss and fragmentation is the most significant threat to the giant garter snake. Urbanizing areas within the Action Area include Sacramento and West Sacramento. Habitat loss through water transfers and rice fallowing also negatively affects giant garter snakes. In the Sacramento Valley, rice has served as a substitute for the large amounts of historical wetlands that used to exist in the Central Valley. Loss of this habitat has been shown to reduce or exclude giant garter snakes compared to areas which are actively irrigated in rice (Wylie *et al.* 2002a, b, 2004).

Flood control maintenance and agricultural activities can reduce and prevent the establishment of vegetation and burrows needed by the giant garter snake for cover and shelter on canals, levees, and agricultural ditches. This can also reduce the prey base for giant garter snake, affecting their feeding. Additionally, clearing, scraping and/or re-contouring canals, ditches, and levees, destroys burrows and crevices that are used as over-wintering habitat and during the summer for thermoregulation, shedding, and giving birth. These activities are being conducted by local maintaining agencies throughout the Action Area.

Other factors which effect the giant garter snake population in the Action Area include vehicular mortality particularly where canals or aquatic habitat are bordered by roads such as the crown of the

levees. Non-native predators such as game fish, bull frogs (*Rana catesbiana*), and domestic cats can affect giant garter snake populations (Service 1999b). This can be particularly detrimental to young and juvenile giant garter snakes. All of the Action Area has non-native predators occurring in it.

Snakes have been located within the Yolo Bypass within 2 miles of the Sacramento Bypass. Numerous irrigation and drainage canals exist which provide connectivity from the Sacramento Bypass and areas that are known to support snakes in the Yolo Bypass. A snake observed 0.5 mile to the west of the NEMDC along Elkhorn Boulevard in 1996 (CNDDB 2015). Borrow site 2's northern boundary is Elkhorn Boulevard on the east side of the NEMDC. Giant garter snakes could be using the NEMDC for aquatic habitat and the surrounding grasslands for uplands.

Western Yellow-Billed Cuckoo Status of the Species

For the most recent assessment of the species range-wide status please refer to the October 3, 2014, *Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (Coccyzus americanus occidentalis)* (79 FR 59991). Ongoing threats to the yellow-billed cuckoo include habitat loss from flood control projects and maintenance, alterations to hydrology, climate change, and invasive species. While these threats continue to affect the yellow-billed cuckoo throughout its range, no project, to date, has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the yellow-billed cuckoo.

Western Yellow-Billed Cuckoo Baseline

Yellow-billed cuckoo detections have occurred most frequently in the upper Sacramento River where levees are setback from the river or do not exist. Additionally, the last 20 years has seen a large amount of riparian restoration occur in the upper Sacramento River. Habitat in the action area tends to be more narrow and linear than in the upper Sacramento River. Levees were constructed close to the bank of the Sacramento River leaving narrow bands of small patch sizes. Construction of the setback levee along the right bank of the Sacramento River as part of the West Sacramento Flood Control Project will provide some wider patches of riparian habitat that will benefit the yellow-billed cuckoo. The American River has a wider floodplain due to levees being setback from the channel. There are some patches large enough to support nesting yellow-billed cuckoos, though cuckoos have not been observed nesting along the American River.

Effects of the Proposed Action

Valley Elderberry Longhorn Beetle

Vegetation removal, including elderberries could cause mortality of any beetle larvae within the elderberry shrub. Transplanting the shrubs between November 1 and February 15, when the shrubs are dormant, will minimize the likelihood of killing larvae within the shrub. Transplanting the shrub could still result in mortality to larvae within the shrub, particularly if the shrub does not survive transplantation. Proper care of the transplants through watering in the initial years can minimize this loss and increase the likelihood that the shrub will survive and provide continued habitat for the valley elderberry longhorn beetle.

Construction that occurs near elderberry shrubs that will be protected in place can kill adult beetles if construction equipment is operating between the months of March and June when valley elderberry longhorn beetles have emerged from the elderberry shrubs and are locating mates for reproduction. Fencing the area which contains riparian habitat, specifically elderberry shrubs, and keeping a minimum of a 20 foot buffer from the dripline of the elderberry shrub will keep

construction equipment from driving too close to the shrubs and minimize the number of beetles that might be struck or run over by equipment.

Transplanting elderberry shrubs out of the construction footprint has the potential to affect valley elderberry longhorn beetle dispersal if there is potential to remove large areas of elderberry shrubs. The Corps has provided maps of where existing valley elderberry longhorn beetle habitat exists and where shrubs will be removed due to the project. Along the Sacramento River, 13 elderberry shrubs distributed within 70 acres of riparian habitat will be transplanted as part of the project, however during surveys the Corps has documented an additional 60 elderberry shrubs that will be protected in place along the Sacramento River. The Corps has also proposed to include elderberry shrub plantings along the bank repair footprint where the elevation is suitable so the shrubs are not inundated too frequently. Along the American River, 250 elderberry shrubs distributed within 65 acres of riparian habitat will be transplanted as part of the project. The American River has many conservation sites and the Corps has proposed to offset the removal of elderberry shrubs through development of additional sites and enlargement of existing sites in the lower American River Parkway. The Corps is proposing to create an additional 69.91 acres of habitat for the valley elderberry longhorn beetle in the lower American River Parkway.

Trimming of elderberry shrubs can result in the loss of some habitat for the valley elderberry longhorn beetle. Unlike transplantation however, the shrub remains within the riparian corridor and can provide habitat for the beetle during dispersal. There is potential for one of the pruned stems to contain the larvae of the valley elderberry longhorn beetle. While elderberry shrubs do resprout readily, there is a temporal loss of habitat for the beetle and as part of the maintenance any resprouted stems will be removed in order to provide maintenance equipment access. To offset these effects the local maintaining agencies have proposed to create a 40-acre conservation area for the valley elderberry longhorn beetle. This area will be selected as described in the preceding paragraph. This will ensure habitat connectivity and help with long-term maintenance and monitoring of these lands.

Delta Smelt

Construction along the Sacramento River will place bank protection along a 50,300 linear foot section of the left bank of the Sacramento River. Delta smelt are a pelagic species that is typically found in the center of the channel. However, as described in the status of the species they do spawn on sandy beaches in shallow water habitat (0 to 3 meters) and in this portion of the Sacramento River are found close to the banks. The rock footprint will change the substrate along the 50,300 linear feet of 33 acres of shallow water habitat. Additionally 13 acres are being converted from riverine bank edge to a rock wedge. Construction related effects to individual delta smelt will be avoided because construction is occurring between August 1 and November 30, a time when delta smelt are located further downstream in the Delta and Suisun Bay. Effects due to increasing sediment downstream of the work area will be minimized through the conservation measures involving monitoring water quality during construction to ensure that effects do not extend into the portion of the Delta that delta smelt occupies during the late summer/fall period. Construction to widen the Sacramento Weir will occur on the landside of the existing Sacramento River right bank levee. Upon completion of the weir extension the levee removed between August 1 and November 30 avoiding effects to delta smelt habitat.

The primary negative effect of the project on potential spawning habitat is the change of substrate from sand to riprap. Rock used for bank protection is large enough to retard erosional forces of the river and therefore has interstitial spaces. Should delta smelt spawn over this riprap substrate, it is very likely that any eggs will fall into these interstitial spaces resulting in the loss of eggs and

potentially causing fertilization to not occur if the eggs fall into the interstitial spaces. The Corps has proposed to offset this loss of spawning potential in these areas through the purchase of 33 acres of credits at a Service-approved delta smelt conservation bank. The placement of rock will permanently narrow the channel by 13 acres through the change of riverine edge to rock wedge. Rock slope protection limits the lateral mobility of a river channel, increases flow velocities (Sedell *et al.* 1990), limit sediment transport, and eliminates bankside refugia areas (Gregory *et al.* 1991). Rock placement can also affect primary productivity through the loss of vegetation. The Corps will protect large trees in place and plant riparian benches at the conclusion of the rock placement to replace the loss of vegetation. Planting benches and vegetation planting will also help to offset the increased velocities that the bank protection sites will experience due to the smoother rock surface. To offset the complete loss of riverine edge habitat the Corps has proposed to purchase 39 acres of credits at a Service-approved delta smelt conservation bank for a total of 72 acres of credits.

The Corps has proposed to evaluate effects to listed species including delta smelt when long-term maintenance activities for the Sacramento River can be described. If maintenance activities will affect delta smelt the Corps will reinitiate consultation with the Service. Therefore, this biological opinion does not address effects to the delta smelt from any long-term levee maintenance activities.

Delta Smelt Critical Habitat

This opinion on the critical habitat for the delta smelt does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR § 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in *Gifford Pinchot Task Force v. U. S. Fish and Wildlife Service* (No. 03-35279) to complete the following analysis with respect to the proposed critical habitat.

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. The placement of rock will change the substrate of shallow water habitat for 46 acres. Any loss of shallow water habitat will be compensated through the purchase of credits at a delta smelt conservation bank. It is expected that planting the sites post-construction will replace any loss of primary productivity within the Sacramento River water column.

Giant Garter Snake

Borrow Site 2 – Upland habitat will be disturbed at borrow site 2 (5.5 acres) when heavy equipment is brought in to remove soil for the Arcade Creek levee repair. Removal of soil from the site will result in the crushing of burrows that snakes use for aestivating and thermoregulation. Fencing the borrow site prior to borrow excavation will minimize the likelihood that snakes will be in the borrow site when construction equipment begins to mobilize. Fencing the site will temporarily (one active season) exclude the use of the area for giant garter snake. This could result in snakes having to move further distances to find upland refugia in the summer months and expose them to predation or other sources of mortality such as being run over by a vehicle on the levee road on the opposite side of the NEMDC. Because the aquatic habitat will not be disturbed by the project, there will not be any effects on the snake's ability to forage.

Upon completion of the project, the site will restored and re-graded to create three habitat types. The creation of additional tule marsh along the edge of the canal will benefit giant garter snakes that may be using the NEMDC as it will provide cover, an area for prey production, and refugia from predators. Additionally, the seasonal wetland bench will only provide aquatic habitat in the winter months when the snake is typically in burrows. The wetland bench will provide some upland habitat

for the giant garter snake during the summer when the snake is active in the form of basking habitat and if dried wetland vegetation remains some refugia from predators; however, because the site will be flooded in the winter it will not serve as overwintering habitat for the snake. The remaining 3.5 acres of the borrow site will be restored to native grassland and will function as summer upland refugia and basking and in the winter serve as overwintering habitat for the snake.

Sacramento Bypass – Enlarging the Sacramento Bypass and Weir will result in both permanent and temporary effects to giant garter snake habitat. Construction of the widened bypass will have similar effects to giant garter snake as the work along borrow site 2. Snakes could be crushed by heavy equipment, entombed in refugia when burrows collapse, and exposed to increased predation because they may have to travel further to find habitat that is unavailable to them due to the project. The 25 acres of aquatic habitat and 50 acres of upland habitat that will be temporarily affected because of the relocation of a levee toe drain will be replaced within one year of construction. The Corps has committed to creating a toe drain that closely mimics the existing aquatic and upland habitat along the northern levee of the Sacramento Bypass. The effects of crushing snakes and exposing them to increased predation will be minimized through the use of the conservation measures described in the project description above.

Permanently, 15 acres of aquatic and 30 acres of upland habitat will be lost through the removal of drainage ditches and farm canals in the area that is currently outside of the bypass footprint. The Corps has committed to offsetting the loss of this habitat through the purchase of 135 acres of giant garter snake credits at a Service-approved conservation bank. Conservation banks provide protection, conservation easement, and funding, endowment, in perpetuity for the giant garter snake. These long-term protections and location of the conservation banks all contribute to the long-term recovery of the giant garter snake.

Operation of the expanded Sacramento Weir and Bypass will result in an increase of water surface elevation of approximately 0.5-foot on the levee slopes on either side of the Yolo Bypass. However, when this increase occurs, during a 200-year flood event, the Yolo Bypass levees already contain water up to 21 feet deep. As a result, giant garter snake burrows would likely already be saturated before the additional water associated with the widened Sacramento Bypass is a factor. The additional 0.5-foot resulting from this action would not significantly change the timing or duration of this flooding and would not result in further impacts to giant garter snake habitat.

The Corps has proposed to evaluate effects to listed species including giant garter snake when long-term maintenance activities for the Sacramento Bypass can be described. If maintenance activities will affect giant garter snakes the Corps will reinitiate consultation with the Service. Therefore, this biological opinion does not address effects to the giant garter snake from any long-term levee maintenance activities.

Yellow-Billed Cuckoo

Sacramento River – The Corps is planning on removing 70 acres of riparian habitat along the Sacramento River. The riparian corridor in this section of the Sacramento River is narrow (about 100 feet wide) because the levees were constructed so close to the edge of the channel bank. This is too narrow for the yellow-billed cuckoo to nest, however it is possible for the yellow-billed cuckoo to use this as a stopover when migrating to the Central Valley to breed. Vegetation removal will reduce the width of the riparian corridor from 100 feet to 40 feet on average. The Corps proposal to plant the bank protection sites will create a 25-foot wide planting berm leaving a loss of about 35 feet of riparian corridor. The Corps proposes to offset the loss of the 70 acres of riparian through the creation of 140 acres of riparian habitat along the lower American River.

American River – The construction of launchable rock trench will remove 65 acres of riparian habitat along the lower American River. The lower American River does have habitat patches large enough to support nesting yellow-billed cuckoos. Large patches of habitat will not be removed; rather a strip will be removed adjacent to the levee which could reduce the size of some of the potential nesting areas. To compensate for this the Corps is proposing to plant 130 acres along the lower American River. As described in the conservation measures, the Corps will develop a Riparian Conservation Plan that will determine the best locations to develop additional riparian habitat. The conservation areas will provide both habitat for yellow-billed cuckoo and valley elderberry longhorn. The areas will also ensure that there is a net increase of potential yellow-billed cuckoo nesting habitat along the lower American River Parkway. There will be a temporal loss of habitat because riparian habitat can take up to 20 years to develop.

In addition to the habitat loss for both the Sacramento and American Rivers, construction itself has the potential to adversely affect yellow-billed cuckoos. Construction that occurs when the cuckoo is in the Sacramento Valley has the potential to harass the bird due to noise. To minimize effects to the cuckoo due to construction noise the Corps conservation measure to do protocol level surveys prior to beginning construction will enable the Corps to determine if yellow-billed cuckoos are nesting near the construction footprint. The Corps has committed to avoid construction near an active yellow-billed cuckoo nest. However, cuckoos that could be foraging in the area could be harassed due to construction activities and noise and move to other locations in the lower American River parkway which could expose individual cuckoos to increased predation.

The Corps has proposed to evaluate effects to listed species including yellow-billed cuckoo when long-term maintenance activities for the Sacramento River and American River can be described. If maintenance activities will affect yellow-billed cuckoos the Corps will reinitiate consultation with the Service. Therefore, this biological opinion does not address effects to the yellow-billed cuckoo from any long-term levee maintenance activities.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Valley Elderberry Longhorn Beetle

Non-Federal adverse effects to the valley elderberry longhorn beetle include effects from nearby pesticide spraying drifting into valley elderberry longhorn beetle habitat and levee and channel maintenance. In the areas of the urbanized areas of the American and Sacramento Rivers human started fires is by far the largest effect to valley elderberry longhorn beetles. Over the last several years numerous fires have burned portions of the American River Parkway.

Delta Smelt

Adverse effects to delta smelt may result from point and non-point source chemical contaminant discharges within the action area. These contaminants include but are not limited to ammonia and free ammonium ion, numerous pesticides and herbicides from agricultural activities, and oil and gasoline product discharges. Oil and gasoline product discharges may be introduced into the Sacramento River from shipping and boating activities and from urban activities and runoff. Other future, non-Federal actions within the action area that are likely to occur and may adversely

affect delta smelt include: the dumping of domestic and industrial garbage that decreases water quality; oil and gas development and production that may affect aquatic habitat and may introduce pollutants into the water; agricultural activities, including burning or removal of vegetation on levees that reduce riparian and wetland habitats that contribute to the quality of habitat used by delta smelt; and livestock grazing activities that may degrade or reduce riparian and wetland habitats that contribute to the quantity and quality of habitat used by delta smelt.

San Francisco Bay-Delta Climate Change

The effects of climate change do not act in isolation; they are anticipated to exacerbate existing threats to delta smelt. We considered the potential effects of climate change on the delta smelt based on projections derived from various modeling scenarios. A series of publications (Feyrer *et al.* 2011; Cloern *et al.* 2011; Brown *et al.* 2013) have modeled future impacts of climate change in the Delta and projected how this will affect delta smelt. These models used the B1 and A2 scenarios from the 2007 IPCC report. Each scenario included both a warmer-wetter and warmer-dryer sub scenario. Modeled predictions presented in these publications are based on current baseline conditions (no increased outflow, no breeching of levees) which may or may not change in the future. Temperature increases are likely to lead to a continued rise in sea level, further increasing salinity which will increasingly restrict delta smelt's already limited geographic range (Feyrer *et al.* 2011; Cloern *et al.* 2011; Brown *et al.* 2013). Higher air temperatures will reduce snowpacks, melt snow earlier in the winter or spring, and increase water temperatures. These changes will likely alter freshwater flows, possibly shifting and condensing the timing and location of delta smelt reproduction (Brown *et al.* 2013).

Projections indicate that temperature and precipitation changes will diminish snowpack, changing the availability of natural water supplies (Reclamation 2011). Warming may result in more precipitation falling as rain and less storage as snow. This would result in increased rain on snow events and increase winter runoff with an associated decrease in runoff for the remainder of the year (Reclamation 2011). Sacramento Valley Ecoregion projections include a 27 percent decrease in annual freshwater flows and earlier snowmelts, with increased freshwater flows in January and February but reduced throughout the rest of the year (PRBO Conservation Science 2011). Earlier seasonal warming increases the likelihood of rain-on-snow events, which are associated with mid-winter floods. Smaller snowpacks that melt earlier in the year may result in increased drought frequency and severity (Rieman and Isaak 2010). Thus overall, these changes may lead to increased frequency of flood and drought cycles during the 21st century (Reclamation 2011).

Sea level rise is likely to increase the frequency and range of saltwater intrusion. Salinity within the northern San Francisco Bay is projected to rise by 4.5 by the end of the century (Cloern *et al.* 2011). Elevated salinity levels could push the position of X2 farther up the estuary if outflows were not increased to compensate for it. Fall X2 mean values are projected to increase by a mean of about 7 km to the area of Antioch for a distance of about 90 km from the Golden Gate Bridge by 2100 (Brown *et al.* 2013). This increase in the position of X2 in the fall is expected to result in a decrease in suitable physical habitat (Brown *et al.* 2013) if current levees and channel structures are maintained. A decrease in spring habitat due to the movement of X2 upstream due to sea level rise is also expected to result from climate change.

We expect warmer estuary temperatures to be yet another significant conservation challenge based on climate change models. Mean annual water temperatures within the upper Sacramento River portion of the Bay-Delta estuary are expected to approach or exceed 14 °C during the second half of this century (Cloern *et al.* 2011). Warmer water temperatures could reduce delta smelt growth, increase delta smelt mortality and constrict suitable habitat within the estuary during the summer

months. Due to warming temperatures, delta smelt are projected to spawn an average of 10 to 25 days earlier in the season depending on the location (Brown *et al.* 2013). Also due to expected temperature increases, total number of high mortality days is expected to increase for all IPCC climate change scenarios (Brown *et al.* 2013). The number of stress days is expected to be stable or decrease partly because many stress days will become high mortality days. This could lead to delta smelt being forced to grow under highly stressful conditions during summer and fall with less time to mature because of advanced spawning (Brown *et al.* 2013). Growth rates have been shown to slow as water temperatures increase therefore requiring delta smelt to consume more food to reach growth rates that are normal at lower water temperatures (Rose *et al.* 2013a). Delta smelt are already often smaller than they used to be (Sweetnam 1999; Bennett 2005) and expected temperature increases due to climate change will likely further slow growth rates.

At the same time, warmer water will tend to move the spawning season earlier in the year (Brown *et al.* 2013). That means the fish will have to grow faster still to compensate for that shorter growing season to produce even as many eggs as they do now – and that may already be a serious limitation on their population fecundity (Rose *et al.* 2013b). Higher temperatures may restrict delta smelt distribution into the fall, limiting their presence in Suisun Bay for more than just salinity reasons and force greater inhabitation of cooler high salinity waters (Brown *et al.* 2013). Water temperatures are already presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding 25 °C for short periods.

The delta smelt is currently at the southern limit of the inland distribution of the family Osmeridae along the eastern Pacific coast. That indicates that this region was already about as warm as that fish family can handle. Increased temperatures associated with climate change may result in a habitat in the Bay-Delta that is outside of the species ecological tolerance limits.

Giant Garter Snake

The Service is aware of other projects currently under review by the State, county, and local authorities where biological surveys have documented the occurrence of federally-listed species. These projects include such actions as urban expansion, water transfer projects that may not have a Federal nexus, and continued agricultural development. The cumulative effects of these known actions pose a significant threat to the eventual recovery of the species. Additionally, an undetermined number of future land use conversions and routine agricultural practices are not subject to Federal permitting processes and may alter the habitat or increase incidental take of snakes, and are, therefore, cumulative to the proposed project. For example other cumulative effects include: (1) unpredictable fluctuations in aquatic habitat due to water management and diversions; (2) dredging and clearing of vegetation from irrigation canals; (3) discing or mowing upland habitat; (4) increased vehicular traffic on access roads adjacent to aquatic habitat; (5) use of burrow fumigants on levees and other potential upland refugia; (6) human intrusion into habitat; (7) use of inappropriate plastic erosion control netting (Stuart *et al.* 2001); (8) riprapping or lining of canals and stream banks; (9) fluctuations in acreages of rice production due to market conditions or water availability; (10) ornamental cultivation; (11) routine grounds maintenance of upland habitat; (12) contaminated runoff from agriculture and urbanization; (13) maintenance of non-Federal flood control structures; and (14) predation by feral animals and pets. Specific cumulative effects related to the proposed project include maintenance activities and/or an increased potential for vandalism, which may degrade or destroy habitat or cause unpredictable fluctuations in habitat.

Yellow-Billed Cuckoo

Habitat that is currently occupied by the yellow-billed cuckoo occurs on public and privately owned lands. Activities on non-Federal lands that may affect the yellow-billed cuckoo include the construction and maintenance of recreational hiking and bicycle trails; restoration of native riparian habitat; transportation related projects like construction and maintenance of State, county, and private roads and bridges; flood channel maintenance by the State water resources agencies, and conversion of riparian habitat to agriculture on private lands.

Conclusion

After reviewing the current status of the valley elderberry longhorn beetle, delta smelt, giant garter snake and yellow-billed cuckoo, the environmental baseline for the action area, the effects of the proposed ARFC project, and the cumulative effects on these species, it is the Service's biological opinion that the proposed AFRC project, is not likely to jeopardize the continued existence of these species. The Service reached this conclusion because the project-related effects to the species, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding recovery or reducing the likelihood of survival of the species based on the conservation measures proposed by the Corps including: creating additional riparian habitat for the valley elderberry longhorn beetle and the yellow-billed cuckoo; purchasing credits at conservation banks for giant garter snake and delta smelt; and restoring any temporarily affected habitat to pre-project conditions.

After reviewing the current status of designated critical habitat for delta smelt, the environmental baseline of critical habitat in the action area, the effects of the proposed ARFC project, and the cumulative effects, it is the Service's biological opinion that the proposed ARFC project, as proposed, is not likely to destroy or adversely modify designated critical habitat. The Service reached this conclusion because the project-related effects to the designated critical habitat, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding the function of the delta smelt critical habitat, to serve its intended conservation role for the species based on the Corps proposal to purchase credits at a conservation bank for permanent effects to the substrate of the Sacramento River. The effects to delta smelt critical habitat are small and discrete, relative to the entire area designated, and are not expected to appreciably diminish the value of the critical habitat or prevent it from sustaining its role in the conservation of the delta smelt.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action

is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by the Corps and SAFCA so that become binding conditions of any contract issued for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions, or (2) fails to require their contractor or SAFCA or to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

Valley Elderberry Longhorn Beetle

The Service anticipates that incidental take of valley elderberry longhorn beetle will be difficult to detect due to its life history and ecology. Specifically, valley elderberry longhorn beetles can be difficult to locate due to the fact that a majority of their life cycle is spent in the elderberry shrub and finding a dead or injured individual is unlikely due to their relatively small size. There is a risk of harm, harassment, injury and mortality as a result of the proposed construction activities; therefore, the Service is authorizing take incidental to the proposed action as harm, harassment, injury, and mortality of all valley elderberry longhorn beetles within 263 shrubs that will be transplanted as a result of construction and 40 acres of elderberry shrubs that will be trimmed for maintenance purposes over the project's 50 year life.

Delta Smelt

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults, their occurrence in turbid aquatic habitat makes them difficult to detect, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in the 46 acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion. Incidental take of delta smelt for maintenance activities is not covered in this biological opinion.

Giant Garter Snake

The Service anticipates that incidental take of the snake will be difficult to detect or quantify for the following reasons: snakes are cryptically colored, secretive, and known to be sensitive to human activities. Snakes may avoid detection by retreating to burrows, soil crevices, vegetation, and other cover. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. It is not possible to make an accurate estimate of the number of snakes that will be harassed during construction activities, including in staging areas and roads carrying vehicular traffic. In instances when take is difficult to detect, the Service may estimate take in numbers of species per acre of habitat lost or degraded as a result of the action as a surrogate measure for quantifying individuals.

Therefore, the Service anticipates the number of giant garter snakes that may be found in 125.5 acres of aquatic and upland habitat will be harmed or killed as a result of habitat modification due to the proposed project. Incidental take of giant garter snake for maintenance activities is not covered in this biological opinion.

Yellow-Billed Cuckoo

The Service anticipates that incidental take of yellow-billed cuckoo will be difficult to detect due to its life history and ecology. Specifically, yellow-billed cuckoos can be difficult to locate due to their cryptic appearance and behavior and finding a dead or injured individual is unlikely. There is a risk of harm and harassment as a result of proposed construction activities and operations and maintenance of the restoration plantings; therefore, the Service is authorizing take incidental to the proposed action as harm of all yellow-billed cuckoos within 135 acres. Incidental take of yellow-billed cuckoo for maintenance activities is not covered in this biological opinion.

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Reasonable and Prudent Measures

All necessary and appropriate measure to avoid or minimize effects on the species resulting from implementation of this project have been incorporated into the project's proposed conservation measures. Therefore, the Service believes the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the species.

1. All conservation measures, as described in the biological assessment and restated here in the Project Description section of this biological opinion, shall be fully implemented and adhered to. Further, this reasonable and prudent measure shall be supplemented by the terms and conditions below.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. The Corps shall include full implementation and adherence to the conservation measures as a condition of any permit or contract issued for the project.

2. The Corps will develop a Riparian Planting Plan. The plan will evaluate locations for riparian vegetation planting based on land use in the lower American River Parkway, effects from future projects, such as the reoperation of Folsom Dam, where existing riparian and valley elderberry longhorn beetle habitat exists, creating and maintaining connectivity between large riparian patches, and coordination with Sacramento County Parks. The plan will maximize habitat quality for both the valley elderberry longhorn beetle and the yellow-billed cuckoo.

3. In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the Corps shall adhere to the following reporting requirements. Should this anticipated amount or extent of incidental take be exceeded, the Corps must immediately reinitiate formal consultation as per 50 CFR 402.16.

   (a) For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, the Corps will provide monthly updates to the Service with a precise accounting of the total acreage of habitat impacted. Updates shall also include any information about changes in project implementation that result in habitat disturbance not described in the Project Description and not analyzed in this biological opinion.
   (b) For those components of the action that may result in direct encounters between listed species and project workers and their equipment whereby incidental take in the form of harassment, harm, injury, or death is anticipated, the Corps shall immediately contact the Service's Sacramento Fish and Wildlife Office (SFWO) at (916) 414-6600 to report the encounter. If the encounter occurs after normal working hours, the Corps shall contact the SFWO at the earliest possible opportunity the next working day. When injured or killed individuals of the listed species are found, the Corps shall follow the steps outlined in the Salvage and Disposition of Individuals section below.
   (c) Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as a Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, and the name of the person who found it. The bag containing the specimen must be frozen in a freezer located in a secure site, until instructions are received from the Service regarding the disposition of the dead specimen. The Service contact persons are the Habitat Conservation Division Chief at the Sacramento Fish and Wildlife Office at (916) 414-6600; the Assistant Field Supervisor of ESA/Regulatory Division at the Bay Delta Fish and Wildlife Office at (916) 930-5603; and the Resident Agent-in-Charge of the Service's Office of Law Enforcement at (916) 569-8444.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1. The Service recommends the Corps develop and implement restoration measures in areas designated in the Delta Fishes Recovery Plan (Service 1996) the Giant Garter Snake Recovery Plan (1999) and the Valley Elderberry Longhorn Beetle Recovery Plan (1984).

2. The Corps and SAFCA should develop and implement projects that support DWR's Central Valley Flood System Conservation Strategy. This document provides goals and measurable objectives and potential projects which could be implemented in a manner that while improving the riverine ecosystem also will improve the flood system.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation with the Corps on the American River Common Features GRR Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

(a) If the amount or extent of taking specified in the incidental take statement is exceeded;

(b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or

(d) If a new species is listed or critical habitat designated that may be affected by the identified action.

If you have any questions regarding this biological opinion, please contact Jennifer Hobbs (jennifer_hobbs@fws.gov or (916) 414-6541) or Doug Weinrich, Assistant Field Supervisor at the letterhead address, (916) 414-6600.

Sincerely,

Jennifer M. Norris
Field Supervisor

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

SEP 9 2015

Refer to NMFS No: WCR-2014-1377

Ms. Alicia Kirchner
Department of the Army
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, for the American River Common Features General Reevaluation Report (Common Features GRR)

Dear Ms. Kirchner:

Thank you for your letter of April 3, 2015, providing an updated biological assessment and requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 *et seq.*) for the Common Features GRR.

This letter also transmits NMFS's essential fish habitat (EFH) conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.*).

Based on the best available scientific and commercial information, the Biological Opinion (BO) concludes that the Common Features GRR is not likely to jeopardize the continued existence of the federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), threatened California CV steelhead distinct population segment (DPS) (*O. mykiss*), or the threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*) and is not likely to destroy or adversely modify their designated critical habitats. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

The EFH consultation concludes that the proposed action would adversely affect the EFH of Pacific salmon in the action area. The EFH consultation adopts the ESA reasonable and prudent measures and associated terms and conditions from the BO and includes additional conservation recommendations specific to the adverse effects to fall- and late fall-run Chinook salmon (*O. tshawytscha*) EFH.

The U.S. Army Corps of Engineers (Corps) has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the Common Features GRR and the measures needed to avoid, minimize, or mitigate (also referred to as compensate by NMFS) such effects.

Please contact Howard Brown at the NMFS California Central Valley Office, 916-930-3608, or at Howard.Brown@noaa.gov, if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

for William W. Stelle, Jr.
Regional Administrator

Enclosure

CC: CHRON File: 151422WCR2014SA00215

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation.

Common Features GRR
NMFS Consultation Number: 151422WCR2015SA00215

Action Agency: U.S. Army Corps of Engineers (Corps)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?*	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
CV spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*)	Endangered	Yes	No	No
California CV steelhead DPS (*O. mykiss*)	Threatened	Yes	No	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	No	No	Yes

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

for William W. Stelle, Jr.
Regional Administrator

Date:

List of Acronyms

BA	Biological Assessment
BCSSRP	Battle Creek Salmon and Steelhead Restoration Program
BMP	Best Management Practices
BO	Biological Opinion
BSSCP	Bentonite Slurry Spill Contingency Plan
CCV	California Central Valley
CDFG	California Department of Fish and Game
CDFW	California Department of Fish Wildlife
CEQA	California Environmental Quality Act
cfs	Cubic Feet per Second
CNFH	Coleman National Fish Hatchery
Corps	US Army Corps of Engineers
CRR	Cohort Replacement Rate
CV	Central Valley
CVP	Central Valley Project
CVFPB	Central Valley Flood Protection Board
CWA	Clean Water Act
CWT	Coded Wire Tag
dbh	Diameter at Breast Height
DCC	Delta Cross Channel
Delta	Sacramento-San Joaquin Delta
DO	Dissolved Oxygen
DPS	distinct population segment
DWR	California Department of Water Resources
DWSC	Deep Water Ship Channel
EFH	Essential Fish Habitat
EIP	Early Implementation Project
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ETL	Engineering Technical Letter
FRFH	Feather River Fish Hatchery
GCID	Glenn-Colusa Irrigation District
GRS	General Reevaluation Study
HU	Hydrologic Unit
ITS	Incidental Take Statement
IWM	Instream Woody Material
JPE	Juvenile Production Estimate
Kelts	Post-Spawning Steelhead
lf	Linear Feet
LSNFH	Livingston Stone National Fish Hatchery
LWM	Large Woody Material
mm	millimeter

MMP	Mitigation and Monitoring Plan
MSA	Magnuson-Stevens Fishery Conservation and Management Act
nDPS	Northern Distinct Population Segment
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTUs	Nephelometric Turbidity Units
O&M	Operation and Maintenance
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCE	primary constituent elements
PL	Public Law
PVA	Population Viability Analysis
RBDD	Red Bluff Diversion Dam
RD	Reclamation District
Reclamation	United States Department of the Interior, Bureau of Reclamation
RM	River Mile
RWQB	Regional Water Quality Control Board
SAM	Standard Assessment Methodology
SDFPF	Skinner Delta Fish Protection Facility
sDPS	Southern Distinct Population Segment
SJRRP	San Joaquin River Restoration Program
SPCCP	Spill Prevention, Control, and Counter-Measure Plan
SRA	Shaded Riverine Aquatic
SRBPP	Sacramento River Bank Protection Project
SRFCP	Sacramento River Flood Control Project
SWP	State Water Project
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TCP	Temperature Compliance Point
TFCF	Tracy Fish Collection Facility
TRT	Technical Review Team
USACE	United State Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VSP	Viable Salmonid Populations
VVR	Vegetation Variance Request
WRDA	Water Resources Development Act
WRI	Weighted Species Response Index
WRO	Water Rights Order
WSAFCA	West Sacramento Area Flood Control Agency

Note: Throughout this document there are references cited as CDFG. This refers to the California Department of Fish and Game. This name was changed to California Department of Fish and Wildlife on January 1, 2013. However, for consistency on publications, references prior to January 1, 2013, will remain CDFG.

INTRODUCTION

The U.S. Army Corps of Engineers (Corps) proposes to implement flood risk management improvements under the American River Common Features General Reevaluation Report (Common Features GRR). The purpose of this Biological Opinion (BO) is to analyze the potential effects of repairing the levees in the Sacramento Metropolitan area (including both the Sacramento and American Rivers), widening the Sacramento Weir and Bypass, and diverting more flows into the Yolo Bypass on listed threatened or endangered species and on designated critical habitat, within the project's area of effect (action area).

1.1 Common Features GRR Project Study Area

The Common Features GRR project study area is located within the Sacramento and American River Watersheds. The Sacramento River watershed covers approximately 26,000 square miles in central and northern California. Major tributaries of the Sacramento River include the Feather, Yuba, and American Rivers. The American River Watershed covers about 2,100 square miles northeast of the city of Sacramento and includes portions of Placer, El Dorado, Alpine, and Sacramento counties. The American River watershed includes Folsom Dam and Reservoir; inflowing rivers and streams, including the North, South, and Middle forks of the American River; and the lower American River downstream of Folsom Dam to its confluence with the Sacramento River in the city of Sacramento. The Sacramento and American Rivers, in the Sacramento area, form a flood plain covering roughly 110,000 acres at their confluence. The flood plain includes most of the developed portions of the city of Sacramento. Figure 1 shows the study area.

The Common Features GRR study area includes:

1. Approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River.
2. The east bank of the Dry, and Robla Creeks and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries).
3. The east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee.
4. The Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento (Figure 1).

The action area for the ARCF GRR project includes the American River from below Folsom Dam to the confluence with the Sacramento River and the Sacramento River from the Sacramento Bypass down to below Freeport. In addition the action area includes the East Side Tributaries: Dry and Robla Creeks, and the Magpie Creek Diversion Channel.

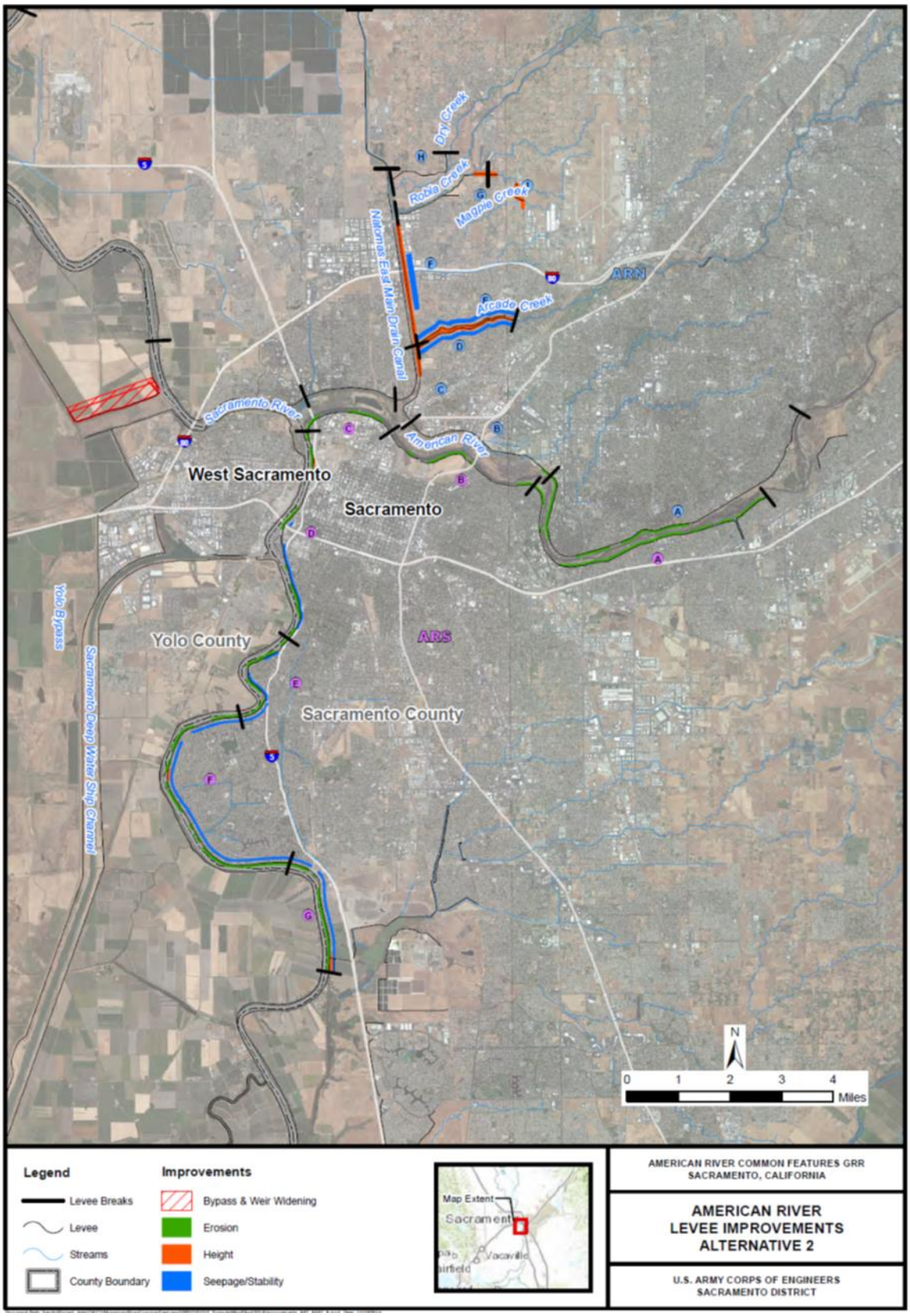


Figure 1. Common Features GRR Study Area (Corps 2014).

1.2 Background, Authority and Policy

The National Marine Fisheries Service (NMFS) prepared the BO and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq*.), and implementing regulations at 50 CFR part 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 *et seq*.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System, https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts. A complete record of this consultation is on file at the NMFS California Central Valley Office.

1.2.1 Background

After the flood of 1986, Congress directed the Corps to investigate the feasibility of reducing flood risk to the city of Sacramento. The Corps completed feasibility studies in 1991 and 1996, recommending a concrete gravity flood detention dam on the north fork of the American River at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features." Thus, the ARCF Project was authorized in WRDA 1996 and a decision on Auburn Dam was deferred to a later date. Major construction components for ARCF in the WRDA 1996 authorization include construction of seepage remediation along approximately 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas.

Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5. In addition, both the north and south bank of the American River from RM 0 to approximately RM 11.4 experienced seepage. Seepage on the Sacramento River was so extensive that Congress, soon after the 1986 flood event, funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport.

In 1999, Congress decided not to authorize Auburn Dam but instead to authorize improvements for Folsom Dam. By doing this, improvements to levees downstream of Folsom Dam could be fine-tuned to work closely with the Folsom Dam improvements being discussed by Congress. Therefore, the Common Features project was modified by WRDA 1999 to include additional necessary features for the American River so that it could safely convey the proposed emergency

release of 160,000 cfs from Folsom Dam. Major construction components for the Common Features project in the WRDA 1999 authorization include construction of seepage remediation and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of Natomas Cross Canal levee in Natomas. All American River features authorized in WRDA 1996 and 1999 have been constructed or are in design analysis for construction within a year or two.

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress throughout the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a general reevaluation study would be required for at least the Natomas Basin portion of the ARCF project. This general reevaluation started in 2006.

At approximately the same time that the reevaluation study was beginning, the Folsom Dam Post Authorization Change report (PAC) was being completed by the Sacramento District. Results of this study showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to truly capture the benefits of the Folsom Dam projects. These levee improvements consisted primarily of addressing erosion concerns on the American River and seepage, stability, erosion, and height concerns on the Sacramento River below the American River.

There are three additional flood management Corps projects related to the Common Features GRR that provide additional context. The Corps initiated consultation for the West Sacramento GRS project in early 2015. Many of the proposed elements associated with the West Sacramento GRS are anticipated to be similar in nature to proposed elements with the Common Features GRR. The project area will include the opposite bank (west bank) of the Sacramento River from the West Sacramento GRS. Potential impacts associated with vegetation removal and bank armoring associated with the West Sacramento GRS could further degrade this area of the Sacramento River watershed. These potential impacts in combination with potential impacts associated with the West Sacramento GRR could degrade the overall health of the lower Sacramento River watershed.

The Corps has initiated consultation for the Sacramento Bank Protection Project Phase II project. Sacramento Bank Protection Project Phase II will cover up to 80,000 lf of bank protection as part of the SRFCP. A number of the potential bank protection sites are located in the general vicinity of the Common Features GRR.

Under the Water Resources Development Act of 1999, Pub. L. No. 106-53, § 366, 113 Stat. 269, 319-320 (1999) (WRDA 1999), Congress authorized improvements to Folsom Dam to control a 200-year flood event with a peak release of 160,000 cfs. WRDA 1999 also authorized the Folsom Dam Modification Project to modify the existing outlets to allow for higher releases earlier in flood events. At the same time, Congress also directed the Corps to review additional modifications to the flood storage of Folsom Dam, indicating that Congress was looking at maximizing the use of Folsom Dam to reduce flood risk prior to consideration of any additional

upstream storage on the American River. The Folsom Dam Raise Project was subsequently authorized by Congress in 2004. The project is designed to allow for the release of 160,000 cubic feet per second (cfs) from Folsom Dam. The levees along the American River are unable to withstand these maximum flows for extended periods of time without increased risk of erosion and potential failure. Erosion within the American River Parkway is being addressed as part of the Folsom Reoperation project currently under evaluation and a biological assessment is being prepared to initiate Section 7 consultation with both USFWS and NMFS. These projects have the potential to increase the bank armoring and could exacerbate any impacts associated with the Common Features GRR.

1.2.2 Authority and Policy

According to the Corps' BA, they have no discretion in regards to the continuing existence and operation of the flood control structures of the SRFCP. They assert to have responsibility to maintain Civil Works structures so that they continue to serve their congressionally authorized purposes is inherent in the authority to construct them and is, according to the Corps, non-discretionary. The Corps also asserts that only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease.

The Corps BA also claims that it has a non-discretionary duty to maintain the SRFCP and the fact the Corps perpetuates the projects existence is not an action subject to consultation. The Federal government maintains oversight but has no ownership of or direct responsibilities for performing maintenance of the Federal levee system, except for few select features that continue to be owned and operated by the Corps. However, the Corps asserts they do have discretion in regard to how and where maintenance actions are performed. The discretion lies within the authorities of the SRBPP and section 408 of the Rivers and Harbors Act. The Corps is seeking additional authorities that will include discretion over future flood risk reduction projects associated with the West Sacramento GRS and the Common Features GRR.

Considering these exceptions, the Corps maintains that the majority of levees, channels, and related flood risk management structures are owned, operated, and maintained by the State of California and local levee and reclamation districts as governed by Corps Operations and Maintenance (O&M) manuals. The Corps points to the May 1955 Standard O&M manual for the SRFCP as the primary O&M manual for the area. The levees of the West Sacramento and Common Features Projects are part of the SRFCP and therefore covered in the 1955 O&M manual.

The BA states that following completion of construction, the Corps will prepare a supplement to the 1955 O&M manual which will specify maintenance requirements for these projects. Because the Corps does have discretion in how and when levee maintenance activities are performed (as opposed to the results of maintenance), maintenance is a discretionary activity that is part of the proposed action subject to consultation.

Typical maintenance activities would include vegetation control through mowing, herbicide application, and/or slope dragging; rodent control; patrol road maintenance; and erosion control

and repair. Vegetation control typically would be performed twice a year. Herbicide and bait station application would be conducted under county permit by experts licensed by the state for pest control. Erosion control and slope repair activities would include re-sloping and compacting; fill and repair of damage from rodent burrows would be treated similarly.

To meet Federal Flood Control Regulations (33 CFR 208.10) and state requirements (California Water Code Section 8370), the Federal Flood Risk Management facilities are inspected four times annually, at intervals not exceeding 90 days. The California Department of Water Resources (DWR) would inspect the system twice a year, and the local maintaining authorities would inspect it twice a year and immediately following major high water events. The findings of these inspections would be reported to the Central Valley Flood Protection Board's (CVFPB) Chief Engineer through DWR's Flood Project Integrity and Inspection Branch.

Each federal agency has an obligation to insure that any discretionary action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or destroy or adversely modify its critical habitat. Furthermore, under Section 2 of the ESA, it is declared that all Federal agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA. In regards to species and critical habitat compensation, the Corps has the authority to compensate prior to or concurrent with project construction impacts. This authority is given under WRDA 1986 (33 USC §§ 2201–2330).

The Common Features Project is being proposed in accordance with the principles that have been outlined in the Corps' SMART Planning Guide (Corps 2013). SMART Planning requires that all feasibility studies should be completed within a target of 18 months (to no more than three years at the greatest), at a cost of no more than $3 million, utilizing 3 levels of vertical team coordination, and of a "reasonable" report size. All designs associated with the Common Features GRR use the largest footprint to evaluate affects to listed species. The larger footprint will look at the maximum extent the project could affect species in the action area.

The Corps proposes to construct the Common Features Project levee improvement measures to comply with the Engineering Technical Letter (ETL) 1110-2-571 Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures. The vegetation requirements include a vegetation-free zone on the levee slopes and crown, 15 feet from both landside and waterside levee toes, and 8 feet vertically.

The levees within the study area require seepage, slope stability, height, and erosion improvements in order to meet Corps levee safety criteria. In order to protect existing vegetation and allow for revegetation to occur, the Corps must apply for and issue itself with a vegetation variance. The vegetation variance will be sought during the preconstruction engineering and design phase to allow vegetation to remain on the lower 2/3 of the waterside slope and out 15 feet from the waterside toe. If the Corps grants itself a variance, the variance would allow for vegetation to remain in these areas. No vegetation would be permitted on the landside slope or within 15 feet of the landside toe. To show that the safety, structural integrity, and functionality of the levee would be retained with a variance, an evaluation of underseepage and waterside embankment slope stability was completed by Corps engineers.

The Corps' preliminary analysis for the vegetation variance was conducted by analyzing two index points. These two index points were chosen for the vegetation variance analyses because they were considered to be representative of the most critical channel and levee geometry, underseepage, slope stability conditions, and vegetation conditions of the respective basins. The analysis incorporated tree fall and scour on the cross-section geometry of the index points by using a maximum depth of scour for cottonwoods as approximately 11.0 feet; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee would meet Corps seepage and slope stability criteria when the seepage and slope stability improvement measures are in place ("with-project" conditions). Therefore, it is a reasonable conclusion that allowing vegetation to remain on the lower waterside levee slope would not affect the safety, structural integrity, and functionality of the Sacramento River levee.

As a result of the geotechnical analysis, the Corps would request a vegetation variance of themselves for the Sacramento River, Dry/Robala Creeks, Arcade Creek, and Magpie Creek portions of the project. In many cases along the American River levees, the levee is far enough back from the water's edge to allow vegetation providing shaded riverine aquatic cover to remain on the bank with no vegetation variance necessary. However, the Sacramento Weir and Bypass levees would be constructed in compliance with the Corps ETL as these would be new levees. No vegetation removal would be required within the existing or expanded Sacramento Bypass. There will be no Vegetation Variance requested for the American River sites and will require removal of vegetation and will therefore comply with the ETL. Refer to Table 1 for reach specific information regarding presence or absence of a vegetation variance.

Table 1: Summary of ETL compliance Method by Waterway.

	Vegetation Variance	**SWIF**
Sacramento River (lower ½ of levee slope which is outside construction footprint)		
Waterside	X	
Landside		X
American River		
Trench Landside[1]		X
Bank Protection		X
North Area Tributaries[2]		
NEMDC	X	X
Dry/Robla Creeks	X	X
Arcade Creek	X	X
Magpie Creek[3]	X	X

1 The waterside footprint for the trench construction would require removal of vegetation and therefore compliance with the ETL.
2 A variance is included for these tributaries waterside slopes outside of the construction footprint, and a SWIF would be prepared by the non-Federal partners for the landside slopes and access.
3 The new levee constructed along Raley Boulevard would be constructed in compliance with the ETL.

In addition to the Vegetation variance, this project will implement the System Wide Improvement Framework (SWIF). The SWIF is an agreement between the Corps and the non-Federal sponsor that allows the local maintain agency (LMA) to defer compliance with ETL 1110-2-583. In an effort to modernize the levee system to meet current engineering standards, vegetation and encroachment issues (including landside levee access) in the study area will be resolved through a combination of construction actions associated with implementation of the recommended plan and formal agreements. The formal agreements involve the integrated use of a SWIF agreement with the LMA and a variance from vegetation standards in ETL 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures.

Under the SWIF agreement, the LMA would address landside vegetation and encroachment issues (including landside levee access) through the implementation of their standard operation and maintenance (O&M) actions over time. Therefore, vegetation not impacted by project construction would be addressed by the LMA in accordance with the State's Levee Vegetation Management Strategy in the Central Valley Flood Protection Plan (CVFPP) over the next 20 to 40 years. The SWIF will be planned and implemented by the non-Federal sponsor and includes the following criteria:

- An engineering inspection and evaluation shall be conducted to identify trees and other woody vegetation (alive or dead) on the levee and within 15 feet of the levee toe that pose an unacceptable threat to the integrity of the levee. Identified trees shall be removed and associated root balls and roots shall be appropriately remediated. Based on the engineering inspection and evaluation, trees and other woody vegetation that do not pose an unacceptable threat need not be removed.

- In cases of levee repair or improvement projects, vegetation within the project footprint shall be removed as part of construction activities.

- Trees and other woody vegetation that are not removed must be monitored as part of routine levee maintenance to identify changed conditions that cause any of these remaining trees and other woody vegetation to pose an unacceptable threat to levee integrity. Otherwise, such trees and woody vegetation are to be maintained according to the levee vegetation management criteria included in the CVFPP which establish a vegetation management zone (including the landside levee slope, crown and upper 1/3 of the waterside slope) in which trees are trimmed up to 5 feet above the ground (12-foot clearance above the crown road) and thinned for visibility and access while brush, trees and other woody vegetation less than four inches in diameter at breast height, weeds or other such vegetation over 12 inches high are to be removed in an authorized manner.

The standard O&M activities will be adjusted to reflect any vegetation variance. Under the adjusted O&M manual, large trees that were protected in place under the variance will be allowed to remain on the waterside slopes, but smaller shrubs will be removed and grasses will be regularly mowed to allow for inspection and access.

The ARCF project was authorized by Section 106(a)(1) of the Water Resources Development Act (WRDA) of 1996, (Public Law [PL] 104-303) (110 Stat. 3658, 3662-3663), as amended by Section 130 of the Energy and Water Development and Related Agencies Appropriations Act of 2008, (PL 110-161) (121 Stat. 1844, 1947). Additional authority was provided in Sections 366 and 566 of WRDA 1999, (PL 106-53), (113 Stat. 269, 319-20. The current estimated cost of the authorized project is $274,100,000. In accordance with Section 902 of WRDA 1986 (Pub. L. 99-662, § 902, Nov. 17, 1986, 100 Stat. 4183), the allowable cost limit is $284,000,000.

1.3 Consultation History

NMFS received a request for initiation of consultation on July 1, 2014. However, the initial request did not contain an appropriate effects determination. The Biological Assessment (BA) was missing necessary information to perform a species impact analysis. NMFS reviewed the biological assessment provided with the initiation letter and concluded it lacked sufficient detail to determine the extent to which the proposed project may affect federally listed species and their designated critical habitats. In addition, NMFS found that the information provided with the letter was incomplete and lacked all the information necessary to initiate section 7 consultation on the proposed project, as outlined in the regulations governing interagency consultation (50 CFR §402.12). On September 9th, 2014 NMFS sent an insufficiency letter outlining the information needs to initiate consultation.

On April 3, 2015 NMFS received a new request for initiation of consultation. The request included the North Sacramento Streams projects that were to be conducted by SAFCA. In the April 3, 2015 letter the Corps requested concurrence from NMFS that the Common Features GRR will adversely affect threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), threatened California CV (CCV) steelhead distinct population segment (DPS) (*O. mykiss*), and threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*), and their designated critical habitats. Additionally, the Corps has determined that the Common Features Project may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Management Act. The Corps also states that there is an expectation that the Common Features GRR may benefit long-term EFH quality in the action area.

After phone conversations, emails, and an inter-agency meeting on April 21, 2015 the Corps agreed to send a letter advising that the North Sacramento Streams projects would be separated from the Common Features GRR for a separate consultation, and that new SAM analysis models needed to be run. NMFS informed the Corps that consultation could not begin until the letter was received and SAM analysis completed.

May 14, 2015 another interagency meeting that included the Corps and NMFS occurred for the revised SAM analysis. NMFS again informed the Corps that consultation could not begin until the letter was received and SAM analysis completed. NMFS and the Corps agreed that the following information should be included in the letter transmitting the new Standard Assessment Methodology (SAM) analysis Memo:

1. Establish that for all of the three reaches what Sac Bank approximation was used for all SAM runs. Meaning the sites constructed near to the sites to be constructed, those specifications were used for the with-construction conditions, remember to add to the SAM analysis memo we are working on.

2. Add all green sturgeon life stages to the SAM analysis for site C since it is in Green Sturgeon Critical habitat.

3. Add green sturgeon juvenile rearing habitat SAM analysis for all America River sites.

4. Add justification for not including certain life history stages to the SAM analysis.

5. Addition of a discussion for the purchase of mitigation credits appropriate for each site.

6. Addition of numbers for fall-run juvenile migration all water levels for EFH.

7. Incorporate 60% IWM into the SAM analysis.

8. Incorporate a discussion of possibly incorporating 80% IWM.

9. Incorporation of plantings (*i.e.* button bush) at the lowest/Fall water line to increase the value.

June 11, 2015 NMFS received email with Draft memo of new Sam analysis information which included a new reach of the Sacramento bypass and weir and NMFS initiated consultation.

August 24, 2015 NMFS met with the Corps and received new conservation measures to add to the project description.

August 28, 2015. NMFS received a letter from the Corps officially providing the revised project description and new Green Sturgeon conservation measures.

1.4 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

The Corps has identified a number of problems associated with the flood risk management system protecting the city of West Sacramento and surrounding areas. There is a high probability that flows in the American and Sacramento Rivers will stress the network of levees protecting Sacramento to the point that levees could fail. Such a levee failure would flood a highly urbanized area.

Levees in the Common Features GRR action area require improvements to address seepage, stability, erosion, and height concerns identified for the American River levees, Dry/Robla, and Magpie Creeks. The levees along the Sacramento River would be improved to address identified

seepage, stability, erosion, and a minimal amount of height concerns. Most height concerns along the Sacramento River would be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass. The measures proposed to improve the levees consist of: (1) bank protection or launchable rock trenches, (2) install cutoff walls, (3) levee raise, (4) construct floodwalls, (5) raise floodwalls, (6) construct new levee, (7) acquire property to create a flood detention basin, (8) widen and raise a bridge crossing, (9) remove a culvert, (10) widen the Sacramento Weir and Bypass, (11) construction of a new weir, and 12) removal of existing levee. The above measures will be implemented by fixing levees in place or constructing adjacent levees. It is possible that sheet pile walls, jet grouting, and relief wells will be used at various locations so they are also described below. Once a levee is modified, regardless of the measure implemented for the alternative, the levee will be brought into compliance with Corps levee design criteria.

For more details on the potential levee repairs listed above and in Table 2, refer to the American River Common Features General Reevaluation Report North Sacramento Streams Levee Improvement Project, specifically Chapter 2 (Corps 2015a).

In addition to the proposed levee improvements measures, the following measures and policies will apply to all of the levee repair alternatives, and will be addressed during construction:

1. Utility encroachments such as structures, certain vegetation, power poles, pump stations, and levee penetrations (*e.g.*, pipes, conduits, cables) will be brought into compliance with applicable Corps policy or removed depending on type and location. This measure will include the demolition of such features and relocation or reconstruction as appropriate on a case-by-case basis (or retrofit to comply with standards). Utilities replacements will occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.

2. Private encroachments shall be removed by the non-federal sponsor prior or property owner prior to construction.

The O&M of the levees in the Sacramento area are the responsibility of the local maintaining agencies, including the American River Flood Control District, Maintenance Area 9, The California Department of Water Resources (DWR), and the City of Sacramento. The applicable O&M Manual for the Sacramento levees is the Standard O&M Manual for the Sacramento River Flood Control Project. Typical levee O&M in the Sacramento area includes the following actions:

1. Vegetation maintenance up to four times a year by mowing or applying herbicide.

2. Control of burrowing rodent activity monthly by baiting with pesticide.

3. Slope repair, site-specific and as needed, by re-sloping and compacting.

4. Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.

5. Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.

6. Post-construction, groundwater levels would be monitored using the piezometers.

Flood risk reduction construction activities will primarily occur during the April 15 to October 31 time frame, although extension of the CVFPB encroachment permit may be sought if weather conditions permit. However, construction activities, including, but not limited to, structure and vegetation removal, roadway removal and replacement, revegetation, and utility removal and replacement, regardless of the construction season will be subject to the conditions of environmental and encroachment permits and authorizations to be issued by the California Department of Fish and Wildlife (CDFW), CV Regional Water Quality Control Board (RWQCB), CVFPB, the Corps, US Fish and Wildlife Service (USFWS), NMFS, Yolo County, City of West Sacramento, and others.

Construction of the Common Features Project is proposed to take approximately 13 years if each reach is constructed sequentially. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that will occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. A summary of the flood risk reduction measures proposed as part of this study are included in Table 2.

Table 2. Proposed Measures for the Common Features GRR Project.

Waterway/Location	Extent of Action	Proposed Measure
American River	North and south levees from the confluence with the Sacramento River upstream for approximately 12 miles.	• Construct bank protection or launchable rock trenches
Sacramento River	East levee from the American River to Morrison Creek.	• Install cutoff walls • Construct bank protection • Construct levee raise
Dry/Robla Creek		• Raise floodwalls
Magpie Creek Diversion Canal	Upstream of Raley Boulevard	• Construct floodwalls
Magpie Creek area	South of Raley Boulevard	• Construct new levee
Magpie Creek area	East of Raley Boulevard	• Acquire property to create a flood detention basin • Widen the Raley Boulevard/Magpie Creek bridge and raise the elevation of the roadway • Remove the Don Julio Creek culvert
Sacramento Weir and Bypass	North bypass levee to 1,500 feet north.	• Widen the Sacramento Weir and Bypass by approximately 1,500 feet • Construct a new section of weir and levee • Remove the existing Sacramento Bypass north levee

The tentative schedule of construction is shown in Table 3. The durations are for construction activities only, and do not include the time needed for design, right-of-way, utility relocation, *etc*.

Table 3. Common Features GRR Project Construction Schedule.

PRIORITY	WATERWAY	REACH	YEAR OF PROJECT CONSTRUCTION												
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	Sacramento River	ARS F													
2	Sacramento River	ARS E													
3	American River	ARS A													
4	Sacramento River	ARS G													
5	Sacramento River	ARS D													
6	American River	ARS B													
7	American River	ARN A													
8	American River	ARS C													
9	American River	ARN B													
10	Sacramento Weir & Bypass	--													
11	Dry/Robla Creek	ARN G													
12	Magpie Creek	ARN I													

Analysis of total linear feet (lf) of shaded riverine aquatic (SRA) habitat was conducted using Google Earth Pro for the reaches only associated with bank protection on the American and Sacramento Rivers in the Common Features GRR action area (Table 4). However, site specific conditions at proposed bank protection sites will evaluate SRA habitat values using the SAM method of analysis to determine impacts and onsite compensation value based on actual designs. The East Side Tributaries were not evaluated because no bank erosion protection is planned. It should be noted however that there is minimal, if any, SRA associated with the tributaries in the reaches where construction is proposed, except Arcade Creek. It is not anticipated that trees would need to be removed within the Sacramento Bypass as a result of the levee relocation effort, since the footprint of the expanded Bypass area is open farmland with no trees present. However, trees along the Sacramento River would be removed to construct the new 1,500 foot Sacramento Weir.

Identification of individual reaches in the Common Features GRR action area can be seen in Figure 1. American River North (ARN) reaches A through I includes the north side of the American River and the East Side Tributaries. American River South (ARS) reaches A through G includes the south side of the American River and the east side of the Sacramento River.

Table 4. SRA Reach Specific Summary

AMERICAN RIVER		SACRAMENTO RIVER	
REACH	**LINEAR FEET (lf) of SRA**	**REACH**	**LINEAR FEET (lf) of SRA**
A	31,174	D	9,643
B	7,259	E	7,709
C	6,934	F	21,263
		G	11,689
		Sac Weir	1,500
Total	**45,367**	**Total**	**51,804**

1.11 Vegetation Policy Compliance

Vegetation removal under the Common Features GRR project would be limited to no more than the upper one-half of the waterside of the levees therefore leaving the lower one-half or more of the trees in place on the Sacramento River within the study area. SRA would not be compromised, thus maximizing existing SRA values in the study area. No vegetation removal would be required within the existing or expanded Sacramento Bypass. New levees (such as setback levees) would be designed to be compliant with Corps levee vegetation policy. Consistent with the Central Valley Flood Protection Plan (CVFPP) guidance. Any vegetation removed as part of direct construction activities would not be replaced onsite if possible.

1.12 Interrelated and Interdependent Actions

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). In this case, there are no interrelated or interdependent actions.

The Folsom Dam Raise Project and subsequent Folsom Reoperation Project have the potential to increase the bank armoring and could exacerbate any impacts associated with the common Features GRR, but are not interrelated or interdependent actions because neither project depends on the other for their justification and they both have independent utility. The erosion issues within the American River Parkway is being addressed as part of the Folsom Reoperation Project currently under evaluation and a biological assessment is being prepared to initiate Section 7 consultation with both USFWS and NMFS.

1.13 Conservation Actions

The Corps will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible, and will implement on-site, and off-site compensation actions as necessary. Compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity. Depending on project impacts, a project may incorporate various habitat and species benefits to compensate for short-term losses in habitat for listed species. Long-term compensation to offset short-term losses is generally not an option for the loss of critical habitats under the ESA (USFWS 1998a). The Corps uses the following compensation time periods (based loosely on life expectancy) as guidelines for compensation:

- Green sturgeon, 15 years;
- Chinook salmon, 5 years; and
- Central Valley steelhead, 4 years (Corps 2012).

1. Obtain an ETL approved vegetation variance exempting sites from vegetation removal prior to final design and construction phase for the Sacramento River.
2. Minimize the removal of existing vegetation in the proposed project area. Any disturbance or removal of vegetation will be replaced with native riparian vegetation, outside of the vegetation-free zone, as established in the ETL.
3. Implement best management practices (BMPs) to prevent slurry seeping out to river and require piping system on land side only.
4. The Corps will incorporate compensation for SRA habitat losses either by project constructed compensation sites or in combination with purchase of credits at a NMFS approved conservation bank where appropriate.
5. The Corps will seek an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower one-third of the waterside of the levee prior to final construction and design phase. Construction may require removal of vegetation on the upper two-thirds of the waterside and landside slope. Full ETL compliance will occur on some of the American River reaches.
6. The Corps will use a rock soil mixture to facilitate re-vegetation of the project sites that require bank protection work. A (70:30) rock to soil ratio will be implemented. The soil-rock mixture will be placed on top of the of the rock revetment along the Sacramento River levees to allow native riparian vegetation to be planted to insure that SRA habitat lost is replaced or enhanced.
7. In addition to an approved vegetation variance, the Corps will minimize the removal of existing vegetation in the proposed project area. Disturbance or removal of trees or larger woody vegetation will be replaced with native riparian species, outside of the vegetation-free zone, as established in the ETL.
8. Levee repair designs will be analogous to those developed for an SRBPP repair site. These levee repair designs include installation of IWM, native vegetation planting, incorporation of soil with the rock, *etc*.
9. Construction will be scheduled when listed terrestrial and aquatic species will be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present coordination with the resource agencies will occur.

10. Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
11. Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a containment system.
12. Erosion control measures including Storm Water Pollution Prevention Program (SWPPP) and Water Pollution Control Program that minimize soil or sediment from entering the river. BMPs shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to Federally listed fish and their designated critical habitat.
13. Site access will be limited to the smallest area possible in order to minimize disturbance.
14. Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
15. Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
16. Designating a Corps-appointed representative as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.
17. Vegetation removed as a part of ETL compliance will be compensated on site, outside of the vegetation-free zone, to the extent feasible. When on-site compensation is not feasible, compensation is proposed at local conservation banks with available credits. If credits are not available locally, then compensation is proposed to occur within the West Sacramento city limits.
18. The Corps will compensate for any short and longer term impacts through additional onsite compensation, purchase of compensatory conservation credits, or development of suitable created aquatic habitat.
19. Screen any water pump intakes.
20. The Corps will work with local cost share sponsors to ensure GRR-related future flood risk reduction actions related to widening the Sacramento Weir shall fully mitigate upstream and downstream fish passage effects at the weir and within the spillway basin.
21. The goal is to ensure that adult CV spring-run and Sacramento River inter-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are able to migrate upstream while the weir is spilling into the bypass and that juvenile stranding in the spillway basin is minimized to the maximum extent possible.
22. The Corps shall ensure the widening of the Sacramento Bypass is designed and constructed to minimize stranding of fish in the depressions wound within the bypass though grading or construction of drainage channels.
23. The goal is to ensure that the bypass is designed and constructed in a manner that reduces adult and juvenile stranding to the maximum extent possible.

A number of measures will be applied to the entire Common Features Project or specific actions, and other measures may be appropriate at specific locations within the Common Features Project study area. Avoidance activities to be implemented during final design and construction may include, but are not limited to, the following:

1. Identifying all habitats utilized by listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
2. Incorporating sensitive habitat information into project bid specifications.
3. Incorporating requirements for contractors to avoid identified sensitive habitats into project bid specifications.
4. Minimizing vegetation removal to the extent feasible.
5. Minimizing, to the extent possible, grubbing and contouring activities.
6. Where feasible compensating for impacts close to where impacts have occurred.

1.14 Additional Conservation Measures for sDPS Green Sturgeon

Through collaboration with NMFS, the Corps has updated the project description in the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) and will implement the following additional measures that have been coordinated with NMFS to reduce impacts to green sturgeon habitat.

1. The Corp's final Environmental Impact Statement/Environmental Impact Report for the American River Common Features GRR shall include a proposal to develop a green sturgeon habitat, mitigation, and monitoring plan (HMMP) with the specific elements that are described below.

   The goal of the developing the HMMP is to ensure that adverse impacts of future American River Common Features GRR projects on sDPS green sturgeon are fully mitigated in order to maintain the growth, survival and recovery of the species in the study area.

2. The green sturgeon HMMP shall be developed in coordination with the IEP green sturgeon project work team and consulted on with NMFS prior to the construction of any work within the designated critical habitat of sDPS green sturgeon related to the American River Common Features GRR. The HMMP should focus on filling important data gaps on green sturgeon life history and micro and macro habitat ecology in both the Sacramento River and the north Delta within the project impact area, in regard to how bank stabilization measures proposed in the American River Common Features GRR affect sturgeon ecology and survival, particularly in regard to juvenile rearing and survival.

   The goal of this conservation measure is to leverage the resources of the IEP to develop an HMMP that utilizes and applies the best available scientific expertise and information available.

3. The Corps shall either refine the SAM or develop an alternative green sturgeon survival and growth response model based on using and updating the existing Hydrologic Engineering Center Ecosystem Function Model (HEC-EFM) that reflects green sturgeon's preference for benthic habitat and that accounts for the physical loss of habitat from revetment footprints instead of the convention used by the SAM where the fish response is evaluated at the intersect of seasonal water surface elevations. The new modeling may include hydraulic modeling, but must be capable of evaluating green sturgeon survival in response to levee repair projects in the project impact area and their effects on all habitat conditions, not exclusively flow changes. Development of the model shall be initiated at the start of the preconstruction engineering and design (PED) phase of the American River Common Features GRS and shall be peer reviewed by sturgeon experts on the IEP, other academia with sturgeon expertise and be consulted on with NMFS.

   The goal of this measure is to develop a functional assessment methodology using the best available scientific expertise and information available to model the effects of future American River Common Features GRR actions and evaluate the performance of mitigation actions relative to the survival and growth of sDPS green sturgeon that are exposed to such actions.

4. The HMMP shall also, restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This mitigation shall be coordinated with the Interagency Working Group (IWG) or a Bank Protection Working Group (BPWG) and must be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat must be capable of providing abundant benthic prey freshwater or estuarine areas; with adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth and viability of all life stages; and provide safe and unobstructed migratory pathways are necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. The restoration/mitigation shall be initiated prior to commencement of construction within the designated critical habitat of sDPS green sturgeon for the American River Common Features GRR and the updated model should be used to validate performance. The restoration site and plan shall be developed in coordination with the IEP and be consulted on with NMFS.

   The goal is to ensure the spatial and temporal ecological impacts from project-related permanent loss of critical habitat for green sturgeon critical for juvenile green sturgeon are fully compensated.

5. The green sturgeon HMMP shall also be developed with measurable objectives for completely offsetting all adverse impacts to all life stages of sDPS green sturgeon (as modeled using refined approaches described in RPA action 3, above, and considering design refinements that occur in the PED phase of project implementation).

The goal of this measure is to develop "SMART" objectives for mitigation. "SMART" objectives are specific (target a specific area for improvement), measurable (quantify or suggest an indicator of progress), attainable (specify who will do the work and if possible how), realistic (state what results can realistically be achieved, given available resources) and timely (specify when the results can be achieved) habitat performance objectives for green sturgeon mitigation.

6. Mitigation actions shall be initiated prior to the construction activities affecting sDPS green sturgeon and their critical habitat. Specific mitigation plans may be developed during project design engineering to reduce the specific impacts of levee construction actions.

   The goal of this measure is to ensure that mitigation coincides with project implementation and to minimize, to the maximum extent possible, extended temporal effects.

7. The sDPS green sturgeon HMMP will include measurable performance standards at agreed upon intervals and will be monitored for a period of at least ten years following construction. If additional monitoring is necessary, the monitoring shall be included in the project O&M plan and carried out by the local sponsor. The HMMP will include adaptive management strategies for correcting any mitigation measures that do not meet performance standards.

   The goal of this measure it to provide a reasonable amount of time to measure performance standards after mitigation occurs to ensure that it meets the objectives of the HMMP.

1.5 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The action area for the Common Features GRR includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Dry, Robla, and Arcade Creeks and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento (Figure 1).

The action area includes perennial waters of the Sacramento River extending 200 feet perpendicular from the average summer-fall shoreline and 1,000 feet downstream from proposed in-water construction areas. This represents the potential area of turbidity and sedimentation effects based on the reported limits of visible turbidity plumes in the Sacramento River during similar construction activities (NMFS 2008).

ENDANGERED SPECIES ACT:
BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This BO includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that will be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This BO does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[1]

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

1. Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
2. Describe the environmental baseline in the action area.
3. Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
4. Describe any cumulative effects in the action area.
5. Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
6. Reach jeopardy and adverse modification conclusions.
7. If necessary, define a reasonable and prudent alternative to the proposed action.

[1] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

2.1.1 Use of Analytical Surrogates

The effects of the Common Features GRR are primarily analyzed using Standard Assessment Methodology (SAM). The Corps provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the federally protected fish species relevant to this consultation.

The SAM was designed to address a number of limitations associated with previous habitat assessment approaches and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species.

It is a computational modeling and tracking tool that evaluates bank protection alternatives by taking into account several key factors affecting threatened and endangered fish species. By identifying and then quantifying the response of focal species to changing habitat conditions over time, project managers, biologists and design engineers can make changes to project design to avoid, minimize, or compensate for impacts to habitat parameters that influence the growth and survival of target fish species by life stage and season. The model is used to assess species responses as a result of changes to habitat conditions, either by direct quantification of bank stabilization design parameters (*e.g.*, bank slope, substrate).

In 2003, the Corps established a program to carry out "a process to review, improve, and validate analytical tools and models for USACE Civil Works business programs". Reviews are conducted to ensure that planning models used by the Corps are technically and theoretically sound, computationally accurate, and in compliance with the Corps planning policy. As such, all existing and new planning models developed by the Corps are required to be certified through the appropriate Planning Center of Expertise and Headquarters in accordance with Corps rules and procedures.

The assumptions, model variables, and modeling approaches used in the SAM have been developed to be adapted and validated through knowledge gained from monitoring and experimentation within the SRBPP while retaining the original overall assessment method and framework. The first update to the SAM included the addition of sDPS green sturgeon as well as a number of modifications to modeled-species responses based upon updated literature reviews and recent monitoring efforts at completed bank protection sites (Stillwater Sciences 2009, USACE 2009).

In late 2010, the certification process for the SAM was initiated by the Corps, Sacramento District in coordination with the Ecosystem Planning Center of Expertise. The process entailed charging a panel of six experts to review the SAM, along with the SAM (version 3.0). The Review Panel was composed of a plan formulation expert, fisheries biologist, aquatic ecologist, geomorphologist/geologist, population biologist/modeling expert, and software programmer. A major advantage of the SAM is that it integrates species life history and seasonal flow-related variability in habitat quality and availability to generate species responses to project actions over time. The SAM systematically evaluates the response of each life stage to habitat features affected by bank protection projects.

The SAM quantifies habitat values in terms of a weighted species response index (WRI) that is calculated by combining habitat quality (*i.e.*, fish response indices) with quantity (*i.e.*, bank length or wetted area) for each season, target year, and relevant species/life stage. The fish response indices are derived from hypothesized relationships between key habitat attributes (described below) and the species and life stage responses. Species response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (*i.e.*, with or without project), the SAM uses these relationships to determine the response of individual species and life stages to the measured or predicted values of each habitat attribute for each season and target year, and then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear feet or area of shoreline to which it applies to generate a weighted species response index expressed in feet or square feet. The species WRI provides a common metric that can be used to quantify habitat values over time, compare project conditions to existing conditions, and evaluate the effectiveness of on-site and off-site compensation actions.

The WRI represent an index of a species growth and survival based on a 30-day exposure to post project conditions over the life of the project. As such, negative SAM values can be used as a surrogate to quantify harm to a target fish species by life stage and season. Also, although SAM values represent and index of harm to a species, since the values are expressed as "weighted bankline feet" or "weighted area", these values can be used to help quantify compensatory conservation actions such as habitat restoration, and are used for that purpose in this BO.

During the process of this consultation, the Corps and NMFS identified several short comings with the SAM as a tool for reliably forecasting the growth and survival of green sturgeon. The primary short coming is that the SAM evaluates habitat conditions at the seasonal water surface intersect with the river bank. While this is considered an effective point for measuring salmon and steelhead habitat, green sturgeon have a greater affinity for benthic habitat than shoreline habitat. Further, during discussions between the Corps and NMFS, it was widely agreed upon that levee repair actions in the West Sacramento Study Area are likely to only affect the juvenile rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present and adults that are migrating upstream are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. Because of this, NMFS has decided to use the SAM as a proxy for quantifying habitat disturbance and harm and use as an ecological surrogate for quantifying the amount and extent of take for juvenile rearing and migrating green sturgeon, but the precision is not as sharp as for salmon and steelhead. Therefore, a new model will be developed to determine compensatory mitigation actions and tracking performance.

2.1.2 Compensation Timing

As described in the proposed action, projects such as this often propose compensation for unavoidable short-term effects to species and impacts to habitat. These compensation timeframes are generally based on anticipated SAM response time. Under the Corps BA, compensation timing is defined and in practice adopts an approach that the SAM modeled impact at the proposed timing (Green sturgeon: 15 years: Chinook salmon, 5 years: Central Valley steelhead, 4 years) is sufficient to compensate for project effects. NMFS adopts a slightly

different approach to the analysis of the BO in that the compensation time should be a target for avoiding exposure of more than one generation of a population with a multiple age class structure. Negative SAM-modeled values beyond those years, especially at winter and spring water surface elevations, may have significant effects to the species and impacts to critical habitat that would reduce the species survival and recovery in the wild or substantially reduce the conservation value of the species because the adverse effects (reduced growth and survival of individuals) would begin to reduce the number of reproducing individuals across multiple generations. In some cases, negative SAM values extend beyond these compensation periods, in which case offsite compensatory mitigation can reduce the long-term effects to a species survival and recovery by creating high quality habitat conditions in areas that provide high ecological value for the species. Because we have determined the SAM model is not a strong representation of green sturgeon growth and survival response, we are applying the implementation of the USACE Green Sturgeon Conservation Measures As key actions necessary to both avoid reducing the survival and recovery of the species in the wild and reducing the conservation value of critical habitat, instead of applying a specific compensation time period for green sturgeon. As such, this BO applies the following compensation timing as general targets for avoiding such long-term effects to salmon and steelhead:

1. Chinook salmon, 5 years;
2. Central Valley steelhead, 4 years

2.2 Rangewide Status of the Species and Critical Habitat

This BO examines the status of each species that will be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The BO also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

One factor affecting the rangewide status of the CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and the sDPS green sturgeon, and aquatic habitat at large is climate change.

The following federally listed species and designated critical habitats occur in the action area and may be affected by the proposed action:

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchu tshawytscha*) Listed as endangered (70 FR 37160, June 28, 2005)

Sacramento River winter-run Chinook salmon designated critical habitat (June 16, 1993, 58 FR 33212)

CV spring-run Chinook salmon ESU (*O. tshawytscha*)
Listed as threatened (70 FR 37160, June 28, 2005)

CV spring-run Chinook salmon designated critical habitat (70 FR 52488, September 2, 2005)

CCV steelhead DPS (*O. mykiss*)
Listed as threatened (71 FR 834, January 5, 2006)

CCV steelhead designated critical habitat
(70 FR 52488, September 2, 2005)

Southern DPS of North American green sturgeon (*Acipenser medirostris*)
Listed as threatened (71 FR 17757, April 7, 2006)

Southern DPS of North American green sturgeon designated critical habitat (74 FR 52300, October 9, 2009)

Critical habitat designations identify those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration or protection. Within the Common Features GRR this includes the river water, river bottom, and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent is defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of one to two years on the annual flood series) used by listed salmonids and sturgeon.

NMFS has recently completed an updated status review of five Pacific salmon ESUs and one steelhead DPS, including Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead, and concluded that the species' status should remain as previously listed (76 FR 50447; August 15, 2011). The 2011 status reviews (NMFS 2011a, 2011b, 2011c) additionally stated that, although the listings should remain unchanged, the status of these populations have worsened over the past five years since the 2005/2006 reviews and recommended that status be reassessed in two to three years as opposed to waiting another five years.

2.2.1 Sacramento River Winter-run Chinook salmon

The Sacramento River winter-run Chinook salmon (winter-run *Oncorhynchus tshawytscha*) ESU, currently listed as endangered, was listed as a threatened species under emergency provisions of the ESA on August 4, 1989 (54 FR 32085) and formally listed as a threatened species in November 1990 (55 FR 46515). On January 4, 1994 (59 FR 440), NMFS re-classified winter-run as an endangered species. NMFS concluded that winter-run in the Sacramento River warranted listing as an endangered species due to several factors, including: (1) the continued decline and increased variability of run sizes since its first listing as a threatened species in 1989;

(2) the expectation of weak returns in future years as the result of two small year classes (1991 and 1993); and (3) continued threats to the "take" of winter-run (August 15, 2011, 76 FR 50447).

On June 28, 2005, NMFS concluded that the winter-run ESU was "in danger of extinction" due to risks to the ESU's diversity and spatial structure and, therefore, continues to warrant listing as an endangered species under the ESA (70 FR 37160). In August 2011, NMFS completed a 5-year status review of five Pacific salmon ESUs, including the winter-run ESU, and again determined that the species' status should remain as "endangered" (August 15, 2011, 76 FR 50447). The 2011 review concluded that although the listing remained unchanged since the 2005 review, the status of the population had declined over the past five years (2005–2010).

The winter-run ESU currently consists of only one population that is confined to the upper Sacramento River (spawning downstream of Shasta and Keswick dams) in California's CV. In addition, an artificial propagation program at the Livingston Stone National Fish Hatchery (LSNFH) produces winter-run that are considered to be part of this ESU (June 28, 2005, 70 FR 37160). Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River. All historical spawning and rearing habitats have been blocked since the construction of Shasta Dam in 1943. Remaining spawning and rearing areas are completely dependent on cold water releases from Shasta Dam in order to sustain the remnant population.

Life History

1. Adult Migration and Spawning

Winter-run exhibit a unique life history pattern (Healey 1994) compared to other salmon populations in the CV (*i.e.*, spring-run, fall-run, and late-fall run), in that they spawn in the summer, and the juveniles are the first to enter the ocean the following winter and spring. Adults first enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate up the Sacramento River, past the RBDD from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, with the peak passage occurring in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type (Table 5; Yoshiyama *et al.* 1998, Moyle 2002).

Winter-run tend to enter freshwater while still immature and travel far upriver and delay spawning for weeks or months upon arrival at their spawning grounds (Healey 1991). Spawning occurs primarily from mid-May to mid-August, with the peak activity occurring in June and July in the upper Sacramento River reach (50 miles) between Keswick Dam and RBDD (Vogel and Marine 1991). Winter-run deposit and fertilize eggs in gravel beds known as redds excavated by the female that then dies following spawning. Average fecundity was 5,192 eggs/female for the 2006–2013 returns to LSNFH, which is similar to other Chinook salmon runs [*e.g.*, 5,401 average for Pacific Northwest (Quinn 2005)]. Chinook salmon spawning requirements for depth and velocities are broad, and the upper preferred water temperature is between 55–57°F (13–14°C) degrees (Snider *et al.* 2001). The majority of winter-run adults return after three years.

Table 5. The temporal occurrence of adult (a) and juvenile (b) winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.

Winter run relative abundance	High				Medium				Low			
a) Adults freshwater												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin[a,b]												
Upper Sacramento River spawning[c]												
b) Juvenile emigration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River at Red Bluff[d]												
Sacramento River at Knights Landing[e]												
Sacramento trawl at Sherwood Harbor[f]												
Midwater trawl at Chipps Island[g]												

Sources: [a] (Yoshiyama *et al*. 1998); (Moyle 2002); [b](Myers *et al.* 1998) ; [c] (Williams 2006) ; [d] (Martin *et al.* 2001); [e] Knights Landing Rotary Screw Trap Data, CDFW (1999-2011); [f,g] Delta Juvenile Fish Monitoring Program, USFWS (1995-2012)

2. Eggs/Fry Emergence

Winter-run incubating eggs are vulnerable to adverse effects from floods, flow fluctuations, siltation, desiccation, disease, predation during spawning, poor gravel percolation, and poor water quality. The optimal water temperature for egg incubation ranges from 46–56°F (7.8–13.3°C) and a significant reduction in egg viability occurs in mean daily water temperatures above 57.5°F (14.2°C; Seymour 1956, Boles 1988, USFWS 1998, EPA 2003, Richter and Kolmes 2005, Geist *et al.* 2006). Total embryo mortality can occur at temperatures above 62°F (16.7°C; NMFS 1997). Depending on ambient water temperature, embryos hatch within 40-60 days and alevin (yolk-sac fry) remain in the gravel beds for an additional 4–6 weeks. As their yolk-sacs become depleted, fry begin to emerge from the gravel and start exogenous feeding in their natal stream, typically in late July to early August and continuing through October (Fisher 1994).

3. Juvenile/Outmigration

Juvenile winter-run have been found to exhibit variability in their life history dependent on emergence timing and growth rates (Beckman *et al.* 2007). Following spawning, egg incubation, and fry emergence from the gravel, juveniles begin to emigrate in the fall. Some juvenile winter-

run migrate to sea after only 4 to 7 months of river life, while others hold and rear upstream and spend 9 to 10 months in freshwater. Emigration of juvenile winter-run fry and pre-smolts past RBDD (RM 242) may begin as early as mid-July, but typically peaks at the end of September (Table 5), and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997).

4. Estuarine/Delta Rearing

Juvenile winter-run emigration into the estuary/Delta occurs primarily from November through early May based on data collected from trawls in the Sacramento River at Sherwood Harbor (West Sacramento), RM 57 (USFWS 2001). The timing of emigration may vary somewhat due to changes in river flows, Shasta Dam operations, and water year type, but has been correlated with the first storm event when flows exceed 14,000 cfs at Knights Landing, RM 90, which trigger abrupt emigration towards the Delta (del Rosario *et al.* 2013). Residence time in the Delta for juvenile winter-run averages approximately 3 months based on median seasonal catch between Knights Landing and Chipps Island. In general, the earlier juvenile winter-run arrive in the Delta, the longer they stay and rear, as peak departure at Chipps Island regularly occurs in March (del Rosario *et al.* 2013). The Delta serves as an important rearing and transition zone for juvenile winter-run as they feed and physiologically adapt to marine waters (smoltification). The majority of juvenile winter-run in the Delta are 104 to 128 millimeters (mm) in size based on USFWS trawl data (1995-2012), and from 5 to 10 months of age, by the time they depart the Delta (Fisher 1994, Myers *et al.* 1998).

5. Ocean Rearing

Winter-run smolts enter the Pacific Ocean mainly in spring (March–April), and grow rapidly on a diet of small fishes, crustaceans, and squid. Salmon runs that migrate to sea at a larger size tend to have higher marine survival rates (Quinn 2005). The diet composition of Chinook salmon from California consist of anchovy, rockfish, herring, and other invertebrates (in order of preference, Healey 1991). Most Chinook from the Central Valley move northward into Oregon and Washington, where herring make up the majority of their diet. However winter-run, upon entering the ocean, tend to stay near the California coast and distribute from Point Arena southward to Monterey Bay. Winter-run have high metabolic rates, feed heavily, and grow fast, compared to other fishes in their range. They can double their length and increase their weight more than ten-fold in the first summer at sea (Quinn 2005). Mortality is typically highest in the first summer at sea, but can depend on ocean conditions. Winter-run abundance has been correlated with ocean conditions, such as periods of strong up-welling, cooler temperatures, and El Nino events (Lindley *et al.* 2009). Winter-run spend approximately 1-2 years rearing in the ocean before returning to the Sacramento River as 2-3 year old adults. Very few winter-run Chinook salmon reach age 4. Once they reach age 3, they are large enough to become vulnerable to commercial and sport fisheries.

Description of Viable Salmonid Population (VSP) Parameters

1. Abundance

Historically, winter-run population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (NMFS 2011). In recent years, since carcass surveys

began in 2001 (Figure 3), the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively. However, from 2007 to 2012, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011 (Figure 3). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley *et al.* 2009), drought conditions from 2007-2009, and low in-river survival (NMFS 2011a). In 2013, the population increased to 6,075 adults, well above the 2007–2012 average, but below the high for the last ten years.

Although impacts from hatchery fish (*i.e.*, reduced fitness, weaker genetics, smaller size, less ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala *et al.* 2012), the winter-run conservation program at LSNFH is strictly controlled by the USFWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 per year (2001–2010 average) compared to the estimated natural production that passes RBDD, approximately 4.7 million (2002–2010 average, Poytress and Carrillo 2011). Therefore, hatchery production typically represents approximately 3-4 percent of the total in-river juvenile production in any given year.

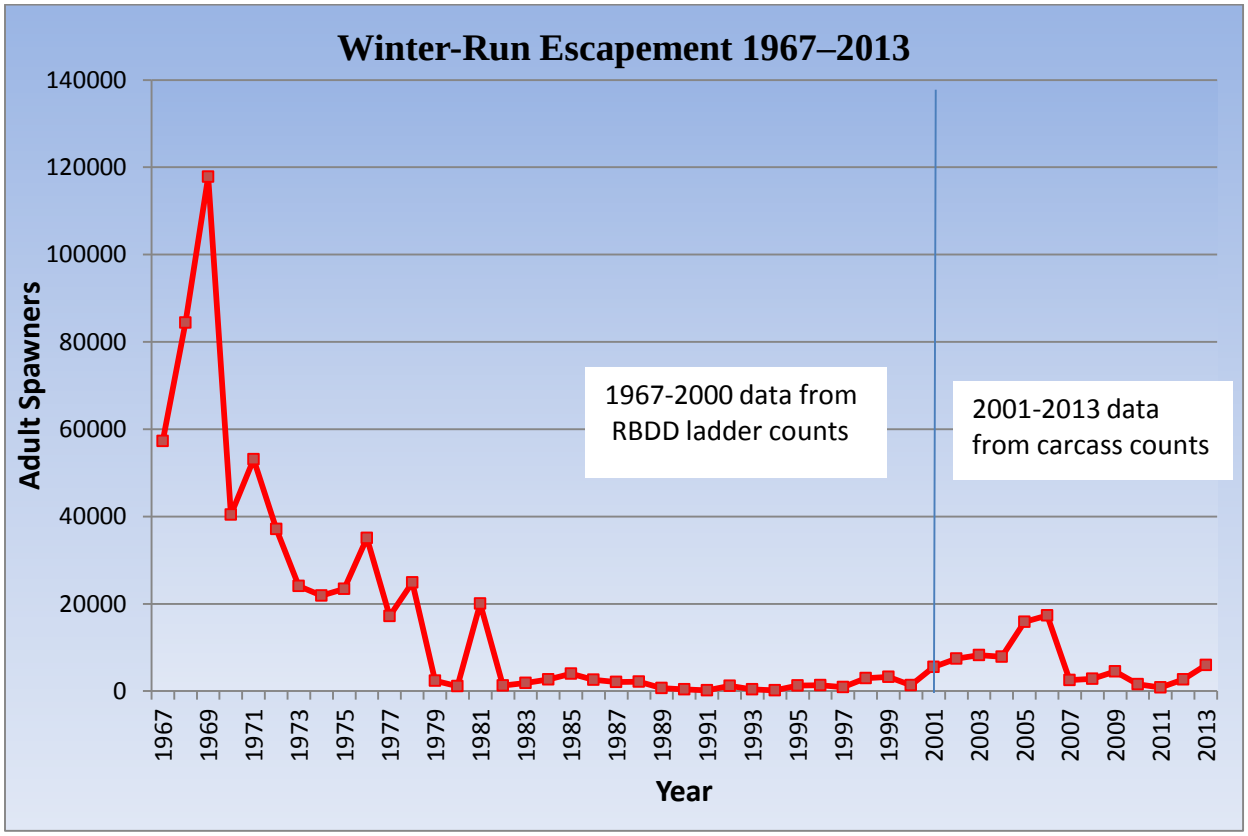


Figure 2. Winter-run Chinook salmon escapement numbers 1970-2013, includes hatchery broodstock and tributaries, but excludes sport catch. RBDD later counts used pre-2000, carcass surverys post 2001(3).

2. Productivity

ESU productivity was positive over the period 1998–2006, and adult escapement and juvenile production had been increasing annually until 2007, when productivity became negative (Figure 4) with declining escapement estimates. The long-term trend for the ESU, therefore, remains negative, as the productivity is subject to impacts from environmental and artificial conditions. The population growth rate based on cohort replacement rate (CRR) for the period 2007–2012 suggests a reduction in productivity (Figure 4), and indicates that the winter-run population is not replacing itself. In 2013, winter-run experienced a positive CRR, possibly due to favorable in-river conditions in 2011 (a wet year), which increased juvenile survival to the ocean.

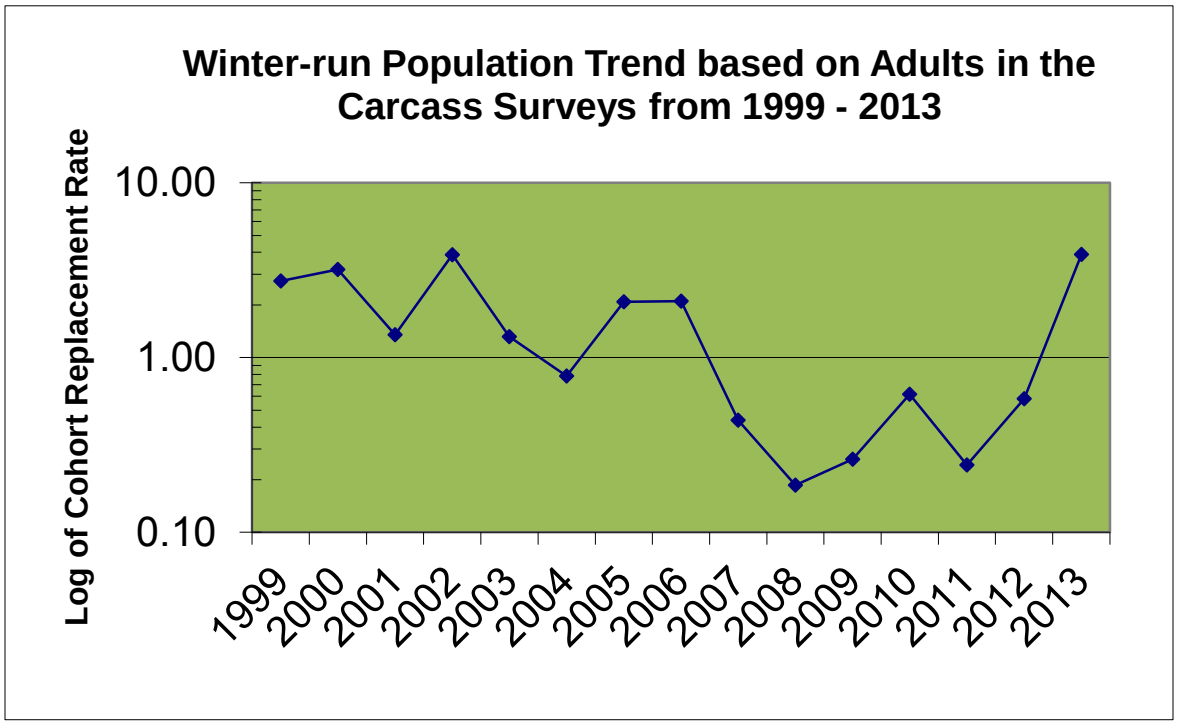


Figure 3. Winter-run population trend using cohort replacement rate derived from adult escapement, including hatchery fish, 1986–2013.

An age-structured density-independent model of spawning escapement by Botsford and Brittnacher (1998) assessing the viability of winter-run found the species was certain to fall below the quasi-extinction threshold of three consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures found a biologically significant expected quasi-extinction probability of 28 percent. Although the growth rate for the winter-run population improved up until 2006, it exhibits the typical variability found in most endangered species populations. The fact that there is only one population, dependent upon cold-water releases from Shasta Dam, makes it vulnerable to periods of prolonged drought (NMFS 2011). Productivity, as measured by the number of juveniles entering the Delta, or juvenile production estimate (JPE), has declined in recent years from a high of 3.8 million in 2007 to 1.1 million in 2013 (Table 6). Due to uncertainties in the various factors, the JPE was updated in

2010 with the addition of confidence intervals (Cramer Fish Sciences model), and again in 2013 with a change in survival based on acoustic tag data (NMFS 2014). However, juvenile winter-run productivity is still much lower than other Chinook salmon runs in the Central Valley and in the Pacific Northwest (Michel 2010).

Table 6. Winter-run adult and juvenile population estimates based on RBDD counts (1986–2001) and carcass counts (2001–2013), with corresponding 3-year-cohort replacement rates

Return Year	**Adult Population Estimate[a]**	**Cohort Replacement Rate[b]**	**NMFS-calculated Juvenile Production**
1986	2596		
1987	2185		
1988	2878		
1989	696	0.27	
1990	430	0.20	
1991	211	0.07	
1992	1240	1.78	40,100
1993	387	0.90	273,100
1994	186	0.88	90,500
1995	1297	1.05	74,500
1996	1337	3.45	338,107
1997	880	4.73	165,069
1998	2992	2.31	138,316
1999	3288	2.46	454,792
2000	1352	1.54	289,724
2001	8224	2.75	370,221
2002	7441	2.26	1,864,802
2003	8218	6.08	2,136,747
2004	7869	0.96	1,896,649
2005	15839	2.13	881,719
2006	17296	2.10	3,556,995
2007	2542	0.32	3,890,534
2008	2830	0.18	1,100,067
2009	4537	0.26	1,152,043
2010	1,596	0.63	1,144,860
2011	827	0.29	332,012
2012	2,674	0.59	162,051
2013	6,075	3.88	1,196,387
median	2,542	0.95	412,507

[a] Population estimates include adults taken into the hatchery and were based on ladder counts at RBDD until 2001, after which the methodology changed to carcass surveys (CDFG 2012).

[b] Assumes all adults return after three years. NMFS calculated a CRR using the adult spawning population, divided by the spawning population three years prior. Two year old returns were not used.

[c] JPE estimates include survival estimates from the spawning gravel to the point where they enter the Delta (Sacramento I St Bridge), but does not include through-Delta survival.

3. Spatial Structure

The distribution of winter-run spawning and initial rearing historically was limited to the upper Sacramento River (upstream of Shasta Dam), McCloud River, Pitt River, and Battle Creek, where springs provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Slater 1963 *op. cit.* Yoshiyama et al. 1998). The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which currently has its own impediments to upstream migration (*i.e.*, a number of small hydroelectric dams situated upstream of the Coleman Fish Hatchery weir). The Battle Creek Salmon and Steelhead Restoration Project (BCSSRP) is currently removing these impediments, which should restore spawning and rearing habitat for winter-run in the future. Approximately 299 miles of former tributary spawning habitat upstream of Shasta Dam is inaccessible to winter-run. Yoshiyama *et al.* (2001) estimated that in 1938, the upper Sacramento River had a "potential spawning capacity" of approximately 14,000 redds equal to 28,000 spawners. Since 2001, the majority of winter-run redds have occurred in the first 10 miles downstream of Keswick Dam. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

The greatest risk factor for winter-run lies within its spatial structure (NMFS 2011). The remnant and remaining population cannot access 95% of their historical spawning habitat, and must therefore be artificially maintained in the Sacramento River by: (1) spawning gravel augmentation, (2) hatchery supplementation, and, (3) regulating the finite cold-water pool behind Shasta Dam to reduce water temperatures. Winter-run require cold water temperatures in the summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure, but restoration is not scheduled to be completed until 2017 (BCSSRP). The draft CV Salmon and Steelhead Recovery Plan includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats upstream of Shasta Dam (NMFS 2009b). Additionally, NMFS (2009a) included a requirement for a pilot fish passage program upstream of Shasta Dam.

4. Diversity

The current winter-run population is the result of the introgression of several stocks (*e.g.*, spring-run and fall-run Chinook) that occurred when Shasta Dam blocked access to the upper watershed. A second genetic bottleneck occurred with the construction of Keswick Dam which blocked access and did not allow spatial separation of the different runs (Good *et al.* 2005). Lindley *et al.* (2007) recommended reclassifying the winter-run population extinction risk from low to moderate, if the proportion of hatchery origin fish from the LSNFH exceeded 15 percent due to the impacts of hatchery fish over multiple generations of spawners. Since 2005, the percentage of hatchery winter-run recovered in the Sacramento River has only been above 15 percent in two years, 2005 and 2012 (Figure 5).

Concern over genetic introgression within the winter-run population led to a conservation program at LSNFH that encompasses best management practices such as: (1) genetic confirmation of each adult prior to spawning, (2) a limited number of spawners based on the effective population size, and (3) use of only natural-origin spawners since 2009. These practices reduce the risk of hatchery impacts on the wild population. Hatchery-origin winter-run have made up more than 5 percent of the natural spawning run in recent years and in 2012, it exceeded 30 percent of the natural run (Figure 5). However, the average over the last 16 years (approximately 5 generations) has been 8 percent, still below the low-risk threshold (15%) used for hatchery influence (Lindley *et al.* 2007).

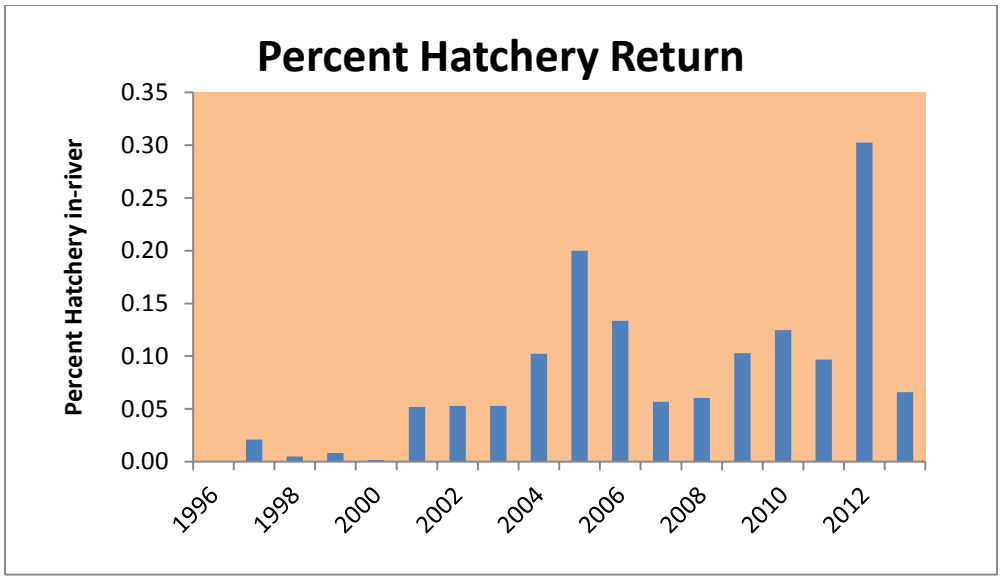


Figure 4. Percentage of hatchery-origin winter-run Chinook salmon naturally spawning in the Sacramento River (1996–2013). Source: CDFW carcass surveys, 2013.

Summary of Sacramento River Winter-run Chinook Salomon ESU Viability

There are several criteria (only one is required) that would qualify the winter-run ESU at moderate risk of extinction, and since there is still only one population that spawns downstream of Keswick Dam, that population would be at high risk of extinction in the long-term according the criteria in Lindley *et al.* (2007). Recent trends in those criteria are: (1) continued low abundance (Figure 3); (2) a negative growth rate over 6 years (2006–2012), which is two complete generations (Figure 4); (3) a significant rate of decline since 2006; and (4) increased risk of catastrophe from oil spills, wild fires, or extended drought (climate change). The most recent 5-year status review (NMFS 2011) on winter-run concluded that the ESU had increased to a high risk of extinction. In summary, the most recent biological information suggests that the extinction risk for the winter-run ESU has increased from moderate risk to high risk of extinction since 2005, and that several listing factors have contributed to the recent decline, including drought and poor ocean conditions (NMFS 2011).

Critical Habitat: Essential Features for Sacramento River Winter-run Chinook Salmon

NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). Critical habitat was delineated as the Sacramento River from Keswick Dam at river mile (RM) 302 to Chipps Island, RM 0, at the westward margin of the Sacramento-San Joaquin Delta (Delta), including Kimball Island, Winter Island, and Brown's Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. In the Sacramento River, critical habitat includes the river water, river bottom, and the adjacent riparian zone.

Critical habitat for winter-run is defined as specific areas (listed below) that contain the physical and biological features considered essential to the conservation of the species. This designation includes the river water, river bottom (including those areas and associated gravel used by winter-run as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing (June 16, 1993, 58 FR 33212). NMFS limits "adjacent riparian zones" to only those areas above a stream bank that provide cover and shade to the near shore aquatic areas. Although the bypasses (*e.g.,* Yolo, Sutter, and Colusa) are not currently designated critical habitat for winter-run, NMFS recognizes that they may be utilized when inundated with Sacramento River flood flows and are important rearing habitats for juvenile winter-run. Also, juvenile winter-run may use tributaries of the Sacramento River for non-natal rearing. Critical habitat also includes the estuarine water column and essential foraging habitat and food resources used by winter-run as part of their juvenile outmigration or adult spawning migration.

The following is the status of the physical and biological habitat features that are considered to be essential for the conservation of winter-run (June 16, 1993, 58 FR 33212):

1. Access from the Pacific Ocean to Appropriate Spawning Areas

Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover, shelter and safe passage conditions in order for adults to reach spawning areas. Adult winter-run generally migrate to spawning areas during the winter and spring. At that time of year, the migration route is accessible to the appropriate spawning grounds on the upper 60 miles of the Sacramento River, however much of this migratory habitat is degraded and they must pass through a fish ladder at the Anderson-Cottonwood Irrigation Dam (ACID). In addition, the many flood bypasses are known to strand adults in agricultural drains due to inadequate screening (Vincik and Johnson 2013). Since the primary migration corridors are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

2. The Availability of Clean Gravel for Spawning Substrate

Suitable spawning habitat for winter-run exists in the upper 60 miles of the Sacramento River between Keswick Dam and Red Bluff Diversion Dam (RBDD). However, the majority of spawning habitat currently being used occurs in the first 10 miles downstream of Keswick Dam.

The available spawning habit is completely outside the historical range utilized by winter-run upstream of Keswick Dam. Because Shasta and Keswick dams block gravel recruitment, the U.S. Bureau of Reclamation (Reclamation) annually injects spawning gravel into various areas of the upper Sacramento River. With the supplemented gravel injections, the upper Sacramento River reach continues to support a small naturally-spawning winter-run Chinook salmon population. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

3. Adequate River Flows for Successful Spawning, Incubation of Eggs, Fry Development and Emergence, and Downstream Transport of Juveniles

An April 5, 1960, Memorandum of Agreement between Reclamation and the CDFW originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. In addition, Reclamation complies with the 1990 flow releases required in State Water Resource Control Board (SWRCB) Water Rights Order (WRO) 90-05 for the protection of Chinook salmon. This order includes a minimum flow release of 3,250 cubic feet per second (cfs) from Keswick Dam downstream to RBDD from September through February during all water year types, except critically dry.

4. Water Temperatures at 5.8–14.1°C (42.5–57.5°F) for Successful Spawning, Egg Incubation, and Fry Development

Summer flow releases from Shasta Reservoir for agriculture and other consumptive uses drive operations of Shasta and Keswick dam water releases during the period of winter-run migration, spawning, egg incubation, fry development, and emergence. This pattern, the opposite of the pre-dam hydrograph, benefits winter-run by providing cold water for miles downstream during the hottest part of the year. The extent to which winter-run habitat needs are met depends on Reclamation's other operational commitments, including those to water contractors, Delta requirements pursuant to State Water Rights Decision 1641 (D-1641), and Shasta Reservoir end of September storage levels required in the NMFS 2009 biological opinion on the long-term operations of the CV Project and State Water Project (CVP/SWP, NMFS 2009a). WRO 90-05 and 91-1 require Reclamation to operate Shasta, Keswick, and Spring Creek Powerhouse to meet a daily average water temperature of 13.3°C (56°F) at RBDD. They also provide the exception that the water temperature compliance point (TCP) may be modified when the objective cannot be met at RBDD. Based on these requirements, Reclamation models monthly forecasts and determines how far downstream 13.3°C (56°F) can be maintained throughout the winter-run spawning, egg incubation, and fry development stages.

In every year since WRO 90-05 and 91-1were issued, operation plans have included modifying the TCP to make the best use of the cold water available based on water temperature modeling and current spawning distribution. Once a TCP has been identified and established in May, it generally does not change, and therefore, water temperatures are typically adequate through the summer for successful winter-run egg incubation and fry development for those redds constructed upstream of the TCP (except for in some critically dry and drought years). However, by continually moving the TCP upstream, the value of that habitat is degraded by reducing the spawning area in size and imprinting upon the next generation to return further upstream.

5. Habitat and Adequate Prey Free of Contaminants

Water quality conditions have improved since the 1980s due to stricter standards and Environmental Protection Agency (EPA) Superfund site cleanups (see Iron Mountain Mine remediation under Factors). No longer are there fish kills in the Sacramento River caused by the heavy metals (*e.g.*, lead, zinc and copper) found in the Spring Creek runoff. However, legacy contaminants such as mercury (and methyl mercury), polychlorinated biphenyls (PCB), heavy metals and persistent organochlorine pesticides continue to be found in watersheds throughout the CV. In 2010, the EPA, listed the Sacramento River as impaired under the Clean Water Act, section 303(d), due to high levels of pesticides, herbicides, and heavy metals (http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml). Although most of these contaminants are at low concentrations in the food chain, they continue to work their way into the base of the food web, particularly when sediments are disturbed and previously entombed compounds are released into the water column.

Adequate prey for juvenile salmon to survive and grow consists of abundant aquatic and terrestrial invertebrates that make up the majority of their diet before entering the ocean. Exposure to these contaminated food sources such as invertebrates may create delayed sublethal effects that reduce fitness and survival (Laetz *et al*. 2009). Contaminants are typically associated with areas of urban development, agriculture, or other anthropogenic activities (*e.g.*, mercury contamination as a result of gold mining or processing). Areas with low human impacts frequently have low contaminant burdens, and therefore lower levels of potentially harmful toxicants in the aquatic system. Freshwater rearing habitat has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

6. Riparian and Floodplain Habitat that Provides for Successful Juvenile Development and Survival

The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from predators. Juvenile life stages of salmonids are dependent on the natural functioning of this habitat for successful survival and recruitment. Ideal habitat contains natural cover, such as riparian canopy structure, submerged and overhanging large woody material (LWM), aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Riparian recruitment is prevented from becoming established due to the reversed hydrology (*i.e.*, high summer time flows and low winter flows prevent tree seedlings from establishing). However, there are some complex, productive habitats within historical floodplains [*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, fish in Yolo and Sutter bypasses experience rapid growth and higher survival due to abundant food resources) seasonally available that remain in the system. Nevertheless, the current condition of degraded riparian habitat along the mainstem Sacramento River restricts juvenile growth and survival (Michel 2010, Michel *et al.* 2012).

7. Access Downstream so that Juveniles Can Migrate from the Spawning Grounds to San Francisco Bay and the Pacific Ocean

Freshwater emigration corridors should be free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. Migratory corridors are downstream of the Keswick Dam spawning areas and include the mainstem of the Sacramento River to the Delta, as well as non-natal rearing areas near the confluence of some tributary streams.

Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. Unscreened diversions that entrain juvenile salmonids are prevalent throughout the mainstem Sacramento River and in the Delta. Predators such as striped bass (*Morone saxatilis*) and Sacramento pikeminnow (*Ptychocheilus grandis*) tend to concentrate immediately downstream of diversions, resulting in increased mortality of juvenile Chinook salmon.

Water pumping at the CVP/SWP export facilities in the South Delta at times causes the flow in the river to move back upstream (reverse flow), further disrupting the emigration of juvenile winter-run by attracting and diverting them to the interior Delta, where they are exposed to increased rates of predation, other stressors in the Delta, and entrainment at pumping stations. NMFS' biological opinion on the long-term operations of the CVP/SWP (NMFS 2009a) sets limits to the strength of reverse flows in the Old and Middle Rivers, thereby keeping salmon away from areas of highest mortality. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function as rearing habitat and as an area of transition to the ocean environment.

2.2.2 Central Valley Spring-run Chinook salmon

In August 2011, NMFS completed an updated status review of five Pacific Salmon ESUs, including CV spring-run Chinook salmon, and concluded that the species' status should remain as previously listed (76 FR 50447). The 2011 Status Review (NMFS 2011b) additionally stated that although the listings will remain unchanged since the 2005 review, and the original 1999 listing (64 FR 50394), the status of these populations has worsened over the past five years and recommended that the status be reassessed in two to three years as opposed to waiting another five years.

CV spring-run Chinook salmon were listed as threatened on September 16, 1999, (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population has been included as part of the CV spring-run Chinook salmon ESU in the most recent modification of the CV spring-run Chinook salmon listing status (70 FR 37160). Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005, (70 FR 52488), and includes the action area for the Proposed Action. It includes stream reaches of the Feather and Yuba rivers, Big Chico,

Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the main stem of the Sacramento River from Keswick Dam through the Delta; and portions of the network of channels in the northern Delta.

Historically spring-run Chinook salmon were the second most abundant salmon run in the CV and one of the largest on the west coast (CDFG 1990, 1998). These fish occupied the upper and middle reaches (1,000 to 6,000 feet elevation) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). The CV Technical Review Team (TRT) estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions (diversity groups) (Lindley *et al.* 2004). Of these 18 populations, only 3 extant populations currently exist (Mill, Deer, and Butte creeks on the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. All populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated. The northwestern California diversity group did not historically contain independent populations, and currently contains two or three populations that are likely dependent on the northern Sierra Nevada diversity group populations for their continued existence.

Construction of low elevation dams in the foothills of the Sierras on the Mokelumne, Stanislaus, Tuolumne, and Merced rivers, was thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American and Yuba rivers of the Sacramento River basin. However, observations in the last decade suggest that perhaps a naturally occurring population may still persist in the Stanislaus and Tuolumne rivers (Franks, personal communication, 2012), as well as in the Yuba River. Documented naturally-spawning populations of CV spring-run Chinook salmon are currently restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and the Yuba River (CDFG 1998).

Life History

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River beginning in March (Yoshiyama 1998). Spring-run Chinook salmon move into tributaries of the Sacramento River (*e.g.* Butte, Mill, Deer creeks) beginning as early as February in Butte Creek and typically mid-March in Mill and Deer creeks (Lindley *et al.* 2004). Adult migration peaks around mid-April in Butte Creek, and mid-to end of May in Mill and Deer creeks, and is complete by the end of July in all three tributaries (Lindley *et al.* 2004) (Table 7). Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

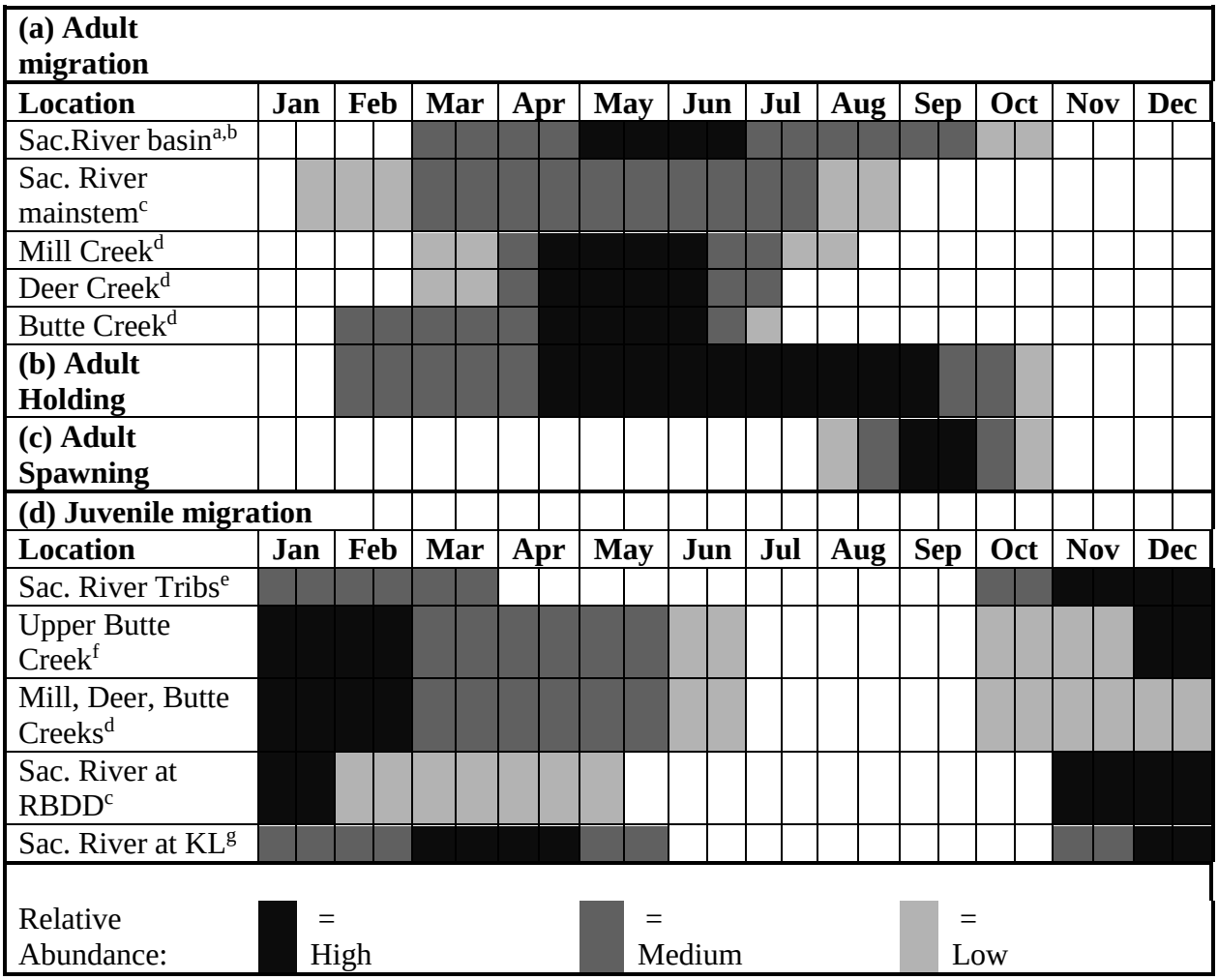
Spring-run Chinook salmon spawning occurs between September and October (Moyle 2002). Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994).

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year or as juveniles or yearlings. The model size of fry migrants at approximately 40 millimeters (mm) between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2004). Studies in Butte Creek, (Ward *et al.* 2003, McReynolds *et al.* 2007) found the majority of CV spring-run Chinook salmon migrants to be fry, which occurred primarily during December, January, and February; and that these movements appeared to be influenced by increased flow. Small numbers of CV spring-run Chinook salmon were observed to remain in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley *et al.* 2004). CDFW (CDFG 1998) observed the emigration period for spring-run Chinook salmon extending from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period. Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

Once juveniles emerge from the gravel they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac and transition to exogenous feeding (Moyle 2002). Many also would disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper faster water as they grow larger. Microhabitat use can be influenced by the presence of predators which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002).

Table 7. The temporal occurrence of adult (a) and juvenile (b) CV spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

Table 7



Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young of the year spring-run Chinook salmon emigrate during the first spring after they hatch.

Sources: [a]Yoshiyama *et al.* (1998); [b]Moyle (2002); [c]Myers *et al.* (1998); [d]Lindley *et al.* (2004); [e]CDFG (1998); [f]McReynolds *et al.* (2007); Ward *et al.* (2003); [g]Snider and Titus (2000)

Description of VSP Parameters

Like the winter-run Chinook salmon population, the CV spring-run Chinook salmon population fails to meet the "representation and redundancy rule" since there are only one demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them. Over the long term, these remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount

Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other.

1. Abundance

The CV drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). The San Joaquin River historically supported large runs of spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast with estimates averaging 200,000 – 500,000 adults returning annually (CDFG 1990). Construction of Friant Dam began in 1939 and was completed in 1942, which blocked access to upstream habitat.

The FRFH spring-run Chinook salmon population has been included in the ESU based on its genetic linkage to the natural population and the potential development of a conservation strategy for the hatchery program. On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRFH. Since 1954, spawning escapement has been estimated using combinations of in-river estimates and hatchery counts, with estimates ranging from 2,908 in 1964 to 2 fish in 1978 (DWR 2001). Spring-run estimates after 1981 have been based solely on salmon entering the hatchery during the month of September. The 5-year moving averages from 1997 to 2006 had been more than 4,000 fish, but from 2007 to 2011, the 5-year moving averages have declined each year to a low of 1,783 fish in 2011 (CDFG 2012). However, coded wire tag (CWT) information from these hatchery returns has indicated that fall-run and spring-run Chinook salmon have overlap (DWR 2001). In addition, genetic testing has indicated substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to temporal overlap and hatchery practices (DWR 2001). Because Chinook salmon have not always been spatially separated in the FRFH, spring-run and fall-run Chinook salmon have been spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock (Good *et al.* 2005; DWR draft Hatchery Genetic Management Plan 2010). For the reasons discussed above, the Feather River spring-run Chinook salmon population numbers are not included in the following discussion of ESU abundance.

In addition, monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the lack of physical separation of spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon makes identification of spring-run Chinook salmon in the mainstem very difficult to determine, but counts of early spawning Chinook salmon redds are typically used as an indicator of abundance. Less than 15 redds per year were observed in the Sacramento River from 1989 to 1993, during September aerial redd counts (USFWS 2003). Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 salmon redds from Keswick Dam downstream to the RBDD, ranging from three to 105 redds (CDFG, unpublished data, 2011). Therefore, even though physical habitat conditions can support spawning and incubation, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon

spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely to have caused extensive introgression between the populations (CDFG 1998). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CV spring-run Chinook salmon ESU as a whole because these streams contain the primary independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance, ranging from 1,013 in 1993 to 23,788 in 1998. Tributary numbers during 2005 to 2011 showed a downturn; however, 2012 and 2013 showed an increase to 10,810 and 18,499 fish, respectively. Escapement numbers for 2013 increased in most tributary populations, which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1960. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish from 1995 to 2005. During this same period, adult returns on Mill and Deer creeks have averaged 780 fish, and 1,464 fish respectively. From 2001 to 2005, the CV spring-run Chinook salmon ESU has experienced a trend of increasing abundance in some natural populations, most dramatically in the Butte Creek population (Good *et al.* 2005). Although trends were generally positive during this time, annual abundance estimates display a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remains well below estimates of historic abundance.

In 2002 and 2003, mean water temperatures in Butte Creek exceeded 21ºC for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of Columnaris Disease (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek due to the disease. Since 2005, abundance numbers in most of the tributaries have declined. From 2006 to 2009, adult returns indicate that population abundance is declining from the peaks seen in the 5 years prior for the entire Sacramento River basin.

For Mill Creek the 2009, return of 220 spring-run Chinook salmon was the lowest return since 1997. Assuming the 2012, spring-run Chinook salmon return was primarily of three year old fish, then those 768 Chinook salmon represent a significant increase over the 2009, parent year. The 2013 estimate was 644, which was an increase from 2010 estimate of 482. The Mill Creek population of spring-run Chinook salmon is currently at a moderate risk of extinction, due to the significant decline in abundance from prior to 2008 through 2011. However, with the increase in abundance in 2012 and 2013, this trend may be improving. The Deer Creek abundance of spring-run Chinook salmon experienced a significant decline starting in 2008, with an increase in 2012 and 2013.

The abundance of spring-run Chinook salmon in Clear Creek was lower in 2010, 2011, and from 2005 through 2011, abundance numbers in most of the tributaries declined. Adult returns from 2006 to 2009, indicate that population abundance for the entire Sacramento River basin was

declining from the peaks seen in the five years prior to 2006. Declines in abundance from 2005 to 2011, placed the Mill Creek and Deer Creek populations in the high extinction risk category due to the rates of decline, and in the case of Deer Creek, also the level of escapement (NMFS 2011). Butte Creek had sufficient abundance to retain its low extinction risk classification, but the rate of population decline in years 2006 through 2011 was nearly sufficient to classify it as a high extinction risk based on this criteria. Nonetheless, the watersheds identified as having the highest likelihood of success for achieving viability/low risk of extinction include, Butte, Deer and Mill creeks (NMFS 2011). Some other tributaries to the Sacramento River, such as Clear Creek and Battle Creek have seen population gains in the years from 2001 to 2009, but the overall abundance numbers have remained low. Year 2012 appeared to be a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799). Additionally, 2013 adult escapement numbers combined for Butte, Mill and Deer creeks increased (over 17,000), which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1998. 2014 adult escapement was lower than 2013 to be lower, with an adult escapement of just over 5,000 fish, which indicates a highly fluctuating and unstable ESU.

1. Productivity

The 5-year geometric mean for the extant Butte, Deer, and Mill creek spring-run Chinook salmon populations ranged from 491 to 4,513 fish, indicating increasing productivity over the short-term and was projected to likely continue into the future (Good *et al.* 2005). However, as mentioned in the previous paragraph, the next five years of adult escapement to these tributaries has seen a cumulative decline in fish numbers and the CRR has declined in concert with the population declines. The productivity of the Feather River and Yuba River populations and contribution to the CV spring-run ESU currently is unknown.

2. Spatial Structure

With only one of four diversity groups currently containing viable populations, the spatial structure of CV spring-run Chinook salmon is severely reduced. Butte Creek spring-run Chinook salmon cohorts have recently utilized all currently available habitat in the creek; and it is unknown if individuals have opportunistically migrated to other systems. The persistent populations in Clear Creek and Battle Creek, with habitat restoration completed and underway are anticipated to add to the spatial structure of the CV spring-run Chinook salmon ESU if they can reach viable status in the basalt and porous lava and northwestern California diversity group areas. The spatial structure of the spring-run Chinook salmon ESU would still be lacking with the extirpation of all San Joaquin River basin spring-run Chinook salmon populations. Plans are underway to re-establish a spring-run Chinook salmon experimental population downstream of Friant Dam in the San Joaquin River, as part of the San Joaquin River Settlement Agreement. This would be done with Feather River Hatchery stock. Interim flows for this began in 2009. Its long-term contribution to the CV spring-run Chinook salmon ESU is uncertain. It is clear that further efforts would need to involve more than restoration of currently accessible watersheds to make the ESU viable. The draft CV Recovery Plan calls for reestablishing populations into

historical habitats currently blocked by large dams, such as a population upstream of Shasta Dam. It also calls to facilitate passage of fish upstream and downstream of Englebright Dam on the Yuba River (NMFS 2009b).

3. Diversity

The CV spring-run Chinook salmon ESU is comprised of two genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the CV indicates that the northern Sierra Nevada diversity group spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retains genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised. The Feather River spring-run Chinook salmon have introgressed with the fall-run Chinook salmon, and it appears that the Yuba River population may have been impacted by FRFH fish straying into the Yuba River. Additionally, the diversity of the spring-run Chinook salmon ESU has been further reduced with the loss of the majority, if not all, of the San Joaquin River basin spring-run Chinook salmon populations. Efforts underway, like the San Joaquin Restoration Project, are needed to improve the diversity of the CV spring-run Chinook salmon ESU.

Summary of CV Spring-run Chinook salmon DPS Viability

Lindley et al. (2007) indicated that the spring-run Chinook salmon populations in the CV had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon population failed to meet the "representation and redundancy rule" since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them. Over the long term, these remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

In the 2011 California CV status review for spring-run Chinook salmon, NMFS identified the status of CV spring-run Chinook salmon ESU as having probably deteriorated since the 2005 status review and Lindley et al.'s (2007) assessment, with two of the three extant independent populations (Deer and Mill creeks) of spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk. Since the abundance of some populations is improving, though this is based on only two years (2012 and 2013), the extinction risk of Sacramento tributary populations generally has improved from high to moderate.

Critical Habitat and Primary Constituent Elements for CV Spring-Run Chinook Salmon

Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005, (70 FR 52488). Critical habitat for CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of one to two years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488). Critical habitat for CV spring-run Chinook salmon is defined as specific areas that contain the primary constituent elements (PCEs) essential to the conservation of the species. Following are the inland habitat types used as PCEs for CV spring-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the CV for Chinook salmon is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for CV spring-run Chinook salmon occurs on the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte creeks; as well as the Feather and Yuba rivers, Big Chico, Battle, Antelope, and Clear creeks. However, little spawning activity has been recorded in recent years on the Sacramento River mainstem for spring-run Chinook salmon. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile salmonid development; and natural cover such as shade, submerged and overhanging large woody material, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from piscivorous fish and birds.

Freshwater rearing habitat also has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, yet a number of challenges exist on many tributary streams. For juveniles, unscreened or inadequately screened water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging large woody material, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging.

The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to provide predator avoidance, as rearing habitat and as an area of transition to the ocean environment.

2.2.3 California Central Valley steelhead

CCV steelhead were listed as threatened on March 19, 1998, (63 FR 13347). Following a new status review (Good *et al.* 2005) and after application of the agency's hatchery listing policy, the NMFS reaffirmed its status as threatened and also listed several hatchery stocks as part of the DPS in 2006 (71 FR 834). In June 2004, after a complete status review of 27 west coast salmonid ESUs, the NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). On January 5, 2006, NMFS reaffirmed the threatened status of the CCV steelhead and applied the

DPS policy to the listed steelhead ESUs because the resident and anadromous life forms of *O. mykiss* remain "markedly separated" as a consequence of physical, ecological and behavioral factors, and therefore warranted delineation as a separate DPS (71 FR 834). On August 15, 2011, the NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (NMFS 2011a).

Critical habitat was designated for CCV steelhead on September 2, 2005, (70 FR 52488). Critical habitat includes the stream channels to the ordinary high water line within designated stream reaches such as those of the American, Feather, and Yuba rivers, and Deer, Mill, Battle, Antelope, and Clear creeks in the Sacramento River basin; the Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers in the San Joaquin River basin; and the Sacramento and San Joaquin rivers and Delta. Currently the CCV steelhead DPS and its designated critical habitat extends up the San Joaquin River upstream to the confluence with the Merced River.

Life History

1. Migratory Forms Present in CV

Steelhead in the CV historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning. Between 1944 and 1947, annual counts of summer-run steelhead passing through the Old Folsom Dam fish ladder during May, June, and July ranged from 400 to 1,246 fish (Gerstung 1971). After 1950, when the fish ladder at Old Folsom Dam was destroyed by flood flows, summer-run steelhead were no longer able to access their historic spawning areas, and either perished in the warm water downstream of Old Folsom Dam or hybridized with winter-run steelhead. Only winter-run (ocean maturing) steelhead currently are found in California CV rivers and streams (Moyle 2002; McEwan and Jackson 1996). Summer-run steelhead have been extirpated due to a lack of access to suitable holding and staging habitat, such as coldwater pools in the headwaters of CV streams, presently located upstream of impassible dams (Lindley *et al.* 2006).

2. Age Structure

Juvenile steelhead (parr) rear in freshwater for one to three years before outmigrating to the ocean as smolts (Moyle 2002). The time that parr spend in freshwater is related to their growth rate, with larger, faster-growing members of a cohort smolting at an earlier age (Peven *et al.* 1994; Seelbach 1993). Hallock *et al.* (1961) aged 100 adult steelhead caught in the Sacramento River upstream of the Feather River confluence in 1954, and found that 70 had smolted at age-2, 29 at age-1, and one at age-3. Seventeen of the adults were repeat spawners, with three fish on their third spawning migration, and one on its fifth. Age at first maturity varies among populations. In the CV, most steelhead return to their natal streams as adults at a total age of two to four years (Hallock 1961, McEwan and Jackson 1996).

3. Egg to Parr Stages

Steelhead eggs hatch in three to four weeks at 10°C to 15°C (Moyle 2002). The length of time it takes for eggs to hatch depends mostly on water temperature. After hatching, alevins remain in the gravel for an additional two to five weeks while absorbing their yolk sacs, and emerge in spring or early summer (Barnhart 1986). Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Upon emergence, fry inhale air at the stream surface to fill their air bladders, absorb the remains of their yolks in the course of a few days, and start to feed actively, often in schools (Barnhart 1986; NMFS 1996).

The newly emerged juveniles move to shallow, protected areas associated within the stream margin (McEwan and Jackson 1996). As steelhead parr increase in size and their swimming abilities improve, they increasingly exhibit a preference for higher velocity and deeper mid-channel areas (Hartman 1965; Everest and Chapman 1972; Fontaine 1988).

4. Preferred Juvenile Habitat

Productive juvenile rearing habitat is characterized by complexity, primarily in the form of cover, which can be deep pools, woody debris, aquatic vegetation, or bolders. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991). Optimal water temperatures for growth range from 15°C to 20°C (McCullough *et al.* 2001, Spina 2006).

5. Smolt Migration

Juvenile steelhead will often migrate downstream as parr in the summer or fall of their first year of life (USFWS 2002), but this is not a true smolt migration (Loch *et al.* 1988). Smolt migrations occur in the late winter through spring, when juveniles have undergone a physiological transformation to survive in the ocean, and become slender in shape, bright silvery in coloration, with no visible parr marks. Emigrating steelhead smolts use the lower reaches of the Sacramento River and the Delta primarily as a migration corridor to the ocean. There is little evidence that they rear in the Delta or on floodplains, though there are few behavioral studies of this life-stage in the CV.

6. Ocean Behavior

Unlike Pacific salmon, steelhead do not appear to form schools in the ocean (Behnke 1992). Steelhead in the southern part of their range appear to migrate close to the continental shelf, while more northern populations may migrate throughout the northern Pacific Ocean (Barnhart 1986).

7. Adult Run-Timing and Spawning Habitat

CCV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), enter freshwater from August to November with a peak in September (Hallock 1961), and spawn from

December to April, with a peak in January through March, in rivers and streams where cold, well oxygenated water is available (Table 8; Williams 2006; Hallock *et al.* 1961; McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets, and the associated change in water temperatures (Workman *et al.* 2002). Adults typically spend a few months in freshwater before spawning (Williams 2006). Female steelhead construct redds in suitable gravel and cobble substrate, primarily in pool tailouts and heads of riffles.

8. Fecundity

The number of eggs laid per female is highly correlated with adult size, though the strain of the fish can also play a role. Adult steelhead size depends on the duration of and growth rate during their ocean residency (Meehan and Bjornn 1991). CCV steelhead generally return to freshwater after one to two years at sea (Hallock *et al.* 1961), and adults typically range in size from two to twelve pounds (Reynolds *et al.* 1993). Steelhead about 55 cm long may have fewer than 2,000 eggs, whereas steelhead 85 cm long can have 5,000 to 10,000 eggs, depending on the stock (Meehan and Bjornn 1991). The average for Coleman National Fish Hatchery (CNFH) since 1999 is about 3,900 eggs per female (USFWS 2011).

9. Iteroparity

Unlike Pacific salmon, steelhead are iteroparous, meaning they are capable of spawning multiple times before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; and repeat spawners tend to be biased towards females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners were relatively numerous (17.2 percent) in Waddell Creek. Null *et al.* (2013) found between 36 percent and 48 percent of kelts released from CNFH in 2005 and 2006 survived to spawn the following spring, which is in sharp contrast to what Hallock (1989) reported for CNFH in the 1971 season, where only 1.1 percent of adults were fish that had been tagged the previous year. Most populations have never been studied to determine the percentage of repeat spawners. Hatchery steelhead are typically less likely than wild fish to survive to spawn a second time (Leider *et al.* 1986).

10. Kelts

Post-spawning steelhead (kelts) may migrate downstream to the ocean immediately after spawning, or they may spend several weeks holding in pools before outmigrating (Shapovalov and Taft 1954). Recent studies have shown that kelts may remain in freshwater for an entire year after spawning (Teo *et al.* 2011), but that most return to the ocean (Null *et al.* 2013).

11. Population Dynamics

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock *et al.* (1961) estimated an

average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990's, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

About 80 percent of the historical spawning and rearing habitat once used by anadromous *O. mykiss* in the CV is now upstream of impassable dams (Lindley *et al.* 2006). The extent of habitat loss for steelhead most likely was much higher than that for salmon because steelhead were undoubtedly more extensively distributed. Due to their superior jumping ability, the timing of their upstream migration which coincided with the winter rainy season, and their less restrictive preferences for spawning gravels, steelhead could have utilized at least hundreds of miles of smaller tributaries not accessible to the earlier-spawning salmon (Yoshiyama *et al.* 1996). Steelhead were found as far south as the Kings River (and possibly Kern river systems in wet years) (McEwan 2001). Native American groups such as the Chunut people have had accounts of steelhead in the Tulare Basin (Latta 1977).

Nobriga and Cadrett (2003) compared CWT and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 through 2001 to estimate that about 100,000 to 300,000 steelhead smolts are produced naturally each year in the CV. Good *et al.* (2005) made the following conclusion based on the Chipps Island data:

> *"If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire CV. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s."*

Existing naturally produced steelhead stocks in the CV are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in Big Chico and Butte creeks and a few wild steelhead are produced in the American and Feather rivers (McEwan and Jackson 1996). Clear Creek steelhead spawner abundance has not been estimated.

Until recently, CCV steelhead were thought to be extirpated from the San Joaquin River system. Monitoring has detected small numbers of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995. A counting weir has been in place in the Stanislaus River since 2002 and in the Tuolumne River since 2009 to detect adult salmon, and have also detected *O. mykiss* passage. In 2012, 15 adult *O. mykiss* were detected passing the Tuolumne River weir and 82 adult *O. mykiss* were detected at the Stanislaus River weir (FishBio 2012a,b). In addition, rotary screw trap sampling has occurred since 1995 in the Tuolumne River, but only one juvenile *O. mykiss* was caught during the 2012 season (FishBio 2012b).

Rotary screw traps are well known to be very inefficient at catching steelhead smolts, so the actual numbers of smolts could be much higher. Rotary screw trapping on the Merced River has occurred since 1999. A fish counting weir was installed on this river in 2012. Since installation, one adult *O. mykiss* has been reported passing the weir. Juvenile *O. mykiss* were not reported captured in the rotary screw traps on the Merced River until 2012, when a total of 381 were caught (FishBio 2013). The unusually high number of *O. mykiss* captured may be attributed to a flashy storm event that rapidly increased flows over a 24 hour period. Zimmerman *et al.* (2009) has documented CCV steelhead in the Stanislaus, Tuolumne, and Merced rivers based on otolith microchemistry.

CDFW conducts annual Kodiak trawl sampling on the San Joaquin River near Mossdale. Based on these catches, as well as rotary screw trap efforts in all three tributaries, Marston (2004) stated that it is "clear from this data that *O. mykiss* do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River." Mossdale Kodiak trawl catches continue to occur and are still being conducted by CDFW. The low adult returns to these tributaries and the low numbers of juvenile emigrants captured suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed. The loss of these populations would severely impact CCV steelhead spatial structure and further challenge the viability of the CCV steelhead DPS.

In the Mokelumne River, East Bay Municipal Utilities District has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season (NMFS 2011a). Based on data from these surveys, the overall trend suggests that redd numbers have slightly increased over the years (2000-2010). However, according to Satterthwaite *et al.* (2010), it is likely that most of the *O. mykiss* spawning in the Mokelumne River are non-anadromous (or resident) fish rather than steelhead. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production. In the past, this hatchery received fish imported from the Feather River and Nimbus hatcheries (Merz 2002). However, this practice was discontinued 11 years ago for Nimbus stock, and 3 years ago for Feather River stock. Recent results show that the Mokelumne River Hatchery steelhead are closely related to Feather River fish, suggesting that there has been little carry-over of genes from the Nimbus stock.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show a decline, an overall low abundance, and fluctuating return rates. Lindley *et al.* (2007) developed viability criteria for CV salmonids. Using data through 2005, Lindley *et al.* (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The most recent status review of the CCV steelhead DPS (NMFS 2011a) found that the status of the population appears to have worsened since the 2005 status review (Good *et al.* 2005), when it was considered to be in danger of extinction. Analysis of data from the Chipps Island monitoring program indicates that natural steelhead production has continued to decline and that hatchery origin fish represent an increasing fraction of the juvenile production in the CV. Since 1998, all hatchery produced steelhead in the CV have been adipose fin clipped (ad-clipped). Since that

time, the trawl data indicates that the proportion of ad-clip steelhead juveniles captured in the Chipps Island monitoring trawls has increased relative to wild juveniles, indicating a decline in natural production of juvenile steelhead. In recent years, the proportion of hatchery produced juvenile steelhead in the catch has exceeded 90 percent and in 2010 was 95 percent of the catch. Because hatchery releases have been fairly consistent through the years, this data suggests that the natural production of steelhead has been declining in the CV.

Salvage of juvenile steelhead at the CVP and SWP fish collection facilities has also shown a shift towards reduced natural production. In the past decade, there has been a decline in the percentage of salvaged juvenile steelhead that are naturally produced from 55 percent in 1998 down to 22 percent in 2010 (NMFS 2011a).

In contrast to the data from Chipps Island and the CVP and SWP fish collection facilities, some populations of wild CCV steelhead appear to be improving (Clear Creek) while others (Battle Creek) appear to be better able to tolerate the recent poor ocean conditions and dry hydrology in the CV compared to hatchery produced fish (NMFS 2011a). Since 2003, fish returning to the CNFH have been identified as wild (adipose fin intact) or hatchery produced (Ad-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely; ranging from 624 to 2,968 fish per year. The returns of wild fish remained steady, even during the recent poor ocean conditions and the 3-year drought in the CV, while hatchery produced fish showed a decline in the numbers returning to the hatchery (NMFS 2011a). Furthermore, the continuing widespread distribution of wild steelhead in the CV provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011a).

Table 8. The temporal occurrence of (a) adult and (b) juvenile CCV steelhead at locations in the CV. Darker shades indicate months of greatest relative abundance

(a) Adult migration and holding

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,3]Sac. River												
[2,3]Sac R at Red Bluff												
[4]Mill, Deer Creeks												
[6]Sac R. at Fremont Weir												
[6]Sac R. at Fremont Weir												
[7]San Joaquin River												

(b) Juvenile migration

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sacramento River												
[2,8]Sac. R at KL												
[9]Sac. River @ KL												
[10]Chipps Island (wild)												
[8]Mossdale												
[11]Woodbridge Dam												
[12]Stan R. at Caswell												
[13]Sac R. at Hood												

Relative Abundance: = High = Medium = Low

Sources: [1]Hallock 1961; [2]McEwan 2001;[3]USFWS unpublished data; [4]CDFG 1995; [5]Hallock *et al.* 1957; [6]Bailey 1954; [7]CDFG Steelhead Report Card Data 2007;[8]CDFG unpublished data; [9]Snider and Titus 2000; [10]Nobriga and Cadrett 2003; [11]Jones and Stokes Associates, Inc., 2002; [12]S.P. Cramer and Associates Inc. 2000 and 2001; [13]Schaffter 1980, 1997.

Description of VSP Parameters

1. Abundance

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good *et al.* 2005; NMFS 2011a); the long-term trend remains negative. Comprehensive steelhead population monitoring has not taken place in the CV, despite 100 percent marking of hatchery steelhead since 1998. Efforts are underway to improve this deficiency, and a long term adult escapement monitoring plan is being considered (Eilers *et al.* 2010). Hatchery production and returns are dominant over natural fish and include significant numbers of non-DPS-origin Eel/Mad River steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead

in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

2. Productivity

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the CV annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries which represent migrants from the Stanislaus, Tuolumne, and Merced rivers suggest that existing populations of CCV steelhead on these tributaries are severely depressed. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams *et al.* 2011).

3. Spatial Structure

Steelhead appear to be well-distributed throughout the CV (Good *et al.* 2005; NMFS 2011a). In the San Joaquin River Basin, steelhead have been confirmed in all of the tributaries: Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers. Zimmerman *et al.* (2009) used otolith microchemistry to show that *O. mykiss* of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River and its tributaries. The efforts to provide passage of salmonids over impassable dams may increase the spatial diversity of CCV steelhead populations if the passage programs are implemented for steelhead. In addition, the San Joaquin River Restoration Program (SJRRP) calls for a combination of channel and structural modifications along the San Joaquin River downstream of Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run and fall-run Chinook salmon. If the SJRRP is successful, habitat improved for spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2011a).

4. Diversity

CCV steelhead abundance and growth rate continue to decline, largely the result of a significant reduction in the diversity of habitats available to CCV steelhead (Lindley *et al.* 2006). Recent reductions in population size are also supported by genetic analysis (Nielsen *et al.* 2003). Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that unlike the situation in coastal California watersheds, fish downstream of barriers in the CV were more closely related to downstream of barrier fish from other watersheds than to *O. mykiss* upstream of barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact upstream of barriers, but may have been altered below barriers by stock transfers. The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, which likely comprise the majority of the spawning run, placing the natural population at a high risk of extinction (Lindley *et al.* 2007). There are four hatcheries (CNFH, FRFH, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery) in the CV which combined

release approximately 600,000 yearling steelhead smolts each year. These programs are intended to compensate for the loss of steelhead habitat caused by dam construction, but hatchery origin fish now appear to constitute a major proportion of the total abundance in the DPS. Two of these hatchery stocks (Nimbus and Mokelumne River hatcheries) originated from outside the DPS (from the Eel and Mad rivers) and are not presently considered part of the DPS.

Summary of CCV Steelhead DPS Viability

All indications are that natural CCV steelhead have continued to decrease in abundance over the past 25 years (Good et al. 2005; NMFS 2011a). The long-term trend remains negative. Hatchery production and returns are dominant over natural fish. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show a decline, an overall low abundance, and fluctuating return rates. Lindley et al. (2007) developed viability criteria for CV salmonids. Using data through 2005, Lindley et al. (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the CV provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011a). The most recent status review of the CCV steelhead DPS (NMFS 2011a) found that the status of the population appears to have worsened since the 2005 status review (Good et al. 2005), when it was considered to be in danger of extinction.

Critical Habitat and Primary Constituent Elements for CCV Steelhead

Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999; 70 FR

52488). Critical habitat for CCV steelhead is defined as specific areas that contain the PCE and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for CCV steelhead. PCEs for CCV steelhead include:

1. Freshwater Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most of the available spawning habitat for steelhead in the CV is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. These reaches are often impacted by the upstream impoundments, particularly over the summer months, when high temperatures can have adverse effects upon salmonids spawning and rearing downstream of the dams. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and survival; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging LWM, log jams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream and downstream passage of adults, and the emigration of smolts. Migratory habitat condition is strongly affected by the presence of barriers, which can include

dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging LWM, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. Estuarine areas are considered to have a high conservation value as they provide factors which function to provide predator avoidance and as a transitional zone to the ocean environment.

2.2.4 Southern DPS of North American Green Sturgeon

The following section entails the status of the species for the Southern distinct population segment of SDPS green sturgeon (sDPS green sturgeon). This section establishes the life history and viability for sDPS green sturgeon, and discusses their critical habitat. The critical habitat analysis is approached by examining the PCEs of that critical habitat, and this analysis considers separately freshwater and estuarine environments. Throughout this analysis of life history, viability, and critical habitat, the focus is upon the CV of California. Therefore, not all aspects of sDPS green sturgeon are presented; for example, the PCEs for the critical habitat in the marine environment are not included.

1. Listed as threatened on June 6, 2006 (71 FR 17757)
2. Critical habitat designated October 9, 2009 (74 FR 52300)

Life History

Our understanding of the biology of the sDPS of green sturgeon is evolving. In areas where information is lacking, inferences are sometimes made from what is known about the Northern distinct population segment (nDPS) green sturgeon and, to a lesser extent, from other sturgeon species, especially the sympatric white sturgeon (*Acipenser transmontanus*). Green sturgeon are long lived, iteroperous, anadromous fish. They may live up to 60-70 years; green sturgeon captured in Oregon have been age-estimated using a fin-spine analysis up to 52 years (Farr and Kern 2005). The green sturgeon sDPS includes those that spawn south of the Eel River. Until recently, it was believed that the green sturgeon sDPS was composed of a single spawning population on the Sacramento River. However, recent research conducted by DWR has revealed spawning activity in the Feather River (Seesholtz, A. M., M. J. Manuel, and J. P. Van Eenennaam). 2015. First documented spawning and associated habitat conditions for green sturgeon in the Feather River, California. Environmental Biology of Fishes 98:905-912. Additionally, there is some evidence of spawning in the Yuba River downstream of Daguerre Point Dam (Cramer Fish Sciences 2013).

Laboratory studies have provided some important information about about larval sturgeon diet and habitat use. Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 15° C (59° F) (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Studies conducted at the University of California, Davis by Van Eenennaam *et al.* (2005) using nDPS juveniles indicated that an optimum range of water temperature for egg development ranged between 14° C (57.2°F) and 17° C (62.6°F). Temperatures over 23 °C (73.4°F) resulted in 100 percent mortality of fertilized eggs before hatching. Eggs incubated at water temperatures between 17.5° C (63.5°F) and 22° C (71.6°F) resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 14° C (57.2°F), hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so (Van Eenennaam *et al.* 2005).

Young green sturgeon appear to rear for the first one to two months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length, indicating they are approximately two weeks old (CDFG 2002, USFWS 2002). Growth is rapid as juveniles reach up to 300 mm the first year and over 600 mm in the first 2 to 3 years (Nakamoto *et al.* 1995). Juvenile green sturgeon have been salvaged at the Federal and State pumping facilities (which are located in the southern region of the Delta), and sampled in trawling studies by the CDFW during all months of the year (CDFG 2002). The majority of these fish that were captured in the Delta were between 200 and 500 mm indicating they were from 2 to 3 years of age, based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile sDPS green sturgeon likely hold in the mainstem Sacramento River for up to 10 months, as suggested by Kynard *et al.* (2005). Both nDPS and sDPS green sturgeon juveniles tested under laboratory conditions, with either full or reduced rations, had optimal bioenergetic performance (*i.e.*, growth, food conversion, swimming ability) between 15°C (59° F) and 19° C (66.2° F), thus providing a temperature related habitat target for conservation of this rare species (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed.

Radtke (1966) inspected the stomach contents of juvenile green sturgeon in the Delta and found food items to include a mysid shrimp (*Neomysis awatschensis)*, amphipods (*Corophium* spp.*),* and other unidentified shrimp. No additional information is available regarding the diet of sDPS green sturgeon in the wild, but they are presumed to be generalist, opportunistic benthic feeders.

There is a fair amount of variability (1.5 – 4 years) in the estimates of the time spent by juvenile green sturgeon in freshwater before making their first migration to sea. Nakamoto *et al.* (1995) found that nDPS green sturgeon on the Klamath River migrated to sea, on average by age three and no later than by age four. Moyle (2002) suggests juveniles migrate out to sea before the end of their second year, and perhaps as yearlings. Laboratory experiments indicate that both nDPS and sDPS green sturgeon juveniles may occupy fresh to brackish water at any age, but they are physiologically able to completely transition to saltwater at around 1.5 years in age (Allen and Cech 2007). In studying nDPS green sturgeon on the Klamath River, Allen *et al.* (2009) devised

a technique to estimate the timing of transition from fresh water to brackish water to seawater by taking a bone sample from the leading edge of the pectoral fin and anlyzing the ratios of stontium and barium to calcium. The results of this study indicate that green sturgeon move from freshwater to brackish water (such as the estuary) at ages 0.5–1.5 years and then move into seawater at ages 2.5-3.5 years. Table 9 shows the migration timing of various life stages throughout the CV, Delta, San Francisco Bay, and into the Pacific Ocean.

In the summer months, multiple rivers and estuaries throughout the sDPS range are visited by dense aggregations of green sturgeon (Moser and Lindley 2007, Lindley *et al.* 2011). Capture of green sturgeon as well as tag detections in tagging studies have shown that green sturgeon are present in San Pablo Bay and San Francisco Bay at all months of the year (Kelly *et al.* 2007, Heublein *et al.* 2009, Lindley *et al.* 2011). An increasing amount of information is becoming available regarding green sturgeon habitat use in estuaries and coastal ocean, and why they aggregate episodically (Lindley *et al.* 2008, Lindley *et al.* 2011). Genetic studies on green sturgeon stocks indicate that almost all of the green sturgeon in the San Francisco Bay ecosystem belong to the sDPS (Israel and Klimley 2008).

Green sturgeon do not mature until they are at least 15–17 years of age (Beamesderfer *et al.* 2007). Therefore, it would not be expected that a green sturgeon returning to freshwater would be younger than this. However, once mature, green sturgeon appear to make spawning runs once every few years. Erickson and Hightower (2007) found that nDPS green sturgeon returned to the Rogue River 2–4 years after leaving; it is presumed that sDPS green sturgeon display similar behavior and return to the Sacramento River or Feather River system to spawn every 2–5 years. Adult sDPS green sturgeon begin their upstream spawning migrations into freshwater as early as late February with spawning occuring between March and July (CDFG 2002, Heublein 2006, Heublein *et al.* 2009, Vogel 2008). Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates featuring crevices and interstices (Van Eenennaam *et al.* 2001). Poytress *et al.* (2012) conducted spawning site and larval sampling in the upper Sacramento River from 2008–2012 and has identified a number of confirmed spawning locations (Figure 6). Green sturgeon fecundity is approximately 50,000 to 80,000 eggs per adult female (Van Eenennaam *et al.* 2001). They have the largest egg size of any sturgeon. The outside of the eggs are mildly adhesive, and are more dense than than those of white sturgeon (Kynard *et al.* 2005, Van Eenennaam *et al.* 2009).

Post spawning, green sturgeon may exhibit a variety of behaviors. Ultimately they will return to the ocean, but how long they take to do this and what they do along the way are open questions. Illustrating the spectrum of behavioral choices, Benson *et al.* (2007) conducted a study in which 49 nDPS green sturgeon were tagged with radio and/or sonic telemetry tags and tracked manually or with receiver arrays from 2002 to 2004. Tagged individuals exhibited four movement patterns: upstream spawning migration, spring outmigration to the ocean, or summer holding, and outmigration after summer holding.

Table 9. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the CV of California. Darker shades indicate months of greatest relative abundance.

(a) Adult-sexually mature (≥145 – 205 cm TL for females and ≥ 120 – 185 cm TL old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River[a,b,c.i]												
SF Bay Estuary[d,h,i]												

(b) Larval and juvenile (≤10 months old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River[e]												
GCID, Sac River[e]												

(c) Older Juvenile (> 10 months old and ≤3 years old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Delta*[f]												
Sac-SJ Delta[f]												
Sac-SJ Delta[e]												
Suisun Bay[e]												

(d) Sub-Adult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Coast[c,g]												

Relative Abundance: = High = Medium = Low

* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al.* (1992); [c]Adams *et al.* (2002) and NMFS (2005); [d]Kelly *et al.* (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al.* (1995); [h]Heublein (2006); [i]CDFG Draft Sturgeon Report Card (2007)

Threats and Stressors

Green sturgeon are long lived, and thus face environmental and anthropocentric stressors that may affect the probability that they reach reproductive maturity. Males are observed to reproduce

as early as 14 years old, while females grow older prior to maturing as early as 16 years old (Van Eenennaam et al. 2005). Both males and females occupy all types of aquatic environments-freshwater, estuarine, and marine. Numerous environmental factors potentially limit green sturgeon survival during the earliest stages of their life cycle while in freshwater. This period is called the "critical age" in fishes due to its relevance in survival and recruitment of individuals into the adult population (Hardy and Litvak 2004). Recruitment failure of the earliest life history stages may be a significant bottleneck for other North American acipenserids such as Pallid sturgeon and the white sturgeon in Upper Columbia and Kootenai rivers, the populations of which have numerous reproductive adults, but few recently surviving wild juveniles (Duke et al. 1999, Hildebrand et al. 1999, Korman and Walters 2001) .

There are many potential limiting factors during this early life period. They are the following: 1) warm water temperatures, 2) insufficient flows, 3) decreased dissolved oxygen, 4) lack of rearing habitat, and 5) increased predation. Water is released from Shasta Dam to maintain daily temperatures below 18º C downstream to a temperature compliance point, which in 2007 was maintained at Jellys Ferry and Balls Ferry to facilitate the incubation of eggs of spawning winter-run Chinook. This maintenance of cool water temperatures benefits green sturgeon spawning upstream of Red Bluff Diversion Dam. Temperature records from acoustic telemetry receivers along the mainstem have not been analyzed, but may provide data for assessing whether temperatures are limiting survival of embryos, larvae or juveniles downstream of RBDD. Once larvae grow into juveniles, their survival may be limited by lack of habitat, insufficient food, and possibly contaminants. Juveniles are fairly tolerant of variable temperature and dissolved oxygen, and are likely mobile enough to select favorable habitats (see Ecology sections). It is possible that juveniles can also be entrained in water diversions for farmland irrigation, although their benthic behavior likely limits this impact, and this is not well understood.

The members of the older age classes principally face anthropocentric threats to their survival in estuarine and marine environments. Once within the estuary, juveniles might accumulate pollutants such as methyl-mercury and pyrethroids, whose uptake is enhanced by the benthic feeding orientation of green sturgeon. Pyrethroids also may limit the availability of prey for young green sturgeon due to their effect of very low dosages on zooplankton and bottom-dwelling organisms. The size of the populations of subadults and adults have been potentially limited by human fisheries and barriers to spawning areas which may prevent them from racing the most optimal spawning habitats. Harvest can cause abrupt declines in green sturgeon adult abundance. Even an amount as small as 10% additional mortality over the green sturgeon's life-span can reduce population abundance by 50% and adult abundance by 90% (Beamesderfer et al. 2007). An additional simulated increase in mortality of 20% over natural mortality resulted in no green sturgeon surviving to adulthood. These forms of mortality could include human and nonhuman sources of direct mortality, and are not well quantified for the Southern DPS. Of greater concern, might be even much smaller additional mortality rates' influence on green sturgeon's reproductive potential. Additional rates of only 2-3% annual mortality over green sturgeon's life cycle reduced egg production to levels making sturgeon stocks extremely susceptible to overfishing (Beamesderfer et al. 2007).

Modification of the riverscape has resulted in loss of spawning habitat, rearing habitat, and increased barriers to migration. Larvae, juveniles, and adults life history stages are all benthic in

orientation and all require deep habitats for dispersal, holding, and spawning. Successful fertilization and survival of embryos seems to require spawning habitats reflecting specific water quality and quantity parameters, which have been negatively impacted by construction of dams and channelization of the river. Riparian habitats provide allochthonous contributions to the river food web that indirectly support juvenile prey items. It is possible that modifications in temperature regime controlled by the Shasta Dam temperature control device may benefit green sturgeon spawning above Red Bluff Diversion Dam, but more research is necessary to understand the impacts of temperature on the distribution and success of green sturgeon spawning.

Channelization of the estuary has likely negative impacted the amount of subtidal and intertidal habitat available for green sturgeon foraging. These habitats have been lost along San Pablo and Suisun bays, where subadult and adult green sturgeon are commonly found. These estuarine habitats are likely important for growth during the juvenile, coastal migrant, and adults life stages. Invasive plant species in the estuary have likely impacted the quantity of shallow habitat available to coastal migrant and adult green sturgeon, and alterations of the food web due to invasive species have also likely shifted green sturgeon estuarine diet.

Future Research

One conclusion of the NMFS BRT assessing the status of green sturgeon was that "it is essential that immediate efforts be undertaken to implement population monitoring for the DPS using methods that directly assess population status" (NMFS 2005). Although laboratory studies have yielded much information on the physiological needs of the species, field studies have yet to be completed applying this information to identifying adult spawning, larval survival, juvenile rearing, and juvenile smoltification. Information is necessary about the life history diversity, abundance, population growth rate, foraging behavior and temporal presence of Sacramento River green sturgeon.

Managers should develop research and monitoring to estimate the riverine larval and juvenile populations for a period of time reflecting the potential variation in physical and biological processes influencing recruitment. These results will give managers an idea for the effect of management on critical habitats, influence of adult demography on recruitment dynamics, and the actual production of green sturgeon in younger cohorts. Estimates derived from these types of studies may be a good indication for spawning and abundance, which are not negatively influenced by the impact of entrainment, operations, and harvest. If estimates of young riverine fish are known, then adaptive research evaluating the impacts of anthropocentric stressors on older life history stages will allow managers to assess the actual effects of these anthropocentric stressors. Currently, abundance derived from harvest or operational entrainment data does not allow managers to determine if these impacts are causing declines in abundance or just reflect the natural production of spawning adults.

The distribution of spawning adults as well as a characterization of their spawning habitat within the Sacramento River should be completed. This will provide insight into the density of spawning adults and influence spawning aggregation have to the juvenile population, the rates of egg and larval mortality, and the potential loss of this spawning habitat by flow and temperature

modification in the system. In 2008, UCD, BOR, and FWS initiated tracking green sturgeon as they move within the upper mainstem and collected eggs at spawning sites. Additional funding is necessary to adequately monitor spawning movements and increased egg and larval collection sites along the Sacramento riverscape to evaluate green sturgeon habitat relationships.

Little is known about green sturgeon food selection and foraging behavior making the predictability of where preferred food is available low. As green sturgeon move into lower riverine reaches, the estuary and marine environments, food resources are not well understood (Israel and Klimley 2008). If native food sources have declined due to invasive species occupying their habitat or pollutants reducing available food, finding sufficient food may be problematic for juvenile green sturgeon. There is a need to investigate further the effects of selenium and other contaminants on green sturgeon and to find ways to reduce sources. Recent evidence indicates adult white sturgeon may be accumulating selenium in concentrations detrimental to reproduction, presumably by consuming the introduced overbite clam (Linville 2006).

Support should be provided for priority research guided by the Interagency Ecological Program Sturgeon Work Team. This conceptual model should indicate that much is already known about the basic biology of green sturgeon from laboratory studies and can serve as the basis for developing hypotheses for testing in field studies. The next research step should be to discern the importance of this biology on population viability within the watershed. A systematically applied research program attempting to study the critical periods and habitats of green sturgeon in riverine and estuarine environments will provide managers with information on the actual utilization, status, and abundance of different life history stages of green sturgeon in the Sacramento River. Once these field observations are completed, our larger and more comprehensive understanding for the basic ecology of the species will permit the development of a population viability model, which could prioritize the above-mentioned risks to the population and guide management decisions (Israel and Klimley 2008).

Description of Viability Parameters for sDPS Green Sturgeon

As an approach to determining the conservation status of salmonids, NMFS has developed a framework for identifying attributes of a VSP. The intent of this framework is to provide parties with the ability to assess the effects of management and conservation actions and ensure their actions promote the listed species' survival and recovery. This framework is known as the VSP concept (McElhany *et al.* 2000). The VSP concept measures population performance in term of four key parameters: abundance, population growth rate, spatial structure, and diversity. Although the VSP concept was developed for Pacific salmonids, the underlying parameters are general principles of conservation biology and can therefore be applied more broadly; here we adopt the VSP concept for sDPS green sturgeon.

1. Abundance

Abundance is one of the most basic principles of conservation biology, and from this measurement other parameters can be related. In applying the VSP concept, abundance is examined at the population level, and therefore population size is perhaps a more appropriate

term. Population estimates of the green sturgeon sDPS are in development. A decrease in sDPS green sturgeon abundance has been inferred from the amount of take observed at the south Delta pumping facilities; the Skinner Delta Fish Protection Facility (SDFPF) and the Tracy Fish Collection Facility (TFCF) (Figure 7). There are, however, uncertainties with the data in figure 7. Adams et al. (2007) describe that while the numbers of green sturgeon still were higher in the pre 1986 period, it appears that the expansion procedure exaggerated that difference. These entrainment estimates suffer from problems of species identification (green sturgeon were not identified until 1981 at the federal facility), and the estimates are expanded catches from brief sampling periods.

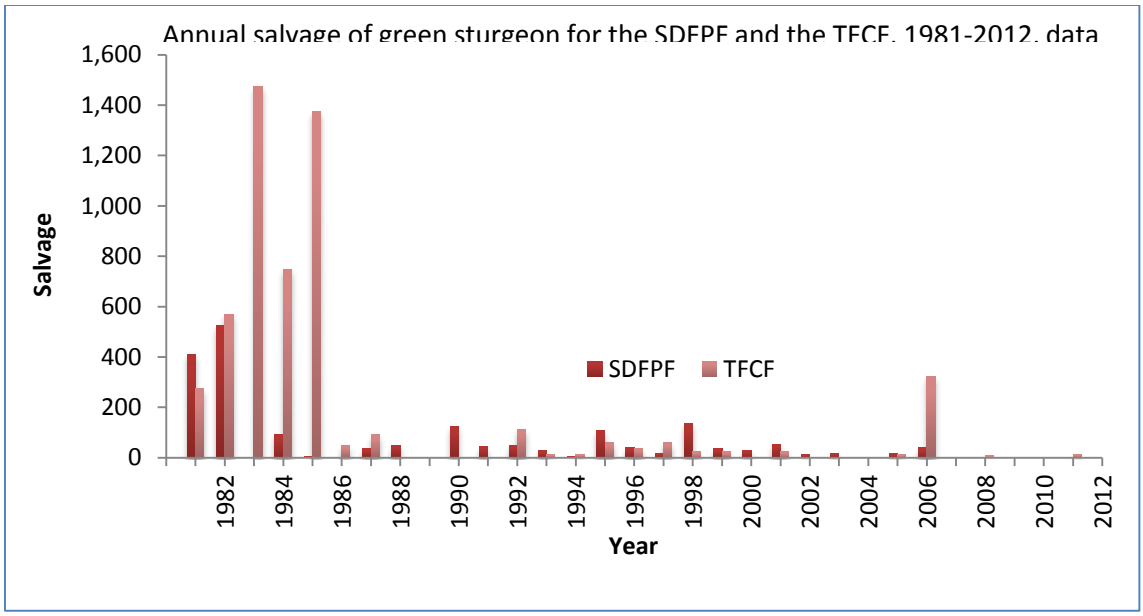


Figure 7. Annual salvage of green sturgeon for the SDFPF and the TFCF from 1981 to 2012. Data source: ftp://ftp.delta.dfg.ca.gov/salvage

Adult spawning population estimates in the upper Sacramento River (above RBDD), using sibling based genetics, indicates 10-28 spawners contributed to juvenile production per year between 2002-2006 (Israel and May 2010). This is a minimum estimate of the effective adult spawning population because sampling was limited, may have preferentially selected for larvae spawning immediately above RBDD, and did not include animals spawning downstream of the RBDD. Fish monitoring efforts at RBDD and Glen Colusa Irrigation District (GCID) on the upper Sacramento River have captured anywhere between 0 and 2,068 juvenile green sturgeon per year, between 1986 and 2000 (Adams *et al.* 2002).

In determining the conservation status of sDPS green sturgeon, a few notes with regards to population size are crucial. Population(s) should be large enough to survive environmental variations, catastrophes, and anthropogenic perturbations. Also, the population(s) should be sufficiently large to maintain long term genetic diversity (McElhany *et al.* 2000). Our understanding of the status of sDPS green sturgeon towards these concerns is developing.

Because of their long life span, green sturgeon abundance is particularly sensitive to increased mortality. Even relatively small increases in annual mortality can substantially reduce adult abundance due to cumulative effects accruing over a number of years. Because of their delayed age of maturation, cumulative impacts may severely reduce the population's reproduction potential.

Beamesderfer *et al*. (2007) used the life table model to evaluate the sensitivity of the population to additional mortality rates when applied to different life stages. The analyses showed that low rates of additional mortality (2% to 5%), when applied across multiple life stages, can result in abrupt declines in green sturgeon population numbers and reproductive potential.

2. Productivity

For long-lived species such as sturgeon, abundance, age structure, and sex ratios are particularly powerful indicators of long-term productivity patterns. Viable sturgeon populations are characterized by a broad distribution of size classes and ages. In order for sDPS green sturgeon to rebound from being threatened to a viable status, its population growth rate will need to be positive until some equilibrium population size is reached, at which point the growth rate should stabilize.

Productivity and recruitment information for sDPS green sturgeon is an area that requires additional research; existing data is too limited to be presented as robust estimates. Incidental catches of larval green sturgeon in the mainstem Sacramento River and of juvenile green sturgeon at the south Delta pumping facilities suggest that green sturgeon are successful at spawning, but that annual year class strength may be highly variable (Beamesderfer *et al.* 2007, Lindley *et al.* 2007). In general, sturgeon year class strength appears to be episodic with overall abundance dependent upon a few successful spawning events (NMFS 2010). It is unclear if the population is able to consistently replace itself. This is significant because the VSP concept requires that a population meeting or exceeding the abundance criteria for viability should, on average, be able to replace itself (McElhany *et al*. 2000). More research is needed to establish green sturgeon sDPS productivity.

3. Spatial Structure

Green sturgeon, as a species, are known to range from Baja California to the Bering Sea along the North American continental shelf. During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett 1991, Moser and Lindley 2007). Based on genetic analyses and spawning site fidelity (Adams *et al.* 2002, Israel *et al.* 2004), green sturgeon are comprised of at least two DPSs.

1. A nDPS consisting of populations originating from coastal watersheds northward of and including the Eel River (*i.e.* Klamath, Rogue, and Umpqua rivers), and
2. A sDPS consisting of populations originating from coastal watersheds south of the Eel River.

Throughout much of their range, sDPS and nDPS green sturgeon are known to co-occur, especially in northern estuaries and over-wintering grounds. However, those green sturgeon that are found within the inland waters of the Central Valley, California are almost entirely sDPS green sturgeon (Israel and Klimley 2008).

Adams *et al.* (2007) summarizes information that suggests green sturgeon may have been distributed upstream of the locations of present-day dams on the Sacramento and Feather rivers. In the California CV, sDPS green sturgeon are known to range from the Delta to the Sacramento River up to Keswick Dam, the Feather River up to the fish barrier structure downstream of Oroville Dam, and the Yuba River up to Daguerre Point Dam. Additional habitat may have historically existed in the San Joaquin River basin. Anecdotal evidence from anglers suggest sDPS green sturgeon presence in the San Joaquin River. Since implementation of the Sturgeon Report Card in 2007, anglers have reported catching 177 white sturgeon and 7 green sturgeon on the San Joaquin River upstream from Stockton (Dubois, J., M. D. Harris, and J. Mauldin. 2014. 2013 Sturgeon Fishing Report Card: Preliminary Data Report. CDFW Bay Delta Region, Stockton, CA, May 8, 2014).

In applying the VSP concept to sDPS green sturgeon, it is important to look at the within-population spatial diversity. Ongoing research is being conducted to determine if the green sturgeon sDPS is composed of a single population, or perhaps several populations. It is known that sDPS green sturgeon spawn in the mainstem Sacramento River, the Feather River, and the Yuba River; but it is not yet known if these spawning areas represent individual populations, sub-populations, or if they are all part of one single population. However, it is encouraging to note that at least this level of spatial diversity exists; when sDPS green sturgeon were originally listed as threatened under the ESA, the only known spawning locations at the time were those on the mainstem Sacramento River.

4. Diversity

The VSP concept identifies a variety of traits that exhibit diversity within and among populations, and this variation has important effects on population viability (McElhany *et al.* 2000). For sDPS green sturgeon, such traits include, but are not limited to fecundity, age at maturity, physiology, and genetic characteristics. On a species-wide scale, studies have examined the genetic differentiation between sDPS and nDPS green sturgeon (Israel *et al.* 2004).

Although the population structure of sDPS green sturgeon is still being refined, it may be the case that only a single population exists. This may have the effect of providing for lower diversity than if two or more populations existed. Lindley *et al.* (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population.

Summary of sDPS Green Sturgeon Viability

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The

risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a). Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany et al. 2000). The best available scientific information does not indicate that the extinction risk facing sDPS green sturgeon is negligible over a long term (~100 year) time horizon; therefore the sDPS is not believed to be viable. To support this statement, the population viability analysis (PVA) that was done for sDPS green sturgeon in relation to stranding events (Thomas et al. 2013) may provide some insight. While this PVA model made many assumptions that need to be verified as new information becomes available, it was alarming to note that over a 50-year time period the DPS declined under all scenarios where stranding events were recurrent over the lifespan of a green sturgeon.

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010a).

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their habitat needs.

Southern DPS of North American Green Sturgeon Critical Habitat

Critical habitat was designated for the sDPS green sturgeon on October 9, 2009 (74 FR 52300). A full and exact description of all sDPS green sturgeon critical habitat, including excluded areas, can be found at 50 CFR 226.219. Critical habitat includes the stream channels and waterways in the Delta to the ordinary high water line. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for sDPS green sturgeon.

Critical habitat for sDPS green sturgeon includes principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. PCEs for

sDPS green sturgeon have been designated for freshwater riverine systems, estuarine habitats, and nearshore coastal areas. In keeping with the focus on the California CV, we will limit our discussion to freshwater riverine systems and estuarine habitats.

Freshwater Riverine Systems

1. Food Resources

Abundant food items for larval, juvenile, subadult, and adult life stages for sDPS green sturgeon should be present in sufficient amounts to sustain growth, development, and support basic metabolism. Although specific information on food resources for green sturgeon within freshwater riverine systems is lacking, they are presumed to be generalists and opportunists that feed on similar prey as other sturgeons (Israel and Klimley 2008). Seasonally abundant drifting and benthic invertebrates have been shown to be the major food items of shovelnose and pallid sturgeon in the Missouri River (Wanner *et al.* 2007), lake sturgeon in the St. Lawrence River (Nilo *et al.* 2006), and white sturgeon in the lower Columbia River (Muir *et al.* 2000). As sturgeons grow, they begin to feed on oligochaetes, amphipods, smaller fish, and fish eggs as represented in the diets of lake sturgeon (Nilo *et al.* 2006), pallid sturgeon (Gerrity *et al.* 2006), and white sturgeon (Muir *et al.* 2000).

2. Substrate Type or Size

Critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development, larval development, subadults, and adult life stages. For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.* 1991, Moyle *et al.* 1995). Eggs are likely to adhere to substrates, or settle into crevices between substrates (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Larvae exhibited a preference for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2006).

3. Water Flow

An adequate flow regime is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11°C - 19°C) (Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs [average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown (2007)]. In Oregon's Rogue River, nDPS green sturgeon have been shown to emigrate to sea during the autumn and winter when water temperatures dropped below 10° C and flows increased (Erickson *et al.* 2002). On the Klamath

River, the fall outmigration of nDPS green sturgeon has been shown to coincide with a significant increase in discharge resulting from the onset of the rainy season (Benson *et al* 2007). On the Sacramento River, flow regimes are largely dependent on releases from Shasta Dam, thus the operation of this dam could have profound effects upon sDPS green sturgeon habitat.

4. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics are necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures would include: stable water temperatures within spawning reaches; temperatures within 11°C - 17°C (optimal range = 14°C - 16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004, Allen *et al.* 2006). Suitable salinity levels range from fresh water (< 3 ppt) for larvae and early juveniles to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Adequate levels of dissolved oxygen (DO) are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles, Allen and Cech (2007). Suitable water quality would also include water with acceptably low levels of contaminants (*i.e*., pesticides, organochlorines, selenium, elevated levels of heavy metals, *etc*.) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Poor water quality can have adverse effects on growth, reproductive development, and reproductive success. Studies on effect of water contaminants upon green sturgeon are needed; studies performed upon white sturgeon have clearly demonstrated the negative impacts contaminants can have upon white sturgeon biology (Foster *et al.* 2001a, 2001b, Feist *et al.* 2005, Fairey *et al.* 1997, Kruse and Scarnecchia 2002). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin, and the CV and Delta.

5. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning and rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

6. Depth

Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River upstream of GCID. The significance and purpose of these aggregations are unknown at the present time, but may be a behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from

high water temperatures (Erickson *et al.* 2002, Benson *et al.* 2007). As described above approximately 54 pools with adequate depth have been identified in the Sacramento River upstream of the GCID location.

7. Sediment Quality

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides] that can result in negative effects on any life stage of green sturgeon or their prey. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. The San Joaquin River is a source for many of these same contaminants, although pollution and runoff from agriculture are the predominant driving force. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate he sequestered contaminants into the river. This is a continuing concern throughout the watershed.

For Estuarine Habitats

1. Food Resources

Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages are required for the proper functioning of this PCE for green sturgeon. Green sturgeon feed primarily on worms, mollusks, and crustaceans (Moyle 2002). Radtke (1966) studied the diet of juvenile sDPS green sturgeon and found their stomach contents to include a mysid shrimp, amphipods, and other unidentified shrimp. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. Currently, the estuary provides these food resources, although annual fluctuations in the population levels of these food resources may diminish the contribution of one group to the diet of green sturgeon relative to another food source.

Invasive species are a concern because they may replace the natural food items consumed by green sturgeon. The Asian overbite clam (*Corbula amurensis*) is one example of a prolific invasive clam species in the Delta. It has been observed to pass through white sturgeon undigested (Kogut 2008).

2. Water Flow

Within bays and estuaries adjacent to the Sacramento River (*i.e.*, the Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay

and to initiate the upstream spawning migration into the upper river. The specific quantity of flow required is a topic of ongoing research.

3. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C (75°F). At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen *et al.* 2006). Suitable salinities in the estuary range from brackish water (10 ppt) to salt water (33 ppt). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.* 2007). Subadult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007).

Suitable water quality also includes water free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

4. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. Within the waterways comprising the Delta, and bays downstream of the Sacramento River, safe and unobstructed passage is needed for juvenile green sturgeon during the rearing phase of their life cycle. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, safe and unobstructed passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean. Currently, safe and unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP, responsible for large volumes of water diversions, alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and Fish Facilities. Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their operations of cooling water diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the Delta Cross Channel (DCC) facilities alter migration corridors available to

green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

5. Water Depth

A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep (≥ 5 m) holding pools within bays, estuaries, and freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia (Benson *et al.* 2007). Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters with depths of less than 10 meters, either swimming near the surface or foraging along the bottom (Kelly *et al.* 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 3 – 8 feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966).

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are composed of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive "flats" occur in the lower reaches of the Sacramento and San Joaquin river systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

6. Sediment Quality

Sediment quality (*i.e.*, chemical characteristics) is necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants (*e.g.*, elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause negative effects on all life stages of green sturgeon (see description of *sediment quality* for riverine habitats above).

Summary of the Conservation Value of Green Sturgeon Critical Habitat

The current condition of critical habitat for the green sturgeon sDPS is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species, especially in the upstream riverine habitat. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the green sturgeon sDPS evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as described for winter-run Chinook salmon critical habitat. In addition, the alterations to the lower Sacramento River and delta may have a particularly strong impact on the survival and

recruitment of juvenile green sturgeon due to the protracted rearing time in the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes, which can ultimately impact the potential population structure for decades.

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The environmental baseline describes the status of listed species and critical habitat in the action area, to which we add the effects of the Common Features GRR, to consider the effects of the proposed Federal actions within the context of other factors that impact the listed species. The effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the status of listed species and, for non-Federal activities in the action area, those actions that are likely to affect listed species in the future, to determine if implementation of the Common Features GRR is likely to cause an appreciable reduction in the likelihood of both survival and recovery or result in destruction or adverse modification of critical habitat.

Reaches throughout the Common Features GRR planning area historically provided both shallow and deeper water habitat. Channel confining levees and upstream reservoirs that maintain year-round outflow have eliminated much of the adjacent shallow water floodplain habitat. Many native fish species are adapted to rear in flooded, shallow water areas that provide abundant cover and prey. As a consequence of habitat alterations, and the introduction of non-native species and pollutants, some native fish species are now extinct while most others are reduced in numbers (Moyle 2002).

The Sacramento River watershed receives winter/early spring precipitation in the form of rain and snow (at higher elevations). Prior to the construction and operation of any reservoirs, winter rainfall events caused extensive flooding and spring snowmelt resulted in high flows during spring and early summer. Summer and fall flows were historically low. Currently, much of the total runoff is captured and stored in reservoirs for gradual release during the summer and fall months. High river flows occur during the winter and spring, but these are usually lower than during pre-European settlement times; summer and fall low flows are sustained by releases from upstream reservoirs.

The flood risk management system protecting the City of Sacramento has been identified as insufficient by the Corps. According to the Corps, there is a high probability that flows in the American and Sacramento Rivers will stress the network of levees protecting Sacramento to the point that levees could fail. Failure of these levees could inundate highly urbanized areas up to 20 feet deep.

Sixteen land cover types were identified in the Common Features GRR project area. Nine of the land cover types are considered natural communities: all four riparian habitats, emergent marsh, valley oak woodland, walnut woodland, nonnative annual grassland, pond, and perennial drainage. The other cover types are associated with human activities: all three agricultural field types, walnut orchard, agricultural ditch, and developed/landscaped.

Despite the impaired status of the Sacramento and American Rivers in the proposed project action area, the value of the lower Sacramento River as a migratory corridor for CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and sDPS green sturgeon is high primarily because it contains habitat elements that support the rearing and growth of juveniles and the successful upstream migration of adults. The same high value can be attributed to the American River for both CV spring-run and sDPS green sturgeon. The Common Features GRR will occur downstream of the confluence of major watersheds, including the American, Yuba, and Feather river and watersheds further upstream such as Butte Creek and Battle Creek. Thus, the action area is also within the migratory corridor for the fish that utilize all the aforementioned watersheds.

Anticipated climate change may affect spatial and temporal precipitation patterns along with the intensity and duration of precipitation within the Sacramento and American River watersheds. The effect of climate change is anticipated to be more winter and less spring and summer run-off within the watershed. In addition, expected run-off is anticipated to be warmer, possibly affecting the ability to meet downstream water temperature objectives to protect salmon, steelhead, and green sturgeon. This combined with more precipitation as rain will affect future operations of all reservoirs within the California CV. A change in the run-off pattern within the Sacramento and American River watersheds will likely affect reservoir storage and downstream river flows due to more frequent spillway releases.

This same flood management system impacts the natural meander and ecosystem of the Sacramento and American Rivers. The Common Features Project study area includes the mainstem The Common Features GRR action area includes the mainstem Sacramento River from Freeport (RM 46) in the Delta upstream to the American River confluence (RM 60). The region also includes the lower American River from the confluence with the Sacramento River upstream to RM 11, NEMDC, Arcade Creek, Dry/Robla Creeks and Magpie Creek.

Downstream from the American River confluence, the Sacramento River is moderately sinuous, with the channel confined on both sides by man-made levees enhanced by decades of man-made additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). Channel migration is similarly limited along the lower American River because of man-made levees and regulated flows from Folsom and Nimbus Dams.

The natural banks and adjacent floodplains of both rivers are composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the rivers, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass (RM 63). Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

NEMDC is an approximately 13.3-mile, human-made, partially leveed drainage channel that provides drainage from Sankey Road and connects streams of the American Basin (Dry, Robla, and Arcade Creeks) to the American River. South of the confluence with Arcade Creek, the east and west levees of NEMDC are dominated by wild oats grasslands, while the channel is characterized by Fremont cottonwood forest, with smaller amounts of valley oak woodland, smart-weed cocklebur patches, and perennial rye grass fields.

The approximately 16.2-mile-long channel of Arcade Creek extends east-to-west from Orangevale to the American River, via NEMDC. The north and south levees are dominated by wild oats grasslands. Valley oak woodland is the main riparian vegetation type along Arcade Creek, but Fremont cottonwood forest occurs in small patches along the easternmost reach of Arcade Creek near NEMDC. Hardstem bulrush marsh is found within Arcade Creek near Norwood Avenue while water primrose wetlands are predominant within the channel of Arcade Creek from approximately the confluence with NEMDC to Norwood Avenue. East of Norwood Avenue, the creek channel becomes narrower, and dominated by a shaded canopy of valley oak woodland.

The environmental baseline in the Common Features GRR action area also includes the sites completed under the WRDA 1996 and WRDA 1999 authorizations for the project. The WRDA 1996 construction included installing slurry walls in the American River levees to address seepage and slope stability concerns. The WRDA 1999 construction included shape and slope improvements to specific reaches of the American River levee system, and some segments of the Sacramento River levees.

The Common Features Project study area consists of primarily riparian forest, valley oak woodland, riparian scrub-shrub habitat, and typically non-native annual grassland. Early riparian habitat may be called scrub-shrub. Scrub-shrub generally refers to areas where the woody riparian canopy is composed of trees or shrubs approximately 20 feet high. Species that are typically found in these habitats include young cottonwood (*Populus trichocarpa*), willow (*Salix spp.*), elderberry (*Sambucus spp.*), buttonbush (*Cephalanthus occidentalis*), Himalaya blackberry (*Rubus armeniacus*), wild grape (*Vitis vinifera*), and poison oak (*Toxicodendron spp.*).

Riparian forest typically has a dominant overstory of cottonwood, California sycamore (*Platanus racemosa*), or valley oak (*Quercus lobata*). Species found in the scrub-shrub will make up the sub canopy and could also include white alder and box elder. Layers of climbing vegetation make up part of the subcanopy, with wild grape being a major component, but wild cucumber and clematis are also found in riparian communities.

The herbaceous ruderal habitat is found on most levees along the Sacramento River. It occurs on the levees and also within gaps in the riparian habitats. Plant species include wild oats (*Avena spp.*), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus hordeaceus*), red brome (*Bromus madritensis*), wild barley (*Bromus hordeaceus)*, and foxtail fescue (*Festuca megalura*). Common forbs include broadleaf filaree (*Erodium spp.*), red stem filaree (*Erodium spp.*), turkey mullein (*Eremocarpus setigerus*), clovers (*Trifolium spp.*), and many others. The majority of these plants are not native to the project area.

Riparian recruitment and establishment models (Mahoney and Rood 1998; Bradley and Smith 1986) and empirical field studies (Scott et al. 1997, 1999) emphasize that hydrologic and fluvial processes play a central role in controlling the elevational and lateral extent of riparian plant species. These processes are especially important for pioneer species that establish in elevations close to the active channel, such as cottonwood and willows (*Salix* spp.). Failure of cottonwood recruitment and establishment is attributed to flow alterations by upstream dams (Roberts et al. 2001) and to isolation of the historic floodplain from the river channel. In addition, many of these formerly wide riparian corridors are now narrow and interrupted by levees and weirs. Finally, draining of wetlands, conversion of floodplains to agricultural fields, and intentional and unplanned introduction of exotic plant species have altered the composition and associated habitat functions of many of the riparian communities that are able to survive under current conditions.

2.3.1 Status of the Species in the Action Area

The action area, which encompasses portions of the lower Sacramento River and lower American River, and associated floodplains and riparian areas at and adjacent to the proposed construction sites functions as a migratory corridor for CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. The action area is also used for rearing and adult feeding.

1. Presence of CCV Steelhead in the Action Area

The CCV steelhead DPS final listing determination was published on January 5, 2006 (71 FR 834) and included all naturally spawned populations of steelhead (and their progeny) downstream of natural and manmade barriers in the Sacramento and San Joaquin rivers and their tributaries. FRFH steelhead are also included in this designation. All adult CCV steelhead originating in the Sacramento River watershed will have to migrate through the action area in order to reach their spawning grounds and to return to the ocean following spawning. Likewise, all CCV steelhead smolts originating in the Sacramento River watershed will also have to pass through the action area during their emigration to the ocean. The waterways in the action area also are expected to provide some rearing benefit to emigrating steelhead smolts. The CCV

steelhead DPS occurs in both the Sacramento River and the San Joaquin River watersheds. However the spawning population of fish is much greater in the Sacramento River watershed and accounts for nearly all of the DPS' population.

CCV steelhead smolts will first start to appear in the action area in November. This is based on the records from the CVP and SWP fish salvage facilities, as well as the fish monitoring program in the northern and central Delta. Their presence increases through December and January, peaks in February and March, and declines in April. By June, the emigration has essentially ended, with only a small number of fish being salvaged through the summer at the CVP and SWP. Adult steelhead are expected to move through the action area throughout the year with the peak of upriver immigration expected to occur August through November. There is potential exposure to adult steelhead moving back downstream in a post-spawn condition (kelts) through the action area during the February to May period. It is expected that more kelts will be observed earlier in the period (February) due to the timing of spawning in the Sacramento River basin.

Based on the temporal presence of adult and juvenile steelhead in the lower Sacramento and American Rivers, the timing of the proposed project, and the location of the action area, it is likely that adult steelhead will be using the action area as a migration corridor during construction. Additionally, it is likely that juvenile steelhead may be emigrating through the action area during construction. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile CCV steelhead may be present in the Yolo Bypass and the Sacramento Bypass.

2. Presence of CV spring-run Chinook salmon in the Action Area

A similar application of the CVP and SWP salvage records and the northern and Central Delta fish monitoring data to the presence of CV spring-run Chinook salmon indicates that juvenile spring-run Chinook salmon first begin to appear in the action area in December and January, but that a significant presence does not occur until March and peaks in April. By May, the salvage of juvenile CV spring-run Chinook salmon declines sharply and essentially ends by the end of June. The data from the northern and central Delta fish monitoring programs indicate that a small proportion of the annual juvenile spring-run emigration occurs in January and is considered to be mainly composed of older yearling spring-run juveniles based on their size at date. Adult spring-run Chinook salmon are expected to start entering the action area in approximately January. Low levels of adult migration are expected through early March. The peak of adult spring-run Chinook salmon movement through the action area is expected to occur between April and June with adults continuing to enter the system through the summer. Currently, all known populations of CV spring-run Chinook salmon inhabit the Sacramento River watershed.

Based on the temporal presence of CV spring-run Chinook salmon in the lower Sacramento and American River, the timing of the proposed project, and the location of the action area, it is likely that adult and juvenile CV spring-run Chinook salmon will be using the action area. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile CV spring-run Chinook salmon may be present in the Yolo Bypass and the Sacramento Bypass. It is possible that any CV spring-run Chinook salmon (particularly adults) that arein the lower Sacramento River may enter into the American River.

3. Presence of Sacramento River winter-run Chinook salmon in the Action Area

The temporal occurrence of Sacramento River winter-run Chinook salmon smolts and juveniles within the action area are best described by a combination of the salvage records of the CVP and SWP fish collection facilities and the fish monitoring programs conducted in the northern and central Delta. Based on salvage records at the CVP and SWP fish collection facilities, juvenile Sacramento River winter-run Chinook salmon are expected in the actions area starting in December. Their presence peaks in March and then rapidly declines from April through June. The majority of winter-run juveniles will enter the action area during February through June. Presence of adult Chinook salmon is interpolated from historical data. Adult winter-run Chinook salmon are expected to enter the action area starting in January, with the majority of adults passing through the action area between February and April.

Based on the temporal presence of Sacramento River winter-run Chinook salmon in the lower Sacramento River, the timing of the proposed project, and the location of the action area, it is likely that adult and juvenile Sacramento River winter-run Chinook salmon will be using the action area. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile Sacramento River winter-run Chinook salmon may be present in the Yolo Bypass and the Sacramento Bypass. It is possible that any Sacramento River winter-run Chinook salmon (particularly adults) that are in lower Sacramento River may enter into the American River.

4. Presence of sDPS green sturgeon in the Action Area

The Sacramento River and a portion of the American River serve as an important migratory corridor for larval and juvenile sturgeon during their downstream migration to the San Francisco Bay Delta and Estuary. The San Francisco Bay Delta and Estuary provides year-round rearing habitat for juveniles, as well as foraging habitat for non-spawning adults and subadults in the summer months (NMFS 2008).

Detailed information regarding historic and current abundance, distribution and seasonal occurrence of SDPS green sturgeon in the action area is limited due to a general dearth of green sturgeon monitoring. The action area is located on the main migratory route for adults moving upstream to spawn, post spawn adults migrating back to the ocean, juvenile outmigrants, and rearing subadults. Juvenile green sturgeon from the sDPS are routinely collected at the SWP and CVP salvage facilities throughout the year. Based on the salvage records, green sturgeon may be present during any month of the year, and have been particularly prevalent during July and August. Adult green sturgeon begin to enter the Delta in late February and early March during the initiation of their upstream spawning run. The peak of adult entrance into the Delta appears to occur in late February through early April with fish arriving upstream in April and May. Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn. It is also possible that some adult green sturgeon will be moving back downstream in April and May through the action area, either as early post spawners or as unsuccessful spawners. Some adult green sturgeon have been observed to rapidly move back downstream following spawning, while others linger in the upper river until the following fall. It is possible that any of the adult or

sub-adult sturgeon that inhabit the lower Sacramento River may swim into the American River. Similar to the salmonid species, depending on the water year type, it is possible that sturgeon will enter the Sacramento and Yolo bypass.

2.3.2 Status of Critical Habitat within the Action Area

The action area occurs within the USGC Hydrologic Unit Code (HUC) Lake Greenhaven-Sacramento River subbasin designated HUC 180201630701. Designated critical habitat for Sacramento River winter-run Chinook salmon (June 16, 1993, 58 FR 33212), CV spring-run Chinook salmon (September 2, 2005, 70 FR 52488), CCV steelhead (September 2, 2005, 70 FR 52488) and the sDPS of green sturgeon (October 9, 2009, 74 FR 52300) occur in this hydrologic unit. The HUC includes portions of the Sacramento and American Rivers. The critical habitat analytical review team (CHART) concluded that it contained one or more PCEs for both the CCV steelhead DPS and CV spring-run Chinook salmon ESU (NMFS 2005). The PCEs for steelhead and spring-run Chinook salmon habitat within the action area include freshwater rearing habitat and freshwater migration corridors. The features of the PCEs included essential to the conservation of the CCV steelhead DPS and CV spring-run Chinook salmon include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by CCV steelhead and CV spring-run Chinook salmon juveniles and smolts and for adult freshwater migration. CCV steelhead also utilize the American River for spawning habitat.

Critical habitat for winter-run Chinook salmon includes the Sacramento River reach within the action area. Critical habitat elements include the river water, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. Downstream migration of juveniles and upstream migration of adults should not be impeded or blocked. Adequate forage base is required to provide food for emigrating juvenile winter-run.

In regards to the designated critical habitat for the sDPS of green sturgeon, the action area includes PCEs concerned with: adequate food resources for all life stages; water flows sufficient to allow adults, subadults, and juveniles to orient to flows for migration and normal behavioral responses; water quality sufficient to allow normal physiological and behavioral responses; unobstructed migratory corridors for all life stages; a broad spectrum of water depths to satisfy the needs of the different life stages present in the estuary; and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment.

The general condition and function of the aquatic habitat has already been described in the *Status of the Species and Critical Habitat* section of this BO. The substantial degradation over time of several of the essential critical elements has diminished the function and condition of the freshwater rearing and migration habitats in the action area. It has only rudimentary functions compared to its historical status. The channels of the lower Sacramento and American Rivers have been riprapped with coarse stone slope protection on artificial levee banks and these

channels have been straightened to enhance water conveyance through the system. The extensive riprapping and levee construction has precluded natural river channel migrations. The natural floodplains have essentially been eliminated, and the once extensive wetlands and riparian zones have been "reclaimed" and subsequently drained and cleared for farming.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. CCV steelhead adults migrate into the lower American River to spawn, which is within the Lake Greenhaven-Sacramento River HUC, and the resulting fry rear and hold over within the American river until they are ready to migrate out to the ocean. All juvenile winter-run and spring-run Chinook salmon, sDPS green sturgeon, as well as those CCV steelhead smolts originating in the Sacramento River basin must pass into and through the Lake Greenhaven-Sacramento River HUC to reach the lower Delta and the ocean. A large fraction of these fish will likely pass downstream through the action area within the Sacramento River channel. Likewise, adults migrating upstream to spawn must pass through Lake Greenhaven-Sacramento River HUC to reach their upstream spawning areas on the tributary watersheds or main stem Sacramento River. A large proportion of the population is expected to move through the action area within the main channel of the Sacramento River. Therefore, it is of critical importance to the long-term viability of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon ESUs, the sDPS of green sturgeon, and the Sacramento River basin portion of the CCV steelhead DPS to maintain a functional migratory corridor and freshwater rearing habitat through the action area and the Lake Greenhaven-Sacramento River HUC in general.

2.3.4 Factors Affecting the Species and Habitat in the Action Area

The action area encompasses a small portion of the area utilized by the Sacramento River winter-run and CV spring-run Chinook salmon ESUs, and the CCV steelhead DPS as well as the sDPS green sturgeon. Many of the factors affecting these species throughout their range are discussed in the *Rangewide Status of the Species and Critical Habitat* section of this BO, and are considered the same in the action area. This section will focus on the specific factors in the action area that are most relevant to the proposed project.

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (*i.e.* levees and bypasses). Consequently, managed flows in the main stem of the river often truncate the peak of the flood hydrograph and extended the reservoir releases over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize gravel and clean sediment from the spawning reaches of the river channel.

High water temperatures also limit habitat availability for listed salmonids in the lower Sacramento River. High summer water temperatures in the lower Sacramento River can exceed 72°F (22.2°C), and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson *et al*. 1982). In addition, water diversions at the dams (*i.e.* Friant, Goodwin, La Grange, Folsom, Nimbus, and other dams) for agricultural and municipal purposes have reduced in-river flows below the dams. These reduced flows frequently result in increased temperatures during the critical summer months which potentially limit the survival of juvenile salmonids in these tailwater sections (Reynolds *et al*. 1993). The elevated water temperatures compel many salmon juveniles to migrate out of the valley floor systems before summer heat makes the tailwaters unsuitable for salmonids. Those fish that remain either succumb to the elevated water temperatures or are crowded into river reaches with suitable environmental conditions.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and shaded riverine aquatic (SRA) cover. Individual bank protection sites typically range from a few hundred to a few thousand linear feet in length. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the accumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach. Revetted embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat. Impacts at the reach level result primarily from halting erosion and controlling riparian vegetation. Reach-level impacts which cause significant impacts to fish are reductions in new habitats of various kinds, changes to sediment and organic material storage and transport, reductions of lower food-chain production, and reduction in large woody debris (LWD).

The use of rock armoring limits recruitment of LWD (*i.e.*, from non-riprapped areas), and greatly reduces, if not eliminates, the retention of LWD once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of LWD to become securely snagged and anchored by sediment. LWD tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place to generate maximum values to fish and wildlife. Recruitment of LWD is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows. Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectedness of remaining near shore refuge areas.

Point and non-point sources of pollution resulting from agricultural discharge and urban and industrial development occur upstream of, and within the action area. The effects of these impacts are discussed in detail in the *Rangewide Status of the Species and Critical Habitat* section. Environmental stressors as a result of low water quality can lower reproductive success and may account for low productivity rates in fish (*e.g.* green sturgeon, Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element (*i.e.* heavy metals) concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995). Principle sources of organic

contamination in the Sacramento River are rice field discharges from Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough, and Jack Slough (USFWS 1995). Other impacts to adult migration present in the action area, such as migration barriers, water conveyance factors, water quality, NIS, *etc.*, are discussed in the *Rangewide Status of the Species and Critical Habitat* section.

As previously stated in the *Rangewide Status of the Species and Critical Habitat* section, the transformation of the Sacramento River from a meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes resulted in homogenization of the river, including effects to the rivers sinuosity. These impacts likely included the removal of valuable pools and holding habitat for SDPS green sturgeon. In addition, the change in the ecosystem as a result of the removal of riparian vegetation and LWD likely reduce access to floodplain and offchannel rearing habitat, reduced the quantity and quality of benthic habitat and reduced the abundance prey items rearing, foraging and holding habitat. A major factor in the decline of sDPS green sturgeon, and the primary reason for listing this species, was the alteration of its adult spawning and larval rearing habitat in California's Sacramento River Basin (71 FR 17757, April 7, 2006).

2.4 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (in this case there are no interrelated or interdependent actions), that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

To evaluate the effects of the Common Features GRR, NMFS examined the potential proposed actions in the designated action areas. We analyzed construction-related impacts and the expected short- and long-term fish response to habitat modifications using the SAM. We also reviewed and considered the Corps proposed conservation measures. This assessment relied heavily on the information from the Corps BA developed for the Common Features GRR, and available monitoring data from other CV fish studies.

In general, the footprint for the Common Features Project consists of the flood risk management system protecting the city of Sacramento and surrounding areas. This will include structure upgrades, levee deconstruction, and adjacent staging areas. The continued existence of any new or improved flood management structures, associated critical habitat disturbance, vegetation removal, and operational aspects may adversely affect several life stages of CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and the sDPS of SDPS green sturgeon in the action area.

The assessment will consider the nature, duration, and extent of the potential actions relative to the migration timing, behavior, and habitat requirements of federally listed CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and sDPS of SDPS green sturgeon. Specifically, this assessment will consider the potential impacts resulting from the construction and subsequent O&M activites. Effects of the Common Features Project

on aquatic resources include both short- and long-term impacts. Short-term effects, which are related primarily to construction activities (*i.e.*, increased suspended sediment and turbidity), may last several hours to several weeks. Long-term impacts may last months or years and generally involve physical alteration of the river bank and riparian vegetation adjacent to the water's edge.

The Common Features Project construction activities may increase noise, turbidity, suspended sediment, and sediment deposition that may disrupt feeding or temporarily displace fish from preferred habitat or impair normal behavior. Construction activities will also introduce rip rap material into the water column that may injure, harm, or kill listed fish. Some of these effects may occur downstream of the construction activities because noise and sediment may be propagated downstream. Substantial increases in suspended sediment could temporarily bury substrates and submerged aquatic vegetation that supports invertebrates for feeding juvenile fish.

The bank armoring and some of the levee repairs will also contribute to the continued confinement of the riverine system that in turn negatively impacts listed fish species and their designated critical habitat. Even with an ETL variance in place, adopting the ETL as part of the proposed project may have long-term impacts to critical habitat and listed species. Additionally, despite the assumption of a variance, there are uncertainties as to the subsequent O&M activities and their impacts.

Since specific project designs were not available at the time of this analysis, impacts are characterized using "worst case scenario" assumptions. With-project conditions were assumed to be analogous a typical SRBPP repair site (bank armoring paired with onsite restoration features including a planted riparian bench and installed IWM). A Vegetation Variance Request (VVR) was assumed to be in place. Project actions along the Sacramento Bypass and weir reaches, including slurry wall construction, slope stabilization, and levee raises, weir repair, and levee construction were assumed to result in removal of all woody and herbaceous vegetation and armoring of both summer-fall and winter-spring shorelines.

The Common Features project reach will be implemented in increments. The timing of each project sub-reach (Table 4) is based on the proposed schedule provided in the BA (USACE 2015). Some of the project increments will be of varying length, thereby impacting the subsequent analysis.

2.4.1 Construction Related Effects

NMFS expects that adult and juvenile CCV steelhead, adult winter-run Chinook salmon, adult spring-run Chinook salmon, and adult and juvenile green sturgeon may be present in the action area (although in low numbers because the construction window avoids periods of peak abundance) during construction activities. Only those fish that are holding adjacent to or migrating past the project sites will be directly exposed or affected by construction activities. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or harm by increasing the susceptibility of some individuals to predation by

temporarily disrupting normal behaviors, and affecting sheltering abilities. If an adult salmonid were to enter the action area, they will likely exhibit avoidance behavior in response to construction and associated activities.

Larger fish will likely respond to construction activities by quickly swimming away from the construction sites, and will escape injury. Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products could enter the waterway as a result of spills or leakage from machinery and injure listed salmonids, and green sturgeon. Petroleum products also tend to form oily films on the water surface that can reduce DO available to aquatic organisms. NMFS expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway.

Green sturgeon move to estuaries and the lower reaches of rivers between late winter and early summer, and ascend rivers to spawn in the spring and early summer. Adult green sturgeon may leave the rivers soon after spawning or hold in the river through the fall or winter (Heublein et al. 2009). Movement and foraging during downstream migration occurs at night for both larvae (approximately 10 days post-hatch) and juveniles (73 FR 52084; Cech *et al*. 2000, as cited in Reclamation 2008). Juvenile emigration reportedly occurs from May through September. Juveniles will experience the greatest exposure to construction activities.

Direct effects are defined as "the direct or immediate effects of the Proposed Action on the species or its habitat" (USFWS and NMFS, March 1998). Direct effects associated with in-river construction work will involve equipment and activities that will produce pressure waves, and create underwater noise and vibration, thereby temporarily altering in-river conditions.

Any increases in turbidity will most likely disrupt feeding and migratory behavior activities of juvenile salmonids (which CCV juvenile Steelhead have a high likely hood of being present).though their abundance is expected to be low). Turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to utilize visual cues (Sillman *et al.* 2005). Green sturgeon, which can occupy waters containing variable levels of suspended sediment and thus turbidity, are not expected to be impacted by the slight increase in the turbidity levels anticipated from the pile driving action as explained above. The construction activities are unlikely to impact any deepwater areas where the species spawn and hold.

NMFS expects that actual physical damage or harassment to listed fish species will be low during the months of construction. Adults will not sustain any physical damage due to construction because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance that occurs during typical daylight construction hours.

2.4.2 Standard Assessment Methodology Analysis

Common Features Project impacts were analyzed using SAM. The Corps provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the federally protected fish species relevant to this consultation. The Corps also included analysis for fall-run and late-fall run Chinook salmon.

The Sacramento River SAM analysis reach includes the entire left bank (east side) of the Sacramento River from the American River confluence to approximately 4,020 linear feet (lf) below the Freeport Bridge. The American River SAM analysis (ARN A-B and ARS A-C) reaches include portions of the right and left bank of the American River from Goethe Park to the confluence of the Sacramento. It also includes portions of NEMDC, Arcade Creek, Magpie Creek, and Dry/Robla Creek.

As described in the *Analytical* Approach section of the BO, during the process of this consultation, the Corps and NMFS identified several short comings with the SAM as a tool for reliably forecasting the growth and survival of green sturgeon. The primary short coming is that the SAM evaluates habitat conditions at the seasonal water surface intersect with the river bank. While this is considered an effective point for measuring salmon and steelhead habitat, green sturgeon have a greater affinity for benthic habitat than shoreline habitat. Further, during discussions between the Corps and NMFS, it was widely agreed upon that levee repair actions in the West Sacramento Study Area are likely to only affect the juvenile rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present and adults that are migrating upstream are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. Because of this, NMFS has decided to use the SAM as a temporary proxy for quantifying habitat disturbance and harm that will ultimately be replaced by a more precise model as proposed by the Corps in the *Proposed Action* section of this BO.

The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the Common Features Project area under baseline conditions:

1. The Corps' Sacramento River revetment database.
2. Aerial images of the Common Features Project reach (Google™ Earth).

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of listed fish species:

1. Bank slope;
2. Floodplain availability;
3. Bank substrate size;
4. Instream structure;
5. Aquatic vegetation; and
6. Overhanging shade.

The following describes how input values for each of these attributes were derived for existing conditions in the SAM assessment.

1. **Bank Slope:** Existing bank slopes (rise-over-run ratio) were extrapolated from cross sections along the Sacramento River and existing SAM analyses performed on regionally analogous sites. Bank slope along all sub-reaches was assumed to be 2.5 for existing conditions.

2. **Floodplain Availability:** The SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to have a value of 1, reflecting the absence of significant floodplain habitat above the winter-spring shoreline under existing conditions.

3. **Bank Substrate Size:** The median substrate size along the summer-fall and winter-spring shorelines of the project reach was determined by referencing the Revetment Database (USACE 2004) and current and historical aerial images.

4. **Instream Structure:** The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines of the Common Features project reach were determined by referencing the revetment database (USACE 2004). The revetment database uses four classes of instream structure, based on ranges of percent shoreline having IWM.

5. **Overhanging Shade:** The extent of overhanging shade along the summer-fall and winter-spring shorelines was determined through analysis of current and historic aerial images. Summer-fall conditions were analyzed using imagery from late summer and early fall months, typically representative of low water conditions. Winter-spring conditions were analyzes using imagery from late winter and early spring months, typically representative of high water conditions.

The following describes how input values for each of the SAM habitat attributes were derived for with-project conditions:

1. **Bank Slope:** With-project bank slopes (rise-over-run ratio) were based on the description of project actions for each sub-reach. Bank slopes for the SAC sub-reach were assumed to be analogous to SRBPP repair sites.

2. **Floodplain Availability:** Levee repair and bank stabilization actions typically do not increase floodplain availability (with exception of constructing setback levees). The Common Features project reaches being analyzed under this SAM do not include construction of any setback levees; therefore, the SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to lack significant floodplain habitat above the winter-spring shoreline under existing conditions.

3. **Bank Substrate Size:** The median substrate size along the summer-fall and winter-spring shorelines of the project reach were based on the description of project actions

for each reach. Bank substrate size along the Sacramento River reach was assumed to be analogous to SRBPP repair sites. Project actions at all other sub-reaches were expected to result in placement of 10 inch rock revetment along both summer-fall and winter-spring shorelines.

4. **Instream Structure:** The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. IWM coverage along the SAC sub-reach was assumed to be analogous to SRBPP repair sites (installation of 40 percent shoreline coverage at summer-fall shoreline). Project actions at all other sub-reaches were not expected to result in a change in available IWM along both summer-fall and winter-spring shorelines; IWM values for these sub-reaches will mirror existing condition values.

5. **Aquatic Vegetation:** The shoreline coverage of aquatic vegetation along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Aquatic vegetation along the Sacramento River was assumed to be analogous to SRBPP repair sites. The vegetation growth model below that was applied to the Sacramento River was taken from a previous SAM analysis conducted for Sacramento RM 62.5R (USACE 2008).

6. **Overhanging Shade:** The shoreline coverage of overhanging shade along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Overhanging shade along the Sacramento River was assumed to be analogous to SRBPP repair sites. It was assumed that a variance will be in place allowing for retention of woody vegetation along the lower 2/3 of the levee slope (applies to Sacramento River only). As the result of constructing a planted bench, it was assumed that the with-project seasonal shoreline will be shifted away from the existing shade providing canopy. Under this assumption, existing summer-fall values for overhanging shade were taken as the starting point for with-project winter-spring conditions. The with-project winter-spring values were further reduced by 75 percent (winter) and 25 percent (spring) to account for defoliation. As a final step, these winter-spring values were reduced by 20 percent to account for trees removed for construction equipment access. With-project overhanging shade values were expected to start at 0 percent as the result of a constructed bench shifting the shoreline away from the existing canopy. The shade growth model used was taken from a previous SAM analysis conducted for Sacramento RM 62.5R (USACE 2008).

Project actions at all other sub-reaches were expected to result in a complete removal of woody vegetation without revegetation efforts. For these sub-reaches, a value of 0 percent shoreline coverage of overhanging shade was applied throughout the life of the project along both summer-fall and winter-spring shorelines.

For more information on the SAM analysis and inputs, refer to the Appendix A.

2.4.3 SAM Results

The SAM results presented below and in Table 10, 11, and 12 are based on a "worst case scenario" analysis, as developed by the Corps. Table 10 and 11 show negative WRI values, but there are several areas where the action will result in improved conditions for salmon and steelhead. These are discussed below, and are summarized in Appendix A table 26, 27, and 28. The with-project conditions for the focus fish species and life stages were evaluated over a 50-year assessment timeline with baseline habitat values for each species and life stage described by pre-project conditions. Biological responses of each focus fish species life stage and average seasonal water surface elevation were predicted within each habitat unit and for each time step, based on habitat variable values and fish residency determined from region-specific timing tables (USACE 2012b). This analysis automatically includes or excludes particular life stages of the focus fish by assessing the river mile locations of each bank repair site, with the encoded timing tables. In general, as calculated, positive differences between the existing and with-project responses are considered to result in improved growth and survival for the focus fish species (*i.e.*, the bank repair action produced superior conditions than pre-project conditions). Negative values indicate the bank repair actions produced inferior conditions when compared with pre-project conditions and reduced growth and survival over a 30 day exposure period. In almost all cases, regardless of the integrated conservation and compensation measures (*i.e.*, installation of IWM, planting riparian habitat, and construction of engineered floodplain) there is a short-term temporal negative habitat impact associated with many of the bank repair activities, mainly because new levee configurations move the river bank away from existing, protected riparian vegetation and because it takes several years for newly planted riparian vegetation to growth out over the river channel and create overhanging shade and other benefits to aquatic habitat such as a source of macroinvertebrate production.

American River

NMFS reviewed the SAM results provided by the Corps. Details of the SAM results can be found Appendix A of this document. This includes tables and graphs of the SAM results from year 0 (beginning of construction) to year 50. Tables 10, 11, and 12 summarize all negative Common Features Project SAM WRI values for Chinook salmon, steelhead, and green sturgeon. It is important to note that when interpreting SAM results, year 0 refers to the year of construction.

Summary of CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead and sDPS green sturgeon effects by water surface elevation per location:

Common Features American River North Reaches A and B:

At fall water surface elevations:

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and

extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The adverse effects are greatest in the first 3 to 5 years for each species at -366 WRI, -712, and -5577, respectively.

Reduced growth and survival of juvenile migrating (smolts) CV spring-run Chinook salmon is expected to extend past 50 years after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this adverse effect is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The adverse effect is greatest at -2303 WRI.

The SAM displays reduced survival of adult migrating CCV steelhead is expected for up to 48 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this potential effect is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The adverse effect is greatest at -1554 WRI and exceeds baseline following year 48 to a maximum increase benefit of 8 WRI.

At winter surface elevations:

Increased growth and survival of fry and juvenile rearing CV spring-run Chinook salmon is expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size reaching a maximum of 1,102 WRI. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO.

Reduced growth and survival of fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The adverse effects are greatest at -36 WRI for steelhead in the first year and the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year one, survival and growth values improve to 1507 for CCV steelhead. The adverse effects to sDPS green sturgeon are greatest at -5020 and are expected to extend past 50 years.

Reduced growth and survival of migrating (smolts) CV spring-run Chinook salmon is expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The adverse effects are greatest at -3,002 WRI. At year 2, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching 1,699 WRI.

The SAM displays reduced survival of adult migrating CCV steelhead for up to 5 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this potential effect is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The adverse effect is greatest at -1554 WRI. At year 5, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching 460 WRI.

Reduced survival of adult residence CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The adverse effect is greatest at -1,558 and -3,621 WRI, respectively. At year 5 for CCV steelhead, the SAM modeled habitat conditions exceed baseline conditions and improves growth and survival conditions are expected, reaching 460 WRI.

At spring water surface elevations:

Increased growth and survival of fry and juvenile rearing CV spring-run Chinook salmon occurs after any construction activities by the first year and reaching a maximum of 1354 WRI. Increased growth and survival of fry and juvenile are expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO.

Reduced growth and survival of fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction due to impacts to riparian habitat IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The adverse effects are greatest at -2681 and -5020, respectively. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1418 WRI. The adverse effects to sDPS green sturgeon are greatest at -5020 WRI and are expected to extend past 50 years.

Reduced growth and survival of juvenile migrating (smolts) CV spring-run Chinook salmon and CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The adverse effects are greatest at -3129 and -2096 WRI, respectively. At year 4, for CV spring-run Chinook salmon, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching 1,699 WRI. At year 2, for CCV steelhead, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching 1173 WRI.

The SAM displays reduced survival of adult migrating CCV steelhead after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this potential effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The adverse effect is greatest at -1635 WRI. At year 6, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching 407 WRI.

Reduced survival of adult resident CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO.

The adverse effects are greatest at -1635 WRI for CCV steelhead in the first six years and the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After six years, survival and growth values improve to 407 for CCV steelhead.

At summer surface elevations:

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The adverse effects are greatest for each species at -421 WRI, -833, and -7118, respectively.

Reduced growth and survival of juvenile migrating (smolts) of CV spring-run Chinook salmon and CCV steelhead are expected to extend past 50 years after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of these adverse effects are quantified in the SAM in table 26 in Appendix A and summarized in table 10 of this BO. The adverse effects are greatest at -3,129 and -3013 WRI, respectively.

Reduced survival of adult resident CV steelhead is expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM and, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The adverse effects on the species are greatest at -3061 WRI, and -942, respectively.

American River South Bank sites A, B, and C

At fall surface elevations:

Reduced growth and survival of fry and juvenile rearing CV spring run Chinook salmon, CCV steelhead, and sDPS green sturgeon are expected after any construction activities due to impacts riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The adverse effects are greatest for each species at -229 WRI, -489, and -2154, respectively. At year 26 for CV spring run Chinook salmon and year 36 for CCV steelhead, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 112 WRI and 88, respectively. The adverse effects to sDPS green sturgeon are greatest at -2154 and are expected to extend past 50 years.

Reduced growth and survival of juvenile migrating (smolts) CV spring run Chinook salmon is expected after any construction due to impacts riparian habitat, IWM, and bank substrate size. The amount and extent of this adverse effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The adverse effect is greatest at -620 WRI. After year 21, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected reaching a maximum of 526 WRI.

The SAM displays increased survival of adult migrating CV steelhead after construction activities due to impacts), IWM, and bank substrate size. The amount and extent of this potential effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The increased benefit maximizes at 3696 of WRI.

Increased survival of adult resident CCV steelhead is expected after construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The maximum increase benefit is for the species is 3696 and WRI and 1548, respectively.

At winter water surface elevations:

Increased growth and survival of fry and juvenile rearing CV spring run Chinook salmon occurs after any construction activities by the first year and reaching a maximum of 1578 WRI. The amount and extent of this effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO.

Reduced growth and survival of fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction due to impacts to riparian habitat IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The adverse effects are greatest at – 489 WRI and – 876, respectively. At year 36, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 88 WRI. At year one, the SAM modeled habitat conditions for sDPS green sturgeon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 2941 WRI.

Increased growth and survival of juvenile migrating (smolts) CV spring run Chinook salmon is expected to occur after construction activities due to impacts on riparian habitat, IWM and, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The maximum increase benefit for this species is 5377 WRI.

The SAM displays increased survival of adult migrating CCV steelhead after construction activities due to impacts on riparian habitat, IWM and, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The increased benefit maximizes at 4015.

Increased survival of adult resident CV steelhead is expected to occur after construction activities, the maximum increase benefit for this species is 4015 WRI.

At spring water surface elevations:

Increased growth and survival of fry and juvenile rearing CV spring run Chinook salmon and CCV steelhead occurs starting at year 0 and increased to the maximum above baseline scores of 2,100 and 2,601 WRI, respectively. Reduced growth and survival of fry and juvenile rearing

sDPS green sturgeon is expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of these effects are quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The greatest adverse effect is at -876 WRI. At year 1, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 2,941 WRI.

Increased growth and survival of juvenile migrating (smolts) CV spring run Chinook salmon and CV steelhead is expected due to impacts on riparian habitat, IWM, and bank substrate size. The greatest effects for each species is 5123 WRI and 4061 WRI respectively. The amount and extent of this potential effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO.

The SAM displays increased survival of adult migrating CCV steelhead after the first year of construction due to impacts on riparian habitat, IWM, and bank substrate size the amount and extent of this potential effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The maximum benefit is 4164 WRI.

Increased survival of resident CCV steelhead occurs starting at year 0 and increased to above baseline 4164 WRI due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of these effects are quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO.

Increased survival of adult resident CV steelhead is expected to occur after construction activities, the maximum increase benefit for this species is 4015 WRI.

At summer water surface elevations:

Reduced growth and survival of fry and juvenile rearing CV spring run Chinook salmon, CCV steelhead, and sDPS green sturgeon are expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The adverse effects are greatest at – 239, -512, and – 2496 WRI, respectively. At year 26, the SAM modeled habitat conditions for CV spring run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 111 WRI. At approximately year 6, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 64 WRI. The adverse effects to sDPS green sturgeon are expected to extend past 50 years.

Reduced growth and survival of juvenile migrating (smolts) CV spring run Chinook salmon and CCV steelhead are expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of these effects are quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The adverse effects are greatest at -967 and -722 WRI, respectively. At year 22, the SAM modeled habitat conditions for CV spring run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 510 WRI. At year 25, the SAM modeled habitat

conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 583 WRI.

Increased survival of adult resident CCV steelhead is expected after construction activities due to impacts on riparian habitat, IWM, and bank substrate size, with maximum benefits of 3616 and 1537 WRI, respectively. The amount and extent of this effect is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO.

Project actions along portions of the American River reach will likely not include bank armoring in their final design, which will significantly reduce estimated impacts to fish species. Additional compensatory mitigation design features or improved erosion repair designs may result in reduced impact compared to the legacy designs used for the basis of this analysis. Site specific designs will be implemented on a site by site basis in consultation with resource agencies and project partners to minimize impacts as well as maximize opportunities for implementing onsite compensatory mitigation features.

The Corps has proposed to offset the effects with onsite and offsite compensation. During project implementation, site specific SAM analyses will be run on final designs to better evaluate these effects. These offsets are likely to improve growth and survival of Chinook salmon and steelhead at higher value habitats in the Delta and along their primary migration corridor of the Sacramento and American Rivers, and spawning and rearing areas along the American River.

Sacramento River Sites D,E,F, and G

At fall water surface elevations:

Reduced growth and survival of fry and juvenile rearing CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. Reduced growth and survival of fry and juvenile rearing sDPS green sturgeon is expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of these effects are quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The greatest adverse effects for the salmonids are -558 WRI, -1156, and -558 WRI respectively. The SAM modeled habitat conditions exceed baseline conditions and improve growth and survival is expected in year 35, 44, and 35, respectively with maximum values reaching 116, 99, and 116 WRI, respectively. The adverse effects to sDPS green sturgeon are greatest at -4674 WRI and are expected to extend past 50 years.

Reduced growth and survival of juvenile migrating (smolts) CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon is expected to extend past 50 years after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of these adverse effects are quantified in the SAM analysis table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest at -3845 WRI, -3985, and -3845, respectively.

The SAM displays reduced survival of adult migrating CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and the extent of these potential effects is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The greatest adverse effects for the salmonids are -1394 WRI, -2053, and 1394, respectively. The SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected at years 35, 29, and 35 respectively. After these years, survival and growth values improve to 362, WRI, 832, and 362 WRI, respectively.

Reduced survival of adult resident CCV steelhead after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this potential effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effect is greatest at -2053 WRI and exceeds baseline following year 29, where adult resident survival increases to a maximum value of 832 WRI.

At winter surface elevations:

Increased growth and survival of fry and juvenile rearing CV spring run Chinook salmon and Sacramento River winter-run Chinook salmon occurs after any construction activities by the first year and reaching a maximum of 2390 WRI for both species. The amount and extent of this effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO.

Reduced growth and survival of fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction due to impacts on riparian habitat, IWM and, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest at -77 and -4397, respectively. At year 1, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 3234 WRI. The adverse effects to sDPS green sturgeon are expected to extend past 50 years.

Reduced growth and survival of juvenile migrating (smolts) CCV spring run Chinook salmon, CCV steelhead, and CV winter run is expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this adverse effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest for the species at -3451 WRI, -3044, and -3451, respectively. At year two, the SAM modeled habitat conditions for CV spring run Chinook salmon and Sacramento River winter-run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 4794 WRI for both species. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 3355 WRI.

The SAM displays reduced survival of adult migrating CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon are expected to occur after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this potential effect is quantified in the SAM table 28 in Appendix A and summarized

in table 12 of this BO. The adverse effects are greatest for the species at -892 WRI, -1747, and -892 WRI, respectively. At year 4, the SAM modeled habitat conditions for CV spring run Chinook salmon and CV winter run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 643 WRI. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1455 WRI.

Reduced survival of adult residence CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest for the species at -1801 WRI, and -3068, respectively. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1757 WRI.

At spring water surface elevations:

Increased growth and survival of fry and juvenile rearing CV spring run and winter-run Chinook salmon occurs after any construction activities by the first year and reaching a maximum of 3445 WRI. The amount and extent of this effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO.

Reduced growth and survival of fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest at -36 WRI and -4397, respectively. At year 1, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 4317 WRI. The adverse effects to sDPS green sturgeon are expected to extend past 50 years.

Reduced growth and survival of juvenile migrating (smolts) CCV spring run Chinook salmon, CCV steelhead, and CV winter run is expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this adverse effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest for the species at -3484 WRI, -3082, and -3484, respectively. At year 2, the SAM modeled habitat conditions for CV spring run Chinook salmon and Sacramento River winter-run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 4862 WRI for both species. At year three, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 3474 WRI.

The SAM displays reduced survival of adult migrating CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon are expected to occur after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this potential effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest for the species at -946 WRI, -1801, and -

946 WRI, respectively. At year 4, the SAM modeled habitat conditions for CV spring run Chinook salmon and CV winter run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 931 WRI. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1757 WRI.

Reduced survival of adult residence CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest for the species at -1801 WRI, and -3068, respectively. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1757 WRI.

At summer water surface elevations:

Reduced growth and survival of fry and juvenile rearing CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. Reduced growth and survival of fry and juvenile rearing sDPS green sturgeon is expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of these effects are quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest for the salmonids are -578 WRI, -1206, and -578 WRI respectively. The SAM modeled habitat conditions exceed baseline conditions and improve growth and survival is expected in years 36, 45, and 36, respectively, with maximum increased WRI values of 113, 92, and 113. The adverse effects to sDPS green sturgeon are greatest at -5009 WRI and are expected to extend past 50 years.

Reduced growth and survival of juvenile migrating (smolts) CCV spring run Chinook is expected to extend past 50 years after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this adverse of these adverse effects are quantified in the SAM analysis table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest at -4258 WRI.

The SAM displays reduced survival of adult migrating CV spring run Chinook salmon, CV steelhead, and Sacramento River winter-run Chinook salmon after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and the extent of these potential effects is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The greatest adverse effects for these species are -2136 WRI, -3793, and -2136 WRI, respectively. The SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected at years 37, 32, and 37 respectively. After these years, survival and growth values improve to 319 WRI, 748, and 319 WRI, respectively.

Reduced survival of adult residence CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this effect is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The adverse effects are greatest for the species at -3793 WRI, and -1298, respectively. At year

32, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 748 WRI.

Effects at the Sacramento Weir and Bypass

Bypass flooding may affect juvenile fish in two different manners: (1) stranding (and killing) of juvenile fish in the widened bypass is possible on the declining limb of flood flows when weir operations cease after a flood event, and (2) increasing floodplain inundation area and increasing juvenile growth and survival. Sommer *et. al.* (2001), have demonstrated that the Yolo Bypass, the primary floodplain of the lower Sacramento River, provides better rearing and migration habitat for juvenile chinook salmon (*Oncorhynchus tshawytscha*) than adjacent river channels. We expect that due to the proximity of the Sacramento Bypass to the Yolo Bypass, the fact that the Sacramento Bypass flows into the Yolo Bypass and similar floodplain conditions in both bypasses, that similar growth and survival conditions would be expected. Both effects are expected to occur approximately once every ten years when the river reaches an elevation of 27.5 feet at the I Street gage with a forecast to continue rising. The duration of bypass inundation is highly variable depending of the magnitude and duration of flood events. After a flood event, weir gates are typically closed as rapidly as practicable once the stage at the weir drops below 25 feet. This provides "flushing" flows to re-suspend sediment deposited in the Sacramento River between the Sacramento Weir and the American River during the low flow periods when the weir is open during the peak of the flood event Baseline stranding and growth levels are not known and it is difficult to predict specific stranding rates with a widened bypass, however, the Corps proposes to grade new and existing bypass features to drain in a manner that reduce juvenile stranding.

Interruption of upstream passage of adult salmonids and sturgeon along the Sacramento weir and stranding within the bypass may occur due to the declining hydrograph as a result of the widening of the bypass. This is also expected to occur once every ten years following the spilling of river water and as the flood flows recede. Stranding in the Sacramento Bypass and blocked upstream passage may not occur however, with the implemented conservation measures as outlined in the project description and may in fact improve passage conditions currently found at the Sacramento weir and bypass and reduce current stranding rates.

Migrating green sturgeon in the lower portion of the Sacramento River become stranded during high flow events in flood control weirs and bypasses. In April 2011, 24 threatened green sturgeon were stranded in two flood diversions along the Sacramento River. Modeling and research suggests that recurrent stranding of a similar magnitude without rescue could affect the long-term viability of Green Sturgeon (Thomas et. al., 2013). With the widening of the Sacramento Weir for increased flow capacity during high flow events, there is a potential to maintain or increase stranding of adults behind the weir individuals if no passage criteria are included within the weir design. However, as stated in the conservation measures as outlines in the Proposed Action section of this BO, the Corps also will work with local cost share sponsors to ensure GRR-related future flood risk reduction actions related to widening the Sacramento Weir shall fully mitigate upstream and downstream fish passage effects at the weir and within the spillway basin. The goal is to ensure that adult CV spring-run and Sacramento River inter-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are able to migrate upstream

while the weir is spilling into the bypass and that juvenile stranding in the spillway basin is minimized to the maximum extent possible. These measures are expected to reduce juvenile and adult stranding in the bypass and provide long-term benefits through improved growth and survival of juveniles and improved survival of adults.

Implementation of the Corps proposed Green Sturgeon Conservation Measures

The implementation of the Corp's Green Sturgeon Conservation Measures will serve several purposes to address scientific uncertainty about the species in the study area and to provide compensatory mitigation for the adverse effects related to shoreline and benthic habitat impacts. The HMMP with ensure that adverse impacts of future West Sacramento projects are sufficiently compensated in order to allow for the growth, survival and recovery of the species in the study area. Coordination of the HMMP with the IEP will leverage green sturgeon scientific expertise to ensure selected mitigation actions fully address the micro- and macro-ecological and survival needs of the species in the study area. Refinement of the SAM or development of alternative green sturgeon survival and response model using the Corps' Hydrologic Ecosystem Function Model, in consultation with NMFS and the IEP, will result in new modeling capacity that more accurately evaluates adverse project actions and the beneficial effects of mitigation actions relative to the growth and survival of green sturgeon in the study area. Restoring and compensating for the number of acres and ecological function of impacted benthic habitat and the initiation of this compensatory mitigation in the study area prior to the commencement of levee construction will reduce the impact of levee construction actions. The development of SMART compensatory mitigation objectives will ensure that all of the ecological impacts of levee construction actions are fully addressed.

2.4.4 Project Effects on Critical Habitat

For CV spring-run Chinook salmon and steelhead, the project generally will have short term impacts on the freshwater rearing and freshwater rearing PCEs of critical habitat. For winter-run Chinook salmon, and for winter-run Chinook salmon impacted essential features of critical habitat that will be affect include the river water, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. The SAM model, which models fish response, also serves as a good proxy for measuring impact to these species critical habitat because it the model evaluates changes to important attributes of PCEs and essential features including overhanging shade, substrate size, instream woody material, bank slope and instream aquatic vegetation. The changes to these features are recognized in Table 10, 11 and 12 below. In general, impacts to critical habitat will generally last between 1 and 10 years, and in almost all cases they improve each year and eventually exceed baseline conditions over the life of the project. For these reasons, we do not expect the proposed action to reduce the conservation value of the critical habitat.

Because the proposed action occurs along the lower Sacramento River at the convergence of the north Delta, the action area includes both freshwater and estuarine habitat types. For green sturgeon, this means there are freshwater and estuarine including:

Freshwater

a) Food resources. Abundant prey items for larval, juvenile, subadult, and adult life stages.
b) Substrate type or size (*i.e.*, structural features of substrates). Substrates suitable for egg deposition and development (*e.g.*, bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to "collect" eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow conditions), and feeding of juveniles, subadults, and adults (*e.g.*, sand/mud substrates).

Estuarine

a) Food resources. Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.

NMFS estimates that approximately 20 acres of soft substrate habitat below the ordinary high water mark will be permanently lost to rock revetment. This number was calculated by using the provided linear feet in reaches C, D, E, F, and G in Table 4 and multiplying it by 15 feet which is the length of the distance revetment is placed from the bank into the river. This is a conceptual estimate that will be further refined during the preliminary engineering design (PED) phase before construction begins. This loss of habitat is expected to adversely affect benthic substrate and impair food resources for all life stages; and the quantity of sediment to allow for normal physiological and behavioral responses to the environment. Similar to salmon and steelhead, the SAM serves as a reasonable proxy for measuring impacts to critical habitat. For most life stages and season water surface elevations, the SAM show immediate adverse effects that continue to decline for the life of the project. However, the Corps' Green Sturgeon Conservation Measures will reduce the impact on critical habitat by providing compensatory mitigation within the action area. Specifically, the HMMP shall also restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This compensation will be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat will be capable of providing abundant benthic prey, freshwater or estuarine areas with adequate water quality, temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth and viability of all life stages. It will also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats.

Table 10. American River North Portion (ARN_AB) of the Common Feathers GRR Project Maximum SAM Modelled WRI Deficits and Duration of Deficits by Species, Life-Stage, and Season.

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-366	50	0
	Juvenile Migration	-2,303	50	0
Winter	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,102
	Juvenile Migration	-3,002	2	1,699
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,354
	Juvenile Migration	-2,681	4	1,699
Summer	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-421	50	0
	Juvenile Migration	-3,129	50	0
Fall-Run Chinook Salmon				
Fall	Adult Migration	-877	39	59
	Fry and Juvenile Rearing	-366	50	0
	Juvenile Migration	-2,303	50	0
Winter	Adult Migration	-759	5	245
	Fry and Juvenile Rearing	0	0	1,102
	Juvenile Migration	-3,002	4	1,699
Spring	Adult Migration	**	**	**
	Fry and Juvenile Rearing	0	0	1,354
	Juvenile Migration	-2,681	3	1,418
Summer	Adult Migration	**	**	**
	Fry and Juvenile Rearing	-421	50	0
	Juvenile Migration	-3,129	50	0
Steelhead				
Fall	Adult Migration	-1,554	48	8
	Fry and Juvenile Rearing	-712	50	0
	Juvenile Migration	***	***	***
	Adult Residence	-1,554	48	8
Winter	Adult Migration	-1,558	5	460
	Fry and Juvenile Rearing	-36	1	1,507

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Juvenile Migration	***	***	***
	Adult Residence	-1,558	5	460
Spring	Adult Migration	-1,635	6	407
	Fry and Juvenile Rearing	-1	1	1,731
	Juvenile Migration	-2,096	2	1,173
	Adult Residence	-1,635	6	407
Summer	Fry and Juvenile Rearing	-833	50	0
	Juvenile Migration	-3,013	50	0
	Adult Residence	-3,061	50	0
Green Sturgeon				
Fall	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-5,677	50	0
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA
Winter	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-5,020	50	0
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA
Spring	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-5,020	50	0
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA
Summer	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-7,118	0	0
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA

* Not applicable, adult spring-run Chinook salmon are not present on the American River

** Not applicable, adult migration of fall-run Chinook begins in early fall.

*** Not applicable, historically juvenile steelhead migration occurs in spring and summer.

Table 11. American River South Portion (ARS_ABC) of the Common Features GRR Project Maximum SAM modelled WRI Deficits and Duration of Deficits by Species, Life-Stage, and Season.

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-229	26	112
	Juvenile Migration	-620	21	526
Winter	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,578
	Juvenile Migration	-333	1	5,377
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	2,001
	Juvenile Migration	0	0	5,123
Summer	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-239	26	111
	Juvenile Migration	-967	22	510
Fall-Run Chinook Salmon				
Fall	Adult Migration	0	0	1,860
	Fry and Juvenile Rearing	-229	26	112
	Juvenile Migration	-620	21	526
Winter	Adult Migration	0	0	1,937
	Fry and Juvenile Rearing	0	0	1,578
	Juvenile Migration	-333	1	5,377
Spring	Adult Migration	**	**	**
	Fry and Juvenile Rearing	0	0	965
	Juvenile Migration	0	0	5,123
Summer	Adult Migration	**	**	**
	Fry and Juvenile Rearing	-239	26	111
	Juvenile Migration	-967	22	510
Steelhead				
Fall	Adult Migration	0	0	3,696
	Fry and Juvenile Rearing	-489	36	88
	Juvenile Migration	***	***	***
	Adult Residence	0	0	3,696
Winter	Adult Migration	0	0	4,015
	Fry and Juvenile Rearing	0	0	2,194

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Juvenile Migration	***	***	***
	Adult Residence	0	0	4,015
Spring	Adult Migration	0	0	4,164
	Fry and Juvenile Rearing	0	0	2,601
	Juvenile Migration	0	0	4,061
	Adult Residence	0	0	4,164
Green Sturgeon				
Fall	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-2,154	50	0
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA
Winter	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-876	1	2,941
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA
Spring	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-876	1	2,941
	Juvenile Migration	0	0	0
	Adult Residence	-2,917	50	0
Summer	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-2,496	50	0
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA

* Not applicable, adult spring-run Chinook salmon are not present on the American River

** Not applicable, adult migration of fall-run Chinook begins in early fall.

*** Not applicable, historically juvenile steelhead migration occurs in spring and summer.

Table 12. Sacramento River Portion (ARS_DEFG) portion of the Common Feathers GRR Project Maximum SAM Modelled WRI Deficits and Duration of Deficits by Species, Life-Stage, and Season.

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Adult Migration	-2,136	37	319
	Fry and Juvenile Rearing	-578	36	113
	Juvenile Migration	-4,258	50	0
Fall-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Fry and Juvenile Rearing	-578	36	113
	Juvenile Migration	-4,258	50	0
Late-Fall-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931
	Fry and Juvenile Rearing	0	0	3,445
Summer	Fry and Juvenile Rearing	-578	36	113
Winter-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Adult Migration	-2,136	37	319
	Fry and Juvenile Rearing	-578	36	113
Steelhead				
Fall	Adult Migration	-2,053	29	832
	Fry and Juvenile Rearing	-1,156	44	99
	Juvenile Migration	-3,985	50	0
	Adult Residence	-2,053	29	832
Winter	Adult Migration	-1,747	3	1,455
	Fry and Juvenile Rearing	-77	1	3,234
	Juvenile Migration	-3,044	3	3,355
	Adult Residence	-1,747	3	1,455
Spring	Adult Migration	-1,801	3	1,757
	Fry and Juvenile Rearing	-36	1	4,317
	Juvenile Migration	-3,082	3	3,474
	Adult Residence	-1,801	3	1,757
Summer	Adult Migration	-3,793	32	748
	Fry and Juvenile Rearing	-1,206	45	92
	Adult Residence	-3,793	32	748

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
sDPS Green Sturgeon				
Fall	Fry and Juvenile Rearing	-4,674	50	0
	Juvenile Migration	0	0	0
Winter	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-4,397	50	0
	Adult Residence	NA	NA	NA
Spring	Fry and Juvenile Rearing	-4,397	50	0
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA
	Adult Migration	NA	NA	NA
Summer	Fry and Juvenile Rearing	-5,009	50	0
	Juvenile Migration	0	0	0
	Adult Residence	NA	NA	NA

* Not applicable because adult fall-run Chinook salmon migrate in early fall.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

2.5.1 Water Diversions and Agricultural Practices

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found along the Common Features GRR action area. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a CV database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

Agricultural practices in the action area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the associated watersheds. Stormwater and irrigation discharges related to both

agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonid and sDPS green sturgeon reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

2.5.2 Aquaculture and Fish Hatcheries

More than 32-million fall-run Chinook salmon, 2-million spring-run Chinook salmon, 1-million late fall-run Chinook salmon, 0.25-million winter-run Chinook salmon, and 2-million steelhead are released annually from six hatcheries producing anadromous salmonids in the CV. All of these facilities are currently operated to mitigate for natural habits that have already been permanently lost as a result of dam construction. The loss of this available habitat results in dramatic reductions in natural population abundance which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations. The high level of hatchery production in the CV can result in high harvest-to-escapements ratios for natural stocks. California salmon fishing regulations are set according to the combined abundance of hatchery and natural stocks, which can lead to over-exploitation and reduction in the abundance of wild populations that are indistinguishable and exist in the same system as hatchery populations. Releasing large numbers of hatchery fish can also pose a threat to wild Chinook salmon and steelhead stocks through the spread of disease, genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production. Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler *et al.* 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

2.5.3 Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and

degrading areas of submerged vegetation. This in turn will reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

2.5.4 Global Climate Change

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (IPCC 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting listed salmonid and green sturgeon PCEs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the CV has been modeled to have an increase of between +2°C and +7°C by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheenen *et al.* 2004, Stewart 2005), with a drier hydrology predominated by rainfall rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the CV from a spring and summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This will truncate the period of time that suitable cold-water conditions exist downstream of existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall

temperatures downstream of reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.* Sacramento River winter-run Chinook salmon and CCV steelhead) that must hold and/or rear downstream of the dam over the summer and fall periods.

2.5.5 Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur within the Sacramento River watershed. For example, most of the levees have roads on top of the levees which are either maintained by the county, reclamation district, owner, or by the state. Landowners may utilize roads at the top of the levees to access part of their agricultural land. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the Common Features Project.

2.6 Integration and Synthesis

The *Integration and Synthesis* section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of the proposed action. In this section, NMFS performs two evaluations: whether, given the environmental baseline and status of the species and critical habitat, as well as future cumulative effects, it is reasonable to expect the proposed action is not likely to: (1) reduce the likelihood of both survival and recovery of the species in the wild; and (2) result in the destruction or adverse modification of designated critical habitat (as determined by whether the critical habitat will remain functional to serve the intended conservation role for the listed anadromous species or retain its current ability to establish those features and functions essential to the conservation of the species).

The *Analytical Approach* described the analyses and tools we have used to complete this analysis. This section is based on analyses provided in the *Status of the Species*, the *Environmental Baseline*, and the *Effects of the Proposed Action*.

In our *Status of the Species* section, NMFS summarized the current likelihood of extinction of each of the listed species. We described the factors that have led to the current listing of each species under the ESA across their ranges. These factors include past and present human activities and climatological trends and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* reviewed the status of the species and the factors that are affecting their survival and recovery in the action area. The *Effects of the Proposed Action* reviewed the exposure of the species and critical habitat to the proposed action and cumulative effects. NMFS then evaluated the likely responses of individuals, populations, and critical habitat. The

Integration and Synthesis will consider all of these factors to determine the proposed action's influence on the likelihood of both the survival and recovery of the species, and on the conservation value of designated critical habitat.

The criteria recommended for low risk of extinction for Pacific salmonids are intended to represent a species and populations that are able to respond to environmental changes and withstand adverse environmental conditions. Thus, when our assessments indicate that a species or population has a moderate or high likelihood of extinction, we also understand that future adverse environmental changes could have significant consequences on the ability of the species to survive and recover. Also, it is important to note that an assessment of a species having a moderate or high likelihood of extinction does not mean that the species has little or no chance to survive and recover, but that the species faces moderate to high risks from various processes that can drive a species to extinction. With this understanding of both the current likelihood of extinction of the species and the potential future consequences for species survival and recovery, NMFS will analyze whether the effects of the proposed action are likely to in some way increase the extinction risk each of the species faces.

In order to estimate the risk to CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and green sturgeon as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is reiterated from the *Status of the Species* section of this BO. We then consider how the status of populations in the action area, as described in the *Environmental Baseline,* is affected by the proposed action. Effects to individuals is summarized, and to the consequence of those effects is applied to establish risk to the diversity group, ESU, or DPS.

In designating critical habitat, NMFS considers the physical and biological features (essential features) within the designated areas that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements of the species include, but are not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring, and generally; and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species [see 50 CFR § 424.12(b)]. In addition to these factors, NMFS also focuses on the principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. Primary constituent elements may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

The basis of the "destruction or adverse modification" analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

2.6.1 Status of the CV Spring-Run Chinook Salmon ESU

The CV spring-run Chinook salmon ESU is at moderate risk of extinction (Lindley *et al.* 2007). The most recent viability assessment of CV spring-run Chinook salmon was conducted during NMFS' 2011 status review (NMFS 2011b). This review found that the biological status of the ESU has worsened since the last status review. In the 2011, the ESU as a whole could not be considered viable because there were no extant viable populations in the three other diversity groups. In addition, Mill, Deer, and Butte creeks are close together geographically, decreasing the independence of their extinction risks due to catastrophic disturbance. These and other conditions covered in the 2011 status review have not changed since 2011. While the abundance for some populations appears to be slightly improving, the ESU is still demonstrating a high variability in adult abundance (especially in Butte Creek), we cannot say based on the trend over the past three years that the risk of extinction for the ESU has improved.

2.6.2 Summary of the Status of the CCV Steelhead DPS

All indications are that natural Central Valley steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good et al. 2005; NMFS 2011); the long-term trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley et al. (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley et al. (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The CCV steelhead DPS is at high risk of extinction (NMFS 2011c), and the extinction risk is increasing. The most recent viability assessment of CCV steelhead was conducted during NMFS' 2011 status review (NMFS 2011c). This review found that the biological status of the ESU has

worsened since the last status review recommend that its status be reassessed in two to three years as opposed to waiting another five years, if it does not respond positively to improvements in environmental conditions and management actions.

2.6.3 Summary of the Status of the Green Sturgeon southern DPS

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a).

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010a).

Adult green sturgeon migrate through the action area to reach upstream spawning habitat. Early larval drift and rearing is also likely to occur upstream from the action area near spawning sites. As juveniles migrate downstream toward the ocean, they become more oriented to benthic environments. Juvenile green sturgeon migrate toward seawater portions of natal estuaries as early as one and a half years old (75cm TL, Allen and Cech 2007). Juvenile and subadult green sturgeon may rear in freshwater and brackish water for up to three years. During laboratory experiments, juvenile green sturgeon select low light habitats and are primarily inactive during daylight hours, while they seemed to forage actively during night (Kynard et al. 2005). Juvenile green sturgeon were captured during the summer in shallow shoals (1-3 m deep) in the lower San Joaquin River (Radtke 1966), and are assumed to occupy similar habitats along the lower Sacramento River.

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology.

2.6.4 Summary of Status of the Environmental Baseline and Cumulative Effects in the Action Area

The action area is used by most diversity groups and populations of the salmon, steelhead and green sturgeon ESUs and DPSs that are the subject of this BO. Salmon, steelhead and green sturgeon use the action area as an upstream and downstream migration corridor and for rearing.

Within the action area, the essential features of freshwater rearing and migration habitats for salmon, steelhead and green sturgeon have been transformed from a meandering waterway lined with a dense riparian vegetation, to a highly leveed system under varying degrees of constraint of

riverine erosional processes and flooding. Levees have been constructed near the edge of the river and most floodplains have been completely separated and isolated from the Sacramento and American Rivers (USFWS 2000). Severe long-term riparian vegetation losses have occurred in this part of the Sacramento and American Rivers, and there are large open gaps without the presence of these essential features due to the high amount of riprap (USFWS 2000). The change in the ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, the removal of riparian vegetation and IWM have likely affected the functional ecological processes that are essential for growth and survival of salmon, steelhead and green sturgeon in the action area.

The *Cumulative Effects* section of this BO describe how continuing or future effects such as non-Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that reduce the carrying capacity of the rearing and migratory corridors.

2.6.5 Summary of Project Effects on Sacramento River Winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Individuals

1. Construction and O&M-related Effects

During construction and O&M, some injury or death to individual fish could result from rock placement (crushing), or predation related to displacement of individuals away from the shoreline or at the margins or turbidity plumes. These construction type actions will occur during summer and early fall months, when the abundance of individual salmon and steelhead is low and should result in correspondingly low levels of injury or death.

Green sturgeon adults may be migrating downstream through the area during construction (Heublein et al. 2009) and juveniles may be in the area May through September (noted in section 2.4.1, pg. 83). Adults and subadults would likely respond to construction activities by quickly swimming away, escaping injury, but juveniles are not strong swimmers and will experience the greatest exposure and may encounter short-term construction-related noise, physical disturbance, and water quality changes that may cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors and affecting sheltering abilities.

2. Long-term Effects Related to the Presence of Project Features

For juvenile and outmigrating salmon and steelhead, the proposed action will result in short- and long-term adverse effects to individual salmon and steelhead that are exposed to the project features along the Sacramento and American Rivers. These adverse effects are indexed by SAM model results and expressed as WRI deficits. The long term WRI deficits are highest at fall and summer water surface elevations. We interpret those flow conditions to be consistent with summer and fall months, which are seasons during which individual Sacramento River winter-run, CV spring-run and CCV steelhead is low (fall), or they are absent. For other seasonal water

surface elevations, there will be short term reductions in survival and growth as indicated by WRI values, but these values will increase above baseline and result in beneficial conditions that exceed baseline values.

NMFS expects that the most significant habitat deficits will occur at summer and fall flows due to the inherent difficulty of successfully establishing riparian vegetation in a zone that is impacted by boat wake erosion, and variable flow conditions typical of a regulated river system. The modeled summer and fall habitat deficits are expected to affect relatively few fish, since the majority of adult migration and juvenile rearing and emigration within the action area does not occur during these periods. Instead, a significant majority of Chinook salmon and steelhead adult migration and juvenile rearing and emigration occurs during periods of higher flow that are more accurately represented by conditions at average winter and spring WSELs. Long-term effects at the winter and spring WSELs will be substantially positive, with conditions improving beyond existing conditions through year 50.

SAM modeled WRI values for adult salmon and steelhead migration and steelhead residence (outmigrating post spawning adults) are deficits at winter, spring and summer water surface elevations. These effects are considered to be *de minimus* because, although modeled as a result of a reduction in IWM and riparian habitat, the actual survival of adults is unlikely to be affected because there will be no increase in predation, and the upstream migration will not be impeded by any structural features that influence upstream migration.

Project actions along portions of the American River reach will likely not include bank armoring in their final design, which will significantly reduce estimated impacts to fish species. Additional compensatory mitigation design features or improved erosion repair designs may result in reduced impact compared to the legacy designs used for the basis of this analysis. Site specific designs will be implemented on a site by site basis in consultation with resource agencies and project partners to minimize impacts as well as maximize opportunities for implementing onsite compensatory mitigation features.

During project implementation, site specific SAM analyses will be run on final designs to better evaluate impact. SAM results will be used by the Corps and NMFS in the negotiation of appropriate mitigation for project actions. Although short term impacts are expected to be self-mitigating through the development of onsite compensatory mitigation features, the Corps will compensate for the temporal impacts to habitat through the purchase of offsite compensatory mitigation credits. Typically appropriate mitigation will be based on the identification of maximum negative WRI values. Offsite mitigation is expected to provide compensatory mitigation value at all seasonal habitat conditions. Longer term impacts to habitat may not recover to baseline conditions over the life of the project due to design restrictions. These impacts to habitat will be compensated through the purchase of offsite compensatory mitigation credits as well as the incorporation of additional onsite compensatory mitigation features (*i.e.* low water plantings, additional IWM, additional revegetation).

Details regarding the extent of juvenile green sturgeon rear in this reach of the river is not clear, but all juvenile sDPS must pass through the area on their migration to the estuary and ocean. Levee repair actions in the Common Features Study Area are likely to only affect the juvenile

rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present in the action area and upstream migrating adults are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. The levee repair actions will cause long-term reductions in shoreline habitat features for juvenile rearing and migrating green sturgeon and a loss of several acres of benthic habitat that is most likely used for foraging.

The implementation of the Corp's Green Sturgeon Conservation Measures will serve several purposes to address scientific uncertainty about the species in the study area and to provide compensatory mitigation for the adverse effects related to shoreline and benthic habitat impacts. The HMMP with ensure that adverse impacts of future Common Features GRR projects are sufficiently compensated in order to allow for the growth, survival and recovery of the species in the study area. Coordination of the HMMP with the IEP will leverage green sturgeon scientific expertise to ensure selected mitigation actions fully address the micro- and macro-ecological and survival needs of the species in the study area. Refinement of the SAM or development of alternative green sturgeon survival and response model using the Corps' Hydrologic Ecosystem Function Model, in consultation with NMFS and the IEP, will result in new modeling capacity that more accurately evaluates adverse project actions and the beneficial effects of mitigation actions relative to the growth and survival of green sturgeon in the study area. Restoring and compensating for the number of acres and ecological function of impacted benthic habitat and the initiation of this compensatory mitigation in the study area prior to the commencement of levee construction will reduce the impact of levee construction actions. The development of SMART compensatory mitigation objectives will ensure that all of the ecological impacts of levee construction actions are fully addressed.

The Corps also will work with local cost share sponsors to ensure GRR-related future flood risk reduction actions related to widening the Sacramento Weir shall fully mitigate upstream and downstream fish passage effects at the weir and within the spillway basin. The goal is to ensure that adult CV spring-run and Sacramento River inter-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are able to migrate upstream while the weir is spilling into the bypass and that juvenile stranding in the spillway basin is minimized to the maximum extent possible. Long-term, and once implemented, this measure would be expected to improve the growth and survival of all affected salmon, steelhead and green sturgeon.

2.6.6 Summary of Project Effects on Sacramento River Winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Critical Habitat

Within the action area, the relevant PCEs of the designated critical habitat for listed salmonids are migratory corridors and rearing habitat, and for green sturgeon the six PCEs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality.

Based on SAM modeled WRIs, we expect small reductions in the value of PCEs for salmon and steelhead freshwater rearing due to the temporary loss of riparian habitat, the conversion of natural substrate river banks with revetment and the short term loss of IWM, but these reductions are at fall and summer water surface elevations and not at water surface elevations when the habitat use is the highest and most significant. Additionally, as planted vegetation begins to

grow, the quality of rearing habitat will improve over baseline. There will also be SAM modeled WRI deficits for adult migration-related PCEs for all species. These deficits are temporary and eventually increase over baseline, so over time we do not expect these effects to reduce the conservation value of critical habitat.

The current condition of critical habitat for the green sturgeon sDPS in the action area is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the green sturgeon sDPS evolved.

The Corps estimates that approximately 20 acres of soft substrate habitat below the ordinary high water mark will be permanently lost to rock revetment. This is a conceptual estimate that will be further refined during the PED phase before construction begins. This loss of habitat is expected to adversely affect benthic substrate and impair food resources for all life stages; and the quantity of sediment to allow for normal physiological and behavioral responses to the environment. Similar to salmon and steelhead, the SAM serves as a reasonable proxy for measuring impacts to critical habitat. For most life stages and season water surface elevations, the SAM show immediate adverse effects that continue to decline for the life of the project. However, the Corps' Green Sturgeon Conservation Measures will reduce the impact on critical habitat by providing compensatory mitigation within the action area. Specifically, the HMMP shall also restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This compensation will be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat will be capable of providing abundant benthic prey, freshwater or estuarine areas with adequate water quality, temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth and viability of all life stages. It will also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats.

The proposed action will permanently destroy up to 20 acres of critical habitat but also includes implementation of a comprehensive suite of conservation measures that will fill important data gaps, address existing modeling insufficiencies and implement compensatory measures with the goal of maintaining green sturgeon growth, survival and recovery in the action area through measures that will be developed in coordination with the IEP's green sturgeon project work team and in consultation with NMFS. The measures will be undertaken prior to or concurrent with project implementation. For these reasons, we expect the proposed action will not reduce the conservation value of critical habitat for sDPS green sturgeon.

2.6.7 Summary

Although there are some short-term and SAM modeled WRI deficits for salmon and steelhead, the effects of these deficits, when added to the environmental baseline and cumulative effects in the action area are small, occur during seasons when fish abundance is low or they are not present at all, and is of short duration. In the case of fry and juvenile rearing and migration for

all species, the SAM modeled WRI values show significant increases in the growth and survival of individuals over baseline conditions between years 0 and 13, especially at winter spring water surface elevations, which represent a shoreline area where most emigrating salmon and steelhead would be exposed. Because the WRI measure growth and survival values recover rather quickly and generally exceed baseline conditions, the incremental effects of the action are not expected to increase the extinction risk of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and or reduce the conservation value of their designated critical habitat.

Furthermore, the anticipated growth and survival of salmon, steelhead rearing and juvenile migration are substantially positive and demonstrate how integrating NMFS high priority recovery actions, such as setback levee construction and restoration of floodplain habitat can contribute to an increase in the production and abundance of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead.

The project will result in unavoidable impacts to the shoreline and benthic habitat of green sturgeon. However, the Corps' proposed Green Sturgeon Conservation Measures are expected to make significant contributions to monitor the species, address important data gaps in the action area, improve species growth and survival modeling and use the modeling to develop and track the performance of compensatory mitigation with the goal of fully addressing the loss of micro and macro-ecological impacts of the levee construction work in a manner that maintains the growth, survival and recovery of the species. The measures also address critical habitat PCEs and will ensure the conservation value of critical habitat is not reduced.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon or destroy or adversely modify their designated critical habitat.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide

that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant, contract or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps: (1) fails to assume and implement the terms and conditions, or (2) fails to require the permittee, contractor, or grantee to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit, contract or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

2.8.1 Amount or Extent of Take

NMFS anticipates incidental take of adult and juvenile listed CV spring-run Chinook salmon, CCV steelhead, and juvenile sDPS green sturgeon and juvenile Sacramento River winter-run Chinook salmon in the action area through the implementation of the proposed action.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS green sturgeon because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible to describe the general programmatic conditions and ecological surrogates using negative SAM WRI values.

Accordingly, NMFS is quantifying take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS green sturgeon incidental to the action resulting from short-term construction impacts, as well as long-term impacts as indexed by the SAM model.

The amount and extent of take described below is in the form of harm due to habitat impacts that will reduce the growth and survival of individuals from predation, or by causing fish to relocate and rear in other locations and reduce the carrying capacity of the existing habitat. This SAM values represent the extent of habitat impacts that will harm fish. As described in the *Analytical Approach* and the *Effects Analysis Sections* of this BO, the SAM values represent an index of fish response to habitat variables to which fish respond including bank slope, bank substrate size, instream structure, overhanging shade, aquatic vegetation and floodplain availability. Positive SAM values represent a positive growth and survival response and negative values index negative growth and survival. There is not a stronger ecological surrogate based on the information available. Due to a lack of site-specific fish data, the exact number of fish that will be affected is not known. The following level of incidental take from program activities is anticipated:

Incidental Take Associated with Construction:

1. Take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon in the form of injury and death from predation caused by construction-related turbidity that extends up to 100 feet from the shoreline, and 1,000 feet downstream, along all project reaches for levee construction activities.

2. Take of juvenile and smolt Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS green sturgeon, in the form of harm or injury of fish from O&M actions is expected from habitat-related disturbances from the annual placement of up to 600 cubic yards of material per site for the extent of the project life (*i.e.*, 50 years). Approximately 60 percent of the 600 cubic yards will be at or below the ordinary high water mark, or approximately 360 cubic yards. Take will be in the form of harm to the species through modification or degradation of the PCEs for rearing and migration that reduces the carrying capacity of habitat.

Incidental Take Associated with Exposure to Project Facilities along the Sacramento and American Rivers

Common Features American River North Reaches A and B:

At fall water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The amount and extent of harm is greatest in the first 3 to 5 years for each species at -366 WRI, -712, and -5577, respectively.

2. Take in the form of harm to juvenile migrating (smolts) CV spring-run Chinook salmon is expected to extend past 50 years after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The amount and extent of harm is greatest at -2303 WRI.

3. Take in the form of harm to adult migrating CCV steelhead for up to 48 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The amount and extent of harm is greatest at -1554 WRI and exceeds baseline following year 48 to a maximum increase benefit of 8 WRI.

At winter surface elevations:

1. Take in the form of harm to fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction activities due to impacts on riparian habitat,

IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The amount and extent of harm is greatest at -36 WRI for steelhead in the first year and the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year one, survival and growth values improve to 1507 for CCV steelhead. The amount and extent of harm to sDPS green sturgeon are greatest at -5020 and are expected to extend past 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CV spring-run Chinook salmon are expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO, harm is greatest in approximately year 3 at -2303 WRI.

3. Take in the form of harm to adult migrating CCV steelhead for up to 48 after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in Table 10 of this BO. The amount and extent of harm is greatest at -1554 WRI. At year 48, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching 8 WRI.

At spring water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction due to impacts to riparian habitat IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The amount and extent of harm is greatest at -2681 and -5020, respectively. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1418 WRI. The extent and amount of harm to sDPS green sturgeon are greatest at -5020 WRI and are expected to extend past 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CV spring-run Chinook salmon and CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The amount and extent of harm is greatest at -3129 for CV spring-run Chinook salmon and is expected to extend past 50 years. The greatest amount and extent of harm for CCV steelhead is greatest at -2096 WRI. At year 2, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching 1173 WRI.

3. Take in the form of harm to adult migrating CCV steelhead after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this harm is quantified in the SAM table 26 in Appendix A and summarized

in table 10 of this BO. The amount and extent of harm is greatest at -1635 WRI. At year 6, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching 407 WRI.

4. Take in the form of harm to adult resident CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The amount and extent of harm is greatest at -1635 WRI for CCV steelhead in the first six years and the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After six years, survival and growth values improve to 407 for CCV steelhead.

At summer surface elevations:

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The amount and extent of harm is greatest for each species at -421 WRI, -833, and -7118, respectively.

2. Take in the form of harm to juvenile migrating (smolts) of CCV steelhead is expected to extend past 50 years after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM in table 26 in Appendix A and summarized in table 10 of this BO. The amount and extent of harm is greatest at -3013 WRI.

3. Take in the form of harm to adult resident CV steelhead is expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM and, and bank substrate size. The amount and extent of harm is quantified in the SAM table 26 in Appendix A and summarized in table 10 of this BO. The amount and extent of harm on the species is greatest at -3061 WRI.

American River North, South Bank sites A, B, and C

***At fall surface elevations*:**

1. Take in the form of harm to fry and juvenile rearing CV spring run Chinook salmon, CCV steelhead, and S DPS green sturgeon are expected after any construction activities due to impacts riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The amount and extent of harm is greatest for each species at -229 WRI, -489, and -2154, respectively. At year 26 for CV spring run Chinook salmon and year 36 for CCV steelhead, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 112 WRI and 88,

respectively. The amount and extent of harm to sDPS green sturgeon are greatest at -2154 and are expected to extend past 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CV spring run Chinook salmon is expected after any construction due to impacts riparian habitat, IWM, and bank substrate size. The amount and extent of this amount and extent of harm is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The amount and extent of harm is greater greatest at -620 WRI and exceed baseline conditions and improved growth and survival conditions are expected following year 2 with the maximum increase benefit of 526 WRI.

3. The SAM displays increased survival of adult migrating CV steelhead after construction activities due to impacts), IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 27and summarized in table 11 of this BO. The increased benefit maximizes at 3696 of WRI.

At winter water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction due to impacts to riparian habitat IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The amount and extent of harm is greatest at – 489 WRI and – 876, respectively. At year 36, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 88 WRI. At year one, the SAM modeled habitat conditions for sDPS green sturgeon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 2941 WRI.

At summer water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CV spring run Chinook salmon and sDPS green sturgeon are expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The amount and extent of harm is greatest at – 239 WRI and – 2496, respectively. At year 26, the SAM modeled habitat conditions for CV spring run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 111 WRI. The amount and extent of harm to sDPS green sturgeon are expected to extend past 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CV spring run Chinook salmon is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 27 in Appendix A and summarized in table 11 of this BO. The amount and extent of harm is greatest at -967 WRI. At year 22, the SAM modeled habitat conditions for CV spring run

Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 510 WRI.

Sacramento River Sites D, E, F, and G

At fall water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. Take in the form of harm to fry and juvenile rearing sDPS green sturgeon is expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The greatest amount and extent of harm for the salmonids is -558 WRI, -1156, and -558 WRI respectively. The SAM modeled habitat conditions exceed baseline conditions and improve growth and survival is expected in year 35, 44, and 35, respectively. The amount and extent of harm to sDPS green sturgeon is greatest at -4674 WRI and are expected to extend past 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon is expected to extend past 50 years after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM analysis table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest at -3845 WRI, -3985, and -3845, respectively.

3. Take in the form of harm to adult migrating CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and the extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The greatest amount and extent of harm for the salmonids are -1394 WRI, -2053, and 1394, respectively. The SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected at years 35, 29, and 35 respectively. After these years, survival and growth values improve to 362, WRI, 832, and 362 WRI, respectively.

4. Take in the form of harm to adult resident CCV steelhead after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest at -2053 WRI and exceeds baseline following year 29, where adult resident survival increases to a maximum value of 837 WRI.

At winter surface elevations:

1. Take in the form of harm to fry and juvenile rearing CCV steelhead, CV winter run Chinook salmon, and sDPS green sturgeon are expected after any construction due to impacts on riparian habitat, IWM and, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest at -77 WRI, -4397, and -558, respectively. At year 1, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 3234 WRI. At year 35, the SAM modeled habitat conditions for CV winter run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 116 WRI. The amount and extent of harm to sDPS green sturgeon are expected to extend past 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CCV spring run Chinook salmon, CCV steelhead, and CV winter run is expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest for the species at -3451 WRI, -3044, and -3085, respectively. At year two, the SAM modeled habitat conditions for CV spring run Chinook salmon and Sacramento River winter-run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 4794 WRI for both species. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 3355 WRI.

3. Take in the form of harm to adult migrating CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon are expected to occur after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest for the species at -892 WRI, -1801, and -892 WRI, respectively. At year 4, the SAM modeled habitat conditions for CV spring run Chinook salmon and CV winter run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 643 WRI. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1757 WRI.

4. Take in the form of harm to adult residence CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest for the species at -1801 WRI. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1757 WRI.

At spring water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CCV steelhead and sDPS green sturgeon are expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest at -36 WRI and -4397, respectively. At year 1, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 4317 WRI. The amount and extent of harm to sDPS green sturgeon are expected to extend past 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CCV spring run Chinook salmon, CCV steelhead, and CV winter run is expected after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest for the species at -3484 WRI, -3082, and -3484, respectively. At year 2, the SAM modeled habitat conditions for CV spring run Chinook salmon and Sacramento River winter-run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 4862 WRI for both species. At year three, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1757 WRI.

3. Take in the form of harm to adult migrating CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon are expected to occur after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest for the species at -946 WRI, -1801, and -946 WRI, respectively. At year 4, the SAM modeled habitat conditions for CV spring run Chinook salmon and CV winter run Chinook salmon exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 931 WRI. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1757 WRI.

4. Take in the form of harm to adult residence CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest for the species at -1801 WRI. At year 3, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 1757 WRI.

At summer water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CV spring run Chinook salmon, CCV steelhead, and CV winter run Chinook salmon after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. Take in the form of harm to fry and juvenile rearing sDPS green sturgeon is expected to extend past 50 years after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of these effects are quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest for the salmonids are -578 WRI, -1206, and -578 WRI respectively. The SAM modeled habitat conditions exceed baseline conditions and improve growth and survival is expected in years 36, 45, and 36, respectively, with maximum increased WRI values of 113, 92, and 113. The amount and extent of harm to sDPS green sturgeon are greatest at -5009 WRI and are expected to extend past 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CCV spring run Chinook is expected to extend past 50 years after any construction due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of this adverse of these amount and extent of harm is quantified in the SAM analysis table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest at -4258 WRI.

3. Take in the form of harm to adult migrating CV spring run Chinook salmon, CV steelhead, and Sacramento River winter-run Chinook salmon after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and the extent of these potential effects is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The greatest amount and extent of harm for these species are -2136 WRI, -3793, and -2136 WRI, respectively. The SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected at years 37, 32, and 37 respectively. After these years, survival and growth values improve to 319 WRI, 748, and 319 WRI, respectively.

4. Take in the form of harm to adult residence CCV steelhead is expected after any construction activities due to impacts on riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 28 in Appendix A and summarized in table 12 of this BO. The amount and extent of harm is greatest for the species at -3793 WRI. At year 32, the SAM modeled habitat conditions for CCV steelhead exceed baseline conditions and improved growth and survival conditions are expected, reaching a maximum of 748 WRI.

Take along and within the Sacramento Bypass and Weir

1. Take in the form of injury or death to adult and juvenile CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and sDPS green sturgeon as a result of stranding in the spillway basin along 3425 linear feet of the expanded Sacramento Weir as a result of impaired upstream or downstream migrations. This take

is expected to occur once every 10 years following the spilling of river water and as the flood flows recede standing these species in the spillway basin.

2. Take in the form of injury or death to adults and juvenile CV spring-run, Sacramento River winter-run Chinook salmon, CCV steelhead, and sDPS green sturgeon due to stranding on the declining hydrograph within 660 acres (Personal Communication, Anne Baker, Army Corps of Engineers) as a result of the widening of the bypass. This take is expected to occur once every ten years following the spilling of river water and as the flood flows recede stranding these species in the Sacramento Bypass.

2.9.2 Effect of the Take

In the BO, NMFS determined that the amount or extent of anticipated take is not likely to result in jeopardy to the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon or destruction or adverse modification of their critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken to ensure that future flood risk reduction projects related to the American River Common Features GRR minimize, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead and green sturgeon that are subject to this consultation.

2. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures through the HMMP to ensure their effectiveness.

3. Measures shall be taken to minimize the impacts of bank protection and setback levee construction by implementing integrated conservation measures that provide beneficial growth and survival conditions for salmonids, and the sDPS of North American green sturgeon.

4. Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this BO.

5. Measures shall be taken to ensure that riparian habitat within the study area is preserved and protected to the maximum extent feasible for protection of fish habitat features that are the subject of this BO.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1: "*Measures shall be taken to ensure that future flood risk reduction projects related to the American River Common Features GRR minimize, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead and green sturgeon that are subject to this consultation.*"

    a. The Corps shall participate in an existing IWG or work with other agencies to participate in a new BPWG to coordinate stakeholder input into future flood risk reduction actions associated with the American River Common Features GRR. The BPWG will hold technical deliberations over proposed bank protection, including the need (basis of/for design), purpose and proposed designs (emphasis on avoidance and fish-friendly designs). Membership in the BPWG will be subject to agency decisions to participate, but should at a minimum include participation from resource agency staff (USFWS, NMFS, CDFW), CVFPB and SAFCA (local sponsors).
    b. The Corps shall coordinate with NMFS during PED as future flood risk reduction actions are designed to ensure conservation measures are incorporated to the extent practicable and feasible and projects are designed to maximize ecological benefits.
    c. The Corps shall include as part of the HMMP, a Riparian Corridor Improvement Plan with the overall goal of mitigating for the impacts to the ecological function and value of the existing levee system within the GRR study area. The Corps shall coordinate this plan with NMFS prior to the construction of any projects related to the GRS.
    d. The Corps shall ensure the widening of the Sacramento Bypass is designed and constructed to minimize stranding of fish at facilities of the weir and in the depressions of the bypass though grading or construction of drainage channels or other mechanisms as applicable.
    e. During Preconstruction Engineering and Design, the Corps, in coordination with the local sponsor, shall coordinate with NMFS to provide an operation of the Sacramento Weir to allow, without detrimental effects to flood management operations, for controlled ramp down rates of water into the Sacramento Bypass following peak flows.
    f. The Corps, in coordination with the local sponsors, shall compensate for fish passage impacts that result from the widening of the Sacramento Weir by including an adult fish passage facility associated with flood operations at the new weir. The fish passage facility would be designed with NMFS technical experts as part of the design team. Measures also shall be taken to modify the downstream side of the Weir to prevent adult and juvenile green sturgeon from stranding in the spillway basin.

g. The Corps shall update the O&M manual to incorporate, without detrimental effects to flood operations, the following measures: (1) an adaptive management plan for operations of the Sacramento Weir that allows for ramp down flows in a manner that minimize juvenile fish stranding in the Sacramento Bypass, (2) integration of Sacramento Weir operations with the Yolo Bypass.

2. The following terms and conditions implement reasonable and prudent measure 2: "*Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures through the HMMP to ensure their effectiveness*."

   a. The Corps shall develop a HMMP with an overall goal of ensuring the conservation measures achieve a high level of ecological function and value. The HMMP shall include specific goals and objectives and a clear strategy for maintaining all of the project conservation elements for the life of the project. The HMMP shall be consulted on with NMFS prior to the onset of any riverside construction, including the placement of in-water revetment or removal of riparian vegetation.
   b. The HMMP measures shall be monitored by the Corps for 10 years following construction and shall update their O&M manual to ensure the HMMP is adopted by the local sponsor to ensure the goals and objectives of the conservation measures are met for the life of the project.
   c. The HMMP shall include specific goals and objectives and a clear strategy for achieving full compensation for all project-related impacts on the affected species described above.
   d. The HMMP shall include a compensatory mitigation accounting plan to ensure the tracking of compensatory measures associated with future American River Common Features GRR projects as described in the proposed action.
   e. The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP.
   f. The Corps shall host an annual meeting and issue annual reports for five years following completion of project construction. The purpose is to ensure that conservation features of the project are developing consistent with the MMP.
   g. The Corps shall update their O&M Manual to ensure that the self-mitigating elements are meeting the criteria established in the HMMP with the goal of meeting SAM values.
   h. The Corps, in coordination with the local sponsor, shall ensure that the mitigation and monitoring plan for the Sacramento Bypass includes baseline post-project monitoring of fish stranding. The monitoring plan shall be developed in coordination with NMFS.

3. The following terms and conditions implement reasonable and prudent measure 3: "*Measures shall be taken to minimize the impacts of bank protection and setback levee construction by implementing integrated conservation measures that provide beneficial growth and survival conditions for salmonids, and the sDPS of North American green sturgeon*."

a. The Corps shall ensure that, for salmon and steelhead, the maximum SAM WRI deficits for each seasonal water surface elevation as determined appropriate with input from the IWG or the BPWG are fully offset through habitat improvements along the future American River Common Features GRR project or through the purchase of credits at a NMFS approved conservation bank (as described in the BA).
b. The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.
c. The Corps shall ensure that the planting of native vegetation will occur as described in the Corps 2014 BA and within this BO. All plantings must be provided with the appropriate amount of water to ensure successful establishment.
d. The Corps shall compensate for lost habitat using NMFS approved mitigation actions at a 1:1 ratio prior to construction, 2:1 ratio during construction, or a 3:1 ratio if mitigation actions occur after construction. This includes habitat improvements adjacent to the project area, or through conservation bank credit purchase as described in the Corps revised, American River Common Features GRR SAM Analysis as received by email on June 18, 2015 and included in this document in Appendix A.

4. The following terms and conditions implement reasonable and prudent measure 4: "*Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this BO*."

a. The Corps shall provide a copy of this BO, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in these documents and to educate and inform all other contractors involved in the project as to the requirements of this BO. A notification that contractors have been supplied with this information will be provided to the reporting address below.
b. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this BO. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training.
c. The Corps shall consider installing IWM along future flood risk reduction projects associated with the American River Common Features GRR at 40 to 80 percent shoreline coverage at all seasonal water surface elevations in coordination with the IWG or the BPWG. The purpose is to maximize the refugia and rearing habitats for juvenile fish.

5. The following terms and conditions implement reasonable and prudent measure 5: "*Measures shall be taken to ensure that riparian habitat within the study area is preserved and protected to the maximum extent feasible for protection of fish habitat features that are the subject of this BO*."

    a. The Corps shall develop a vegetation variance in consultation with NMFS to allow for the protection of existing vegetation in place and the planting of new low-risk vegetation on the lower 1/3 slope of the levee system.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. The Corps should integrate the 2017 California Central Valley Flood Protection Plan's Conservation Strategy into all flood risk reduction projects they authorize, fund, or carry out.
2. The Corps should prioritize and continue to support flood management actions that set levees back from rivers and in places where this is not technically feasible, repair in place actions should pursue land-side levee repairs instead of waterside repairs.
3. The Corps should consult with NMFS in the review of ETL variances for future projects that require ETL compliance.
4. The Corps should develop ETL vegetation variances for all flood management actions that are adjacent to any anadromous fish habitat.
5. The Corps should use all of their authorities, to the maximum extent feasible to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High priority actions related to flood management include setting levees back from river banks, increasing the amount and extent of riparian vegetation along reaches of the Sacramento River Flood Control Project.
6. The Corps should encourage cost share sponsors and applicants to develop floodplain and riparian corridor enhancement plans as part of their projects.
7. The Corps should seek out opportunities for setback levee and other flood management activities that promote overall riverine system restoration.
8. The Corps should support and promote aquatic and riparian habitat restoration within the Sacramento River and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.
9. The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.

10. The Corps should continue to work with NMFS and other agencies and interests to restore fish passage to support the improved growth, survival and recovery of native fish species in the Yolo Bypass and other bypasses within the Sacramento River Flood Control Project.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

2.10 Reinitiation of Consultation

This concludes formal consultation for the West Sacramento River GRS. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

The proposed action is described in detail in Section 1.4 of the Common Features GRR BO.

3.1 Essential Fish Habitat Affected by the Project

The action area for the Common Features GRR has been identified as EFH for Pacific coast salmon. Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), CV spring-run Chinook salmon (*O. tshawytscha*), and CV fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific coast salmon fishery management plan that occur within the proposed action area.
This BO addresses Sacramento River winter-run and CV spring-run Chinook salmon (*O. tshawytscha*). The Sacramento River winter-run and CV spring-run Chinook salmon are listed under both ESA and the MSA and potentially will be affected by the Common Features GRR. This EFH consultation will concentrate on CV fall-/late fall-run Chinook salmon (*O. tshawytscha*) because their habitat is covered under the MSA but not covered in subject BO.

The Habitat Areas of Particular Concern (HAPCs) in the action area include complex channels, floodplain habitats and constrained channels with large woody debris.

3.2 Adverse Effects on Essential Fish Habitat

The effects of the proposed action on Pacific Coast salmon EFH will be similar to those discussed in the *Effects of the Action* section (2.4) for Sacramento River winter-run and CV spring-run Chinook salmon. Based on the information provided, NMFS concludes that the proposed action would adversely affect EFH for federally managed Pacific salmon. A summary of the effects of the proposed action on EFH for Chinook salmon are discussed below.

Adverse effects to the HAPCs of Pacific salmon EFH resulting from the proposed action construction activities may contribute sediment, increase turbidity, and increase localized sound levels, including areas downstream and upstream of the construction site. These impacts will occur only during the time when construction is occurring in or adjacent to the water column. There is potential for toxic compounds to be introduced into EFH during construction. This could occur at any time during the construction, both during in-water and out-of-water phases. All of the above impacts will be short-term. Construction activities may also eliminate or alter habitat that is essential to the life-cycle of Pacific salmon. For example, the addition of rock revetment to a previously vegetated bank may eliminate juvenile rearing habitat. These habitat impacts are better illustrated in Tables 10, 11, and 12 of the BO associated with this EFH consultation and Tables 26, 27 and 28 in Appendix A that summarizes SAM deficits for the Common Features GRR.

3.3 Essential Fish Habitat Conservation Recommendations

Fully implementing these EFH conservation recommendations will protect, by avoiding or minimizing the adverse short-term habitat effects described in section 3.2. The Corps should mitigate for WRI deficits by offsetting the maximum deficits. Below is a summary of WRI that should be mitigated to minimize the adverse effects of the Common Features GRR to Pacific coast salmon species. The Corps should offset deficits either onsite or at a NMFS approved

conservation bank. The mitigation should be at a 1:1 ratio if conducted prior to the compensation timing schedule described in the *Analytical Approach* section of the BO, or at a 3:1 ratio if carried out any later.

Common Features American River North Reaches A and B:

At fall water surface elevations:

1. The maximum impact from the Common Features GRR to adult fall-run Chinook salmon migrating habitat is -877 WRI for 39 years.

2. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon rearing habitat is -366 WRI for 50 years.

3. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon migration habitat is -2,303 WRI for 50 years.

At winter surface elevations:

1. The maximum impact from the Common Features GRR to adult fall-run Chinook salmon migrating habitat is -759 WRI for 5 years.

2. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon migration habitat is –3,002 WRI for 4 years.

At spring water surface elevations:

1. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon migration habitat is -2,681 WRI for 3 years.

2. The maximum impact from the Common Features GRR to adult fall-run Chinook salmon habitat is -773 WRI for 4 years.

At summer surface elevations:

1. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon rearing habitat is -421 WRI for 50 years.

2. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon migration habitat is -3,129 WRI for 50 years.

American River North, South Bank sites A, B, and C

At fall water surface elevations:

1. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon rearing habitat is -229 WRI for 26 years.

2. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon migration habitat is -620 WRI for 21 years.

At winter surface elevations:

1. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon migration habitat is -333 WRI for 1 years.

At summer surface elevations:

1. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon rearing habitat is -239 WRI for 26 years.

2. The maximum impact from the Common Features GRR to juvenile fall- run Chinook salmon migration habitat is -697 WRI for 22 years.

Sacramento River Sites D, E, F, and G

At fall water surface elevations:

1. The maximum impact from the Common Features GRR to adult fall-run and late-fall run Chinook salmon migration habitat is -1,394 WRI for 35 years.

2. The maximum impact from the Common Features GRR to juvenile fall-run and late-fall run Chinook salmon rearing habitat is -558 WRI for 35 years.

3. The maximum impact from the Common Features GRR to juvenile fall-run and late-fall run Chinook salmon migration habitat is -3,845 WRI for 50 years.

At winter surface elevations:

1. The maximum impact from the Common Features GRR to adult fall-run and late-fall run Chinook salmon migration habitat is -892 WRI for 4 years.

2. The maximum impact from the Common Features GRR to juvenile fall-run and late-fall run Chinook salmon migration habitat is -3,451 WRI for 2 years.

At spring water surface elevations:

1. The maximum impact from the Common Features GRR to adult late-fall run Chinook salmon migration habitat is -946 WRI for 4 years.

2. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon migration habitat is -3,484 WRI for 2 years.

At summer surface elevations:

1. The maximum impact from the Common Features GRR to juvenile fall-run and late-fall run Chinook salmon rearing habitat is -578 WRI for 36 years.

2. The maximum impact from the Common Features GRR to juvenile fall-run Chinook salmon migration habitat is -4,258 WRI for 50 years.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, compensate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include SAFCA, USFWS, CDFW, or DWR. Individual copies of this opinion were provided to the Corps. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 *et seq*., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and the EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

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APPENDIX A.

Appendix A comprises the updated SAM analysis report emailed to NMFS from the USACE on JUNE 11, 2015. This represents the final SAM run agreed upon jointly.

Appendix A
American River Common Features GRR SAM Analysis

ARCF GRR Project Reach SAM Analysis

1.0 Introduction

This document provides the background data and assumptions for the Standard Assessment Methodology (SAM) effects analysis of the American River Common Features General Reevaluation Report (ARCF GRR) project on the following focus fish species (Table 1).

Table 1. ARCF GRR Project Focus Fish Species

Species/ESUs	Federal Status
Chinook salmon (*Oncorhynchus tshawytscha*)	
Central Valley spring-run ESU	Threatened
Central Valley fall-run ESU	Species of concern
Central Valley late fall-run ESU	Species of concern
Sacramento River winter-run ESU	Endangered
Central Valley steelhead DPS (*Oncorhynchus mykiss*)	Threatened
green sturgeon (*Acipenser medirostris*)	Threatened

1.1 Background

The US Army Corps of Engineers (Corps) initiated formal Section 7 consultation with the National Marine Fisheries Service (NMFS) for the ARCF GRR on June 27, 2014. The original SAM analysis included in the Section 7 consultation for the ARCF GRR was determined to be insufficient in detail. Through internal discussions and interagency coordination with the NMFS, a revised set of parameters was developed to better assess the project's impact on focus fish species and their habitat. This report documents and provides justification for the revised SAM analysis and should replace the analysis included in the original Biological Assessment (BA) Appendix B.

1.2 SAM Modeling Approach

Long-term effects of the ARCF GRR project on focus fish species and their habitat were estimated using the SAM. The SAM computations were performed using the SAM Electronic Calculation Template (ECT) Version 4.0 (April 2012) developed by the Corps and Stillwater Sciences, in consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife Service (CDFW), and California Department of Water Resources (DWR), academic contributions from the University of California at Davis and Humboldt State University, and peer reviewed by sixteen professionals in fish biology, river geomorphology, environmental sciences, and engineering (USACE 2012). The SAM allows agencies to quantitatively assess the potential effects of bank protection and stream restoration projects to ensure that these activities do not jeopardize Chinook salmon, steelhead, and green sturgeon, or destroy or adversely modify their critical

habitat. The SAM can also determine suitable compensation for habitat loss, by evaluating the benefits of certain design features (*e.g.*, planted emergent vegetation) to target fish species.

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of listed fish species:

- *bank slope*—average bank slope of each average seasonal water surface elevation;
- *floodplain availability*—ratio of wetted channel and floodplain area during the 2-year flood, to the wetted channel area during average winter and spring flows;
- *bank substrate size*—the median particle diameter of the bank (*i.e.*, D50) along each average seasonal water surface elevation;
- *instream structure*—percent of shoreline coverage of instream woody material along each average seasonal water surface elevation;
- *aquatic vegetation*—percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation; and
- *overhanging shade*—percent of the shoreline coverage of shade along each average seasonal water surface elevation.

The SAM does not directly model changes in the above variables. Instead, habitat changes are estimated separately by the user and entered into an input data file to an electronic calculation template (ECT) developed within an MS Access database to track species responses to project actions over time. Changes in habitat variables may be fixed in time, such as installation of revetment at a particular slope and substrate size. In other circumstances, habitat evolution over time may be represented by more gradual changes in variables such as changes in floodplain inundation due to meander migration or changes in shade due to growth of planted vegetation. Typically, habitat evolution modeling is restricted to shade estimates from riparian growth models, but the SAM accommodates any number of other habitat modeling approaches such as meander migration modeling or large woody debris recruitment modeling.

Once a particular time series of habitat variable estimates is developed and entered into an ECT input file fish responses are calculated using previously developed relationships between habitat variables and species/life stage responses (USACE 2012). The response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (*e.g.*, with- or without-project), the ECT uses these relationships to determine the responses of individual species and life stages to the measured or predicted values of each variable, for each season and target year; the ECT then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear distance or area of bank to which it applies; the product is then integrated through time, generating a weighted species response index (WRI expressed as ft or ft^2) in each year of the analysis. The WRI provides a common metric that can be used to quantify habitat values over time, compare project designs to

existing conditions, and evaluate the effectiveness of on-site and off-site habitat compensation actions.

2.0 Habitat Analysis

Following procedures described in the SAM (USACE 2012), construction activities at each site were translated into habitat variables for pre-project and with project conditions in each of four seasons using available data sources. The relevant habitat conditions to encode the conceptual response models for the focus fish species from the present to the future (t = 0, 1, 5, 15, 25, and 50 yrs), and under pre-project and with-project conditions are described below. Revisions to the original SAM analysis are summarized in the discussion.

2.1 Project Description

The ARCF GRR project tentatively selected plan – Alternative 2 – Sacramento Bypass and Improve Levees, involves the construction of fix-in-place levee remediation measures along the Sacramento River, American River, and north side tributaries as well as widening of the Sacramento Weir and Bypass. Proposed repair actions for each waterway are presented below (Table 2). This SDAM analysis groups project actions into 4 SAM reaches based on hydrologic connectivity: American River North (ARN_AB), American River South (ARS_ABC), Sacramento River South (ARS_DEFG), and the Sacramento Bypass (SBP).

2.1.1 Sacramento River

The levees along the Sacramento River under Alternative 2 would be improved to address identified seepage, stability, erosion, and a minimal amount of height concerns. Most height concerns along the Sacramento River would be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass.

2.1.2 American River

Levees along the American River under Alternative 2 require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion to the river bank and levee, which could potentially undermine the levee foundation. There are two measures proposed for the American River levees: (1) bank protection, and (2) launchable rock trench. Both of these measures are described in detail in the BA.

2.1.3 East Side Tributaries

Natomas East Main Drain Canal (NEMDC) requires improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A conventional open trench cutoff wall would be constructed at these locations to address the seepage and stability problems. The NEMDC east levee also

has height issues which will be addressed with construction of a new floodwall. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction.

We will be doing no in-water work on NEMDC under the Alternative 2 scenario and after consultation with NMFS, NEMDC was left out of the SAM analyses.

2.1.4 Sacramento Weir and Bypass

Under Alternative 2, the width of the Sacramento Weir and Bypass would be roughly doubled to accommodate increased bypass flows. The expanded Sacramento Weir and Bypass would generally result in an additional 25,000 cfs flow during high water conditions. The frequency of water diversion is expected to be the same, which is to to use the current Sacramento Weir operation based on a stream gage at the I Street Bridge (Schlunegger 2014). Under normal flow conditions the Sacramento Weir and Bypass would be operating at pre-existing conditions described in detail in the ARCF GRR biological assessment (USACE 2014). Implementation of this action would result in the degradation of the existing north levee of the Sacramento Bypass and construction of a new levee approximately 1,500 feet to the north. The existing Sacramento Weir would be expanded to match the wider bypass. At this time, it is not known whether the new segment of weir would be constructed consistent with the 1916 design described above, or whether it would be designed to be a gravity-type weir. The new north levee of the bypass would be designed to be consistent with the existing Sacramento Bypass north levee, however, it would also include a 300-foot-wide seepage berm on the landside with a system of relief wells.

Table 2. ARCF GRR Project Alternative 2 – Proposed Remediation Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall	Bank Protection	Sacramento Bypass and Weir Widening, Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall
Arcade Creek	Cutoff Wall	Cutoff Wall	---	Floodwall
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek[2]	---	---	---	Floodwall, Levee Raise

[1]American River seepage, stability, and overtopping measures were addressed in the American River Common Features, WRDA 1996 and 1999 construction projects.
[2]In addition to the Floodwall, Magpie Creek will include construction of a new levee along Raley Boulevard south of the creek, and construction of a detention basin on both sides of Raley Boulevard. In addition, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek Bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

2.1.5 Construction Schedule

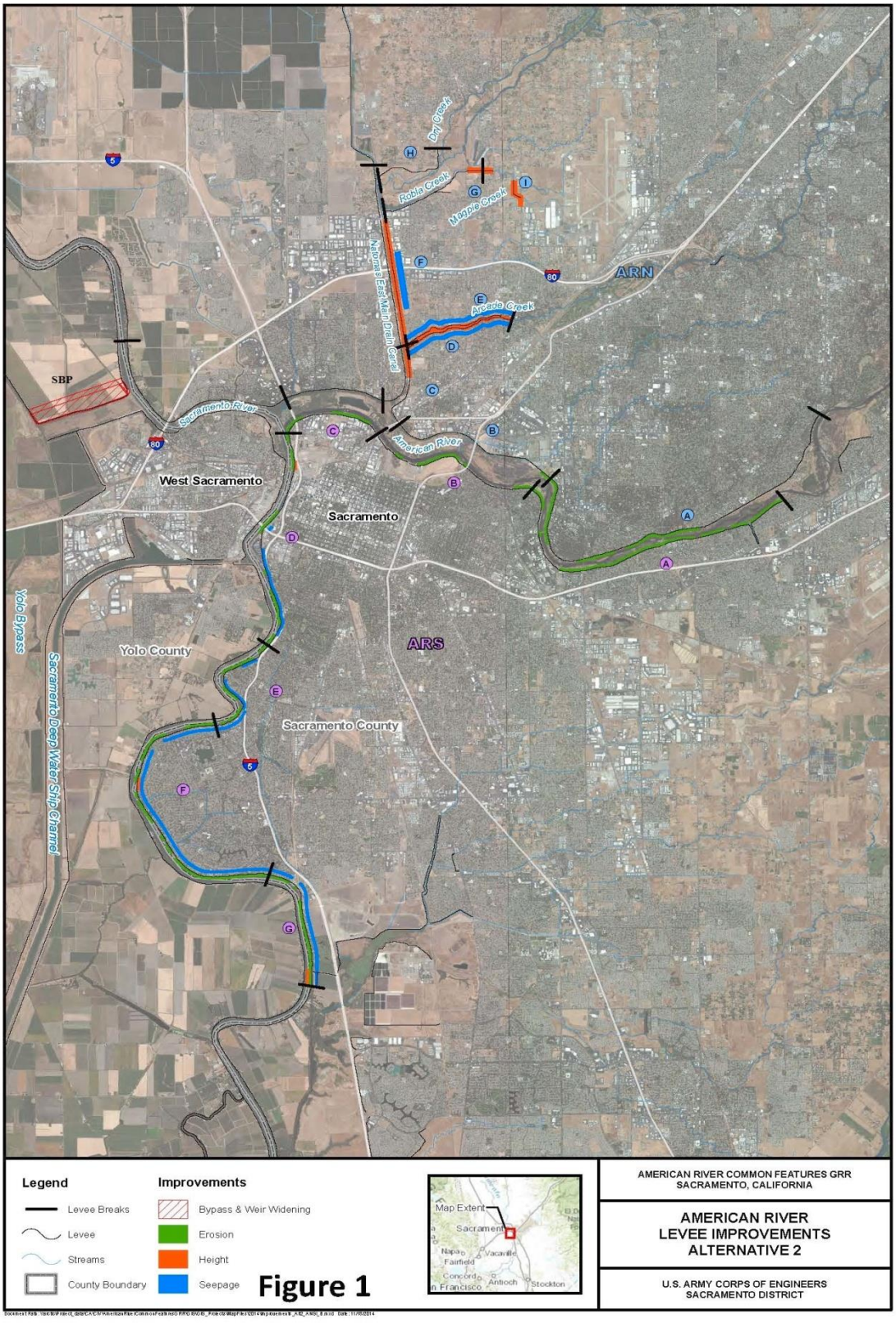
The ARCF GRR project reach will be implemented in increments. The timing of each project reach (Table 3) is based on the proposed schedule provided in the Biological Assessment: American River Common Features General Reevaluation Report (USACE 2014).

Table 3. ARCF GRR Project Alternative 2 – Construction Sequence and Duration

Priority	Construction Sequence	Reach	Construction Duration
1	Sacramento River	ARS F	5 years
2	Sacramento River	ARS E	3 years
3	American River	ARS A	4 years
4	Sacramento River	ARS G	3 years
5	Sacramento River	ARS D	3 years
6	American River	ARS B	2 years
7	American River	ARN A	4 years
8	American River	ARS C	3 years
9	American River	ARN B	2 years
10	Sacramento Weir & Bypass		4 years
11	Arcade Creek	ARN D	2 years
12	NEMDC	ARN F	2 years
13	Arcade Creek	ARN E	2 years
14	NEMDC	ARN C	2 years
15	Dry/Robla Creek	ARN G	3 years
16	Magpie Creek	ARN I	3 years

2.1.6 Vegetation on Levees

Compliance with Engineering Technical Letter 1110-2-571 (ETL) vegetation requires implementation of a vegetation-free zone within 15 ft of the waterside and landside toes of a levee. The levees along the Sacramento and American rivers were often set close to the river which has resulted in limited riparian vegetation in the project reach. The Corps is seeking a variance from the ETL vegetation requirements along the Sacramento River and American River portions of this project. This SAM analysis assumes that a Vegetation Variance Request (VVR) was assumed to be in place for the Sacramento and American River reaches. The Corps will obtain an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The Corps will be complying with the ETL on the American River via a System Wide Implementation Framework (SWIF). The VVR is not assumed to apply to the SBP.


Dry Creek
Roble Creek
Magpie Creek
Natomas East Main Drain Canal
Arcade Creek
ARN
SBP
Sacramento River
American River
West Sacramento
Sacramento
Yolo Bypass
Sacramento Deep Water Ship Channel
Yolo County
ARS
Sacramento County
Legend
Levee Breaks
Levee
Streams
County Boundary
Improvements
Bypass & Weir Widening
Erosion
Height
Seepage
Figure 1
Map Extent
Sacramento
Vacaville
Fairfield
Napa
Concord
San Francisco
Antioch
Stockton
AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA
AMERICAN RIVER
LEVEE IMPROVEMENTS
ALTERNATIVE 2
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

2.2 Characterization of Existing Conditions

The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the ARCF GRR project area under existing or pre-project conditions.

Sacramento River Revetment Database – This database was used to stratify the project reach into subreaches that encompass relatively uniform bank conditions based on their general physical characteristics (USACE 2007). This database was used to characterize existing habitat conditions within individual reaches where more recent data were unavailable.

Aerial images of the ARCF GRR project reach (Google™ Earth Pro), provided current and historical images of bank conditions that were used to address gaps or uncertainties related to existing cover characteristics within individual subreaches.

The following describes how input values for each of these attributes were derived for existing conditions in the SAM assessment. Specific input values for each site can be seen below at the end of report in (Tables 6-25).

2.2.1 Bank Slope

In the SAM, bank slope serves as an indicator of the availability of shallow-water habitat and is obtained from point estimates of bank slope (horizontal change to vertical change, dW:dH) along each seasonal shoreline (*i.e.*, the line where the water surface intersects the bank on average fall, winter, spring, and summer) (USACE 2012). Existing bank slopes were extrapolated from cross sections along the Sacramento River, American River, and existing SAM analyses performed on regionally analogous sites. Bank slope along all reaches was assumed to be 2 for existing conditions.

2.2.2 Floodplain Availability

In the SAM, floodplain habitat availability is considered important for juvenile life stages and is defined by areas that are flooded by the 2-year flood event (Q2) and measured by calculating a Floodplain Inundation Ratio (USACE 2012). This ratio is calculated by dividing the wetted channel and inundated floodplain areas during the 2-year flood event (AQ2) by the wetted channel area (AQavg) during average winter and spring flows. The amount of available floodplain habitat is consequently proportional to the ratio's positive deviation from unity (*i.e.*, values greater than 1) (USACE 2012).

In this SAM analysis, it was assumed that the with-project floodplain inundation ratios would be the same as pre-project values, which is consistent with assumptions made during the pre-construction SAM analyses. As a result, no impacts to habitat quality at the ARCF GRR reaches are expected with respect to this habitat variable.

2.2.3 Bank Substrate Size

The median substrate size (D_{50}) along the summer-fall and winter-spring shorelines of the project reach was determined through by referencing the Revetment Database (USACE 2007) and current and historical aerial images. Based on previous analysis of Sacramento River Bank Protection Project (SRBPP) sites (USACE 2008, USACE 2013) sections of shoreline with natural substrate were assigned a D_{50} of 0.25 inches. Sections of shoreline with rock revetment were assigned a D_{50} of 10 inches.

2.2.4 Instream Structure

The shoreline coverage of Instream Woody Material (IWM) along the average summer-fall and winter-spring shorelines of the ARCF GRR project reach were determined by referencing the revetment database (USACE 2007). The revetment database uses four classes of instream structure, based on ranges of percent shoreline having IWM. Table 4 indicates how these revetment database attribute values were converted to a single value for input to SAM. These values were assumed to be appropriate for both the summer-fall and winter-spring seasons. For sub-reaches without available data, an estimate was based on shoreline conditions assessed from aerial images. Shorelines with dense riparian canopy were assigned 5% shoreline coverage of IWM. Shorelines without dense riparian canopy were assigned 0% shoreline coverage of IWM.

Table 4. Conversion of Revetment Database Instream Woody Material Classes to SAM Attribute Value for Instream Structure

Revetment Database IWM Class	SAM Input Value
None	0%
1 - 10%	5%
11 - 50%	30%
> 50%	75%

2.2.5 Aquatic Vegetation

The revetment database attribute for Emergent Vegetation was used for summer-fall aquatic vegetation characterization, and the Ground Cover attribute was used for winter-spring characterization. Within the ARCF GRR project reaches, this approach generally gave a vegetation value of zero for summer-fall conditions, which is appropriate given the scarcity of emergent aquatic vegetation. Table 5 summarizes the conversion of revetment database attribute values for input to the SAM analysis.

Table 5. Conversion of Revetment Database Emergent Vegetation and Ground Cover Classes to SAM Attribute Values for Vegetation.

	Revetment Database IWM Class	SAM Input Value
Summer and Fall Revetment Database: "Emergent Vegetation" Attribute	False	0%
	PEM 1 - 5%	3%
	PEM 6 - 25%	15%
	PEM 26 – 75%	50%
	PEM >75%	85%
Winter and Spring Revetment Database: "Ground Cover" Attribute	<25%	13%
	26-50%	38%
	51-75%	63%
	>75%	88%

2.2.6 Overhanging Shade

The extent of overhanging shade along the summer-fall and winter-spring shorelines was determined through analysis of current and historic aerial images. Summer-fall conditions were analyzed using imagery from late summer and early fall months, typically representative of low water conditions. Winter-spring conditions were analyzed using imagery from late winter and early spring months, typically representative of high water conditions. Values for overhanging shade at winter and spring habitat conditions were modified by factors of 0.25 and 0.75 respectively to account for seasonal defoliation.

2.3 Characterization of With-Project Conditions

The with-project conditions were characterized using the project description outlined for Alternative 2 in the ARCF GRR BA. This analysis was conducted at a feasibility level of design; specific project designs will be developed under a Planning and Engineering Design phase. In the absence of more specific designs, this SAM analysis was developed using a set of "reasonable worst-case" parameters. The parameters were developed by evaluating the applicability of past levee repair designs to the project reach. Past levee repairs were conducted under the Sacramento River Bank Protection Project (SRBPP) within each of the sub-reaches (USACE 2008, USACE 2013). Applicability of design features was evaluated using the professional judgment and experience of the project team. In cases where the applicability of a particular design feature for a particular reach was in question, the analysis erred on the side of caution and applied reduced values or omitted the feature from final analysis. The set of reasonable worst-case parameters is designed to provide a maximum estimation of impact for the purpose of consultation at feasibility planning level. A Vegetation Variance Request (VVR) was assumed to be in place for the Sacramento and American River reaches. The Corps will obtain an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The

Corps will be complying with the ETL on the American River via a SWIF. The VVR is not assumed to apply to the SBP. Specific habitat attributes are provided by site in (Tables 6-25) and specific justifications for each variable is also provided in those tables.

The following describes how input values for each of the SAM habitat attributes were derived for with-project conditions:

2.3.1 Bank Slope

In the SAM, bank slope serves as an indicator of the availability of shallow-water habitat and is obtained from point estimates of bank slope (horizontal change to vertical change, dW:dH) along each seasonal shoreline (*i.e.*, the line where the water surface intersects the bank on average fall, winter, spring, and summer) (USACE 2004). With-project bank slopes were based on the description of project actions for each reach. Bank slopes for the Sacramento and American River reaches were assumed to be analogous to associated SRBPP repair sites that were in close proximity to the reach being analyzed. Consequently, bank slopes with a summer-fall slope of 3 and winter-spring slope of 10 were used.

2.3.2 Floodplain Availability

The with-project floodplain inundation ratios used in this SAM analysis remained unchanged from existing conditions. Levee repair and bank stabilization actions typically do not increase floodplain availability (with exception of constructing setback levees). In the absence of levee setback actions, the amount of available floodplain areas and channel cross sections would not be greatly altered during levee repair activities.

In this SAM analysis, it was assumed that the with-project floodplain inundation ratios would be the same as pre-project values. As a result, no impacts to habitat quality at the ARCF GRR reaches are expected with respect to this habitat variable.

2.3.3 Bank Substrate Size

The median substrate size (D_{50}) along the summer-fall and winter-spring shorelines of the project reach were based on the description of project actions for each sub-reach. Bank substrate size along the American River sub-reaches were assumed to be 18 inch rock revetment at summer-fall shoreline and 0.25 inch natural substrate at winter-spring shoreline. Bank substrate size along the Sacramento River sub-reaches were assumed to be 12 inch rock revetment at summer-fall shoreline and 0.25 inch natural substrate at winter-spring shoreline.

2.3.4 Instream Structure

The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines was based on the description of project actions for each reach. In the SAM

analysis, IWM coverage along the Sacramento and American River reaches were assumed to include installation of 40% shoreline coverage at summer-fall and winter-spring shoreline conditions.

2.3.5 Aquatic Vegetation

The shoreline coverage of aquatic vegetation along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Aquatic vegetation along the Sacramento and American River sub-reaches were assumed to be analogous to SRBPP repair sites. The vegetation growth models below applied to the Sacramento and American River sub-reaches were taken from previous SAM analysis'. For the American River (ARN_AB, ARS_ABC) four previously constructed SRBPP sites within the ARCF GRR project area were used for analysis (LAR 0.3L, LAR 2.8L, LAR 10.0L, and LAR 10.6L)(USACE, 2013). For the Sacramento River 15 previously constructed SRBPP sites within the ARCF GRR project area were used for analysis (SAC 49.7L, SAC 52.3L, and SAC 53.5R)(USACE 2013) and (RM 47.0L, RM 47.9R, RM 48.2R, RM 49.6R, RM 49.9L, RM 50.2L, RM 50.4L, RM 50.8L, RM 51.5 L, RM 52.4L, RM 53.1L, and RM 56.7L)(USACE 2008). Relevant O&M activities were considered but excluded from this analysis. The assumed vegetation variance would apply to woody vegetation only and O&M activities would be expected to result in the removal of shrubs on the slope of the levee; however, it was assumed that typical SRBPP repair designs would locate the planted riparian bench at appropriate elevations and distance from the levee to allow for revegetation efforts. Any removal of shrubby vegetation as the result of O&M activities would take place on the upper slope of the levee and would not impact the habitat considered in a typical SAM analysis.

2.3.6 Overhanging Shade

The shoreline coverage of overhanging shade along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Overhanging shade along the Sacramento and American River sub-reaches were assumed to be analogous to SRBPP repair sites. It was assumed that a variance would be in place allowing for retention of woody vegetation along the lower 2/3 of the levee slope. As the result of constructing a planted bench, it was assumed that the with-project seasonal shoreline would be shifted away from the existing shade providing canopy. Under this assumption, existing summer-fall values for overhanging shade were taken as the starting point for with-project winter-spring conditions. The with-project winter-spring values were further reduced by 75% (winter) and 25% (spring) to account for defoliation. As a final step, these winter-spring values were reduced by 20% to account for trees removed for construction equipment access. With-project overhanging shade values were expected to start at 0% as the result of a constructed bench shifting the shoreline away from the existing canopy. The shade growth models below were applied to the starting seasonal values for overhanging shade described above along the Sacramento and American River sub-reaches. These shade growth models were taken from previous SRBPP SAM analysis' conducted within the ARCF GRR project area.

3.0 Results

The SAM results are presented as weighted response indices (WRI), that give a relative indication of fish response to a project action over time. A negative WRI can be interpreted as a reduction in habitat value and a positive WRI can be interpreted as a increase in habitat value Although the WRI values are not directly representative of actual lengths or areas, the resource agencies have used those values as proxies in determining determine mitigative requirements. Appropriate mitigation is typically determined by identifying the maximum negative WRI for critical life stages (spawning and egg incubation, fry and juvenile rearing, and juvenile migration) on a site-by-site basis. Therefore this section will present results with a focus on the identification of maximum negative WRIs.

As described above, the ARCF GRR project reaches were grouped into four SAM analysis reaches based on hydrologic connectivity. Results are presented below by reach and species and are summarized in tables 30-32 and figures 2-22 at the end of the document.

3.1 Sacramento River SAM Analysis (ARS_DEFG)

The Sacramento River SAM analysis reach includes the entire left bank (east side) of the Sacramento River from the American River confluence to approximately 4,020 linear feet (lf) below the Freeport Bridge. The response of all runs of Chinook salmon, steelhead, and green sturgeon to project actions were included in the analysis of this reach. The green sturgeon spawning and egg incubation life stage was excluded from the analysis because spawning does not occur in the project area.

3.1.1 Spring/ Fall/ Late-Fall/ Winter Run Chinook Salmon

Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a positive response by year 5 in the winter-spring when most juvenile Chinook salmon are expected in the ARCF GRR project area. Short term negative WRI are expected within the recommended recovery period for Chinook salmon. The maximum negative WRI identified is -4,258 ft for the juvenile migration life stage of Chinook salmon in the summer of year 9. Short term negative WRI values will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions. The SAM data iterations for the various life stages for Chinook salmon can be seen in (Table 28). The WRI response curves for juvenile migration and rearing can be located in (Figures 4 and 7). The NMFS SAM effects analysis summary tables can be seen in (Table 32).

3.1.2 Steelhead

Steelhead are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Steelhead should exhibit a positive response by year 4 in the winter-spring when most juvenile

steelhead will be migrating and rearing through the project area. The maximum negative WRI identified is -3,985 ft for the juvenile migration life stage of steelhead in the fall of year 10. Short term negative WRI values will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions. The WRI response curves for juvenile migration and rearing can be located in (Figures 10 and 13).

3.1.3 Green Sturgeon

SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species. SAM WRI's for green sturgeon generally indicate a negative response or no response to typical onsite mitigative features. Green sturgeon are expected to show long term negative response to project actions in the Sacramento River SAM analysis reach for several life stages at all seasonal habitat conditions over the lifetime of the project. The maximum negative WRI identified is -5,009 for fry and juvenile rearing in the summer of year 1. Negative WRI displayed a general trend toward decreasing beyond the lifetime of the project for fry and juvenile rearing life stages. Negative WRI values for adult life stages will result from the creation of a 10:1 planted bench at winter/spring habitat conditions. The WRI response curves for juvenile rearing can be located in (Figure 16).

3.2 American River SAM Analysis (ARN_AB and ARS_ABC)

The American River SAM analysis reaches include portions of the right and left bank of the American River from Goethe Park to the confluence of the Sacramento. The response of spring and fall runs of Chinook salmon, steelhead, and green sturgeon were included in the analysis of these reaches. Additional seasonal fall run juvenile migration life stage analysis was conducted after consultation with NMFS. Green sturgeon analysis was also included because of critical habitat in the lowest sub-reach (ARS_C) of the American River project area.

3.2.1 Spring/ Fall Chinook Salmon

Chinook salmon are expected to show a long term positive response to project actions in the American River SAM analysis reaches over the lifetime of the project when both IWM and planted benches are incorporated into the with-project conditions. Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. The maximum negative WRI value identified for the American River SAM ARN_AB and ARS_ABC is -3,129 ft for the juvenile migration life stage of fall-run Chinook salmon in the summer of year 1. Short term negative WRI values will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions. The SAM data iterations for the various life stages for Chinook salmon can be seen in (Tables 26-27). The WRI response curves for juvenile migration and rearing can be located in (Figures 2,3,5,and 6). Additional fall-run Chinook salmon juvenile migration life stages not normally set as default in SAM were included on the American River reaches per NMFS request.

3.2.2 Steelhead

Steelhead are expected to show a long term positive response to project actions in the American River SAM analysis reach over the lifetime of the project. Steelhead should exhibit a positive response by year 4. Short term habitat deficits are expected within the recommended recovery period for steelhead. The maximum negative WRI value identified for the American River SAM analysis is -3,061 ft for the adult residence life stage in the summer of year 1 (Figures 20 and 21). Short term negative WRI values will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions. The WRI response curves for juvenile migration and rearing can be located in (Figures 8,9,11, and 12).

3.2.3 Green Sturgeon

Project actions in the American River SAM analysis reach will mimic SRBPP repair site onsite mitigative features. SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species; green sturgeon will exhibit a negative response for juvenile rearing in the summer/fall to these onsite mitigative features. However, during the winter/spring green sturgeon juvenile rearing life stages will exhibit a positive response to these onsite mitigative features. The maximum negative WRI value identified is -7,118 ft for the fry and juvenile rearing life stage in the summer of year 1. The WRI response curves for juvenile rearing can be located in (Figures 14 and 15).

3.3 Sacramento Bypass and Weir SAM Analysis

The Sacramento Bypass SAM analysis reach includes the right bank (north side) of the Sacramento Bypass levee in its entirety from the confluence of the Sacramento River to its termination at the Yolo Bypass. The response of all runs of Chinook salmon, steelhead, and green sturgeon were included in the analysis of this reach.

3.3.1 Spring/ Fall/ Late-Fall/ Winter Run Chinook Salmon

Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a negative response by year 1. The maximum negative WRI value identified is -188 ft for the juvenile migration life stage of Spring and Winter-run Chinook salmon in the spring of year 2. Short term and long term negative WRI values will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir. The SAM data iterations for the various life stages for Chinook salmon can be seen in (Table 29). The NMFS SAM effects analysis summary tables can be seen in (Table 33).

3.3.2 Steelhead

Steelhead are also expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Steelhead should exhibit a negative response by year 1. The maximum negative WRI value identified is -174 ft for the juvenile migration life stage in the spring of year 2. Short term and long term negative WRI values will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir. The NMFS SAM effects analysis summary tables can be seen in (Table 33).

3.3.3 Green Sturgeon

Green Sturgeon are expected to show a long term positive response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project for the fry and juvenile rearing life stages in the winter/spring/summer/fall of year 1. The maximum negative WRI value identified is -8 ft for the adult residence life stage of green sturgeon in the winter/spring/summer of year 1 which carries over through the life of the project into year 50. The SAM data iterations for the various life stages for green sturgeon can be seen in (Table 29). The NMFS SAM effects analysis summary tables can be seen in (Table 33).

4.0 Discussion

The SAM analysis indicates that the project actions in the Sacramento River SAM analysis reach, American River SAM analysis reach, and the Sacramento Bypass SAM analysis reach would result in short and longer-term impacts for focus fish species. Impacts to Chinook salmon, Central Valley steelhead, and green sturgeon are generally the result of reduction in the available natural substrate, shade and the alteration of near-shore slope resulting from bank armoring. Long term recovery of onsite vegetation, addition of IWM, and retention of existing vegetation are all expected to minimize impact as well as contribute to long term gains in habitat value.

This SAM analysis employed a set of worst case scenario parameters developed to capture the maximum potential impacts of the project for the Section 7 consultation process. Future implementation of the project is expected to result in significantly lower impacts. Project actions along portions of the American River reach will likely not include bank armoring in their final design, which will significantly reduce estimated impacts to fish species. Additional mitigative design features or improved erosion repair designs may result in reduced impact compared to the legacy designs used for the basis of this analysis. Site specific designs will be implemented on a site by site basis in consultation with resource agencies and project partners to minimize impacts as well as maximize opportunities for implementing onsite mitigative features.

During project implementation, site specific SAM analyses will be run on final designs to better evaluate impact. SAM results will be used by the Corps and NMFS in the negotiation of appropriate mitigation for project actions. Although short term impacts

are generally self mitigating through the development of onsite mitigative features, the Corps will compensate for the temporal impacts to habitat through the purchase of offsite mitigative credits. Typically appropriate mitigation will be based on the identification of maximum negative WRI values. By mitigating for the maximum negative WRI, lesser impacts are expected to be appropriately mitigated. As a general rule, the SAM applies any habitat characteristics at summer/fall conditions to winter/spring conditions with the assumption that those characteristics would provide similar value during inundation. Onsite mitigation at summer/fall conditions is expected to provide similar habitat benefit for winter/spring conditions. Offsite mitigation is expected to provide mitigative value at all seasonal habitat conditions. Longer term impacts to habitat may not recover to baseline conditions over the life of the project due to design restrictions. These impacts to habitat will be compensated through the purchase of offsite mitigative credits as well as the incorporation of additional onsite mitigative features (ie. low water plantings, additional IWM, additional revegetation).

Additional mitigative concerns, not considered in a SAM analysis, will be addressed along the Sacramento Bypass reach, including potential adult and juvenile passage issues, loss of shoreline riparian vs. gain in floodplain, and contradicting ESA species habitat requirements. These issues will be considered and appropriate actions will be taken where possible in coordination with other agencies.

4.1 Chinook Salmon

Impacts to Chinook salmon were analyzed for the Sacramento River SAM analysis reach (ARS_DEFG), American River SAM analysis reach (ARN_AB, ARS_ABC) and the Sacramento Bypass SAM analysis reach. In the Sacramento River SAM analysis reach, negative WRI values are due to short term removal of aquatic vegetation and overhanging shade caused by the repair action. The SAM analysis indicates that repair actions would result in a maximum negative WRI value of -4,258 ft. This value is based on the maximum negative WRI value observed for juvenile migration life stage of Chinook salmon in the summer of year 9. USACE will mitigate for -4,258 ft of equivalent habitat as described above in Section 4.0.

In the American River SAM analysis reaches ARN_AB and ARS_ABC negative WRI values are due to short term removal of aquatic vegetation and overhanging shade caused by the repair action. The SAM analysis incorporating planted benches and IWM indicates that repair actions would result in a maximum habitat deficit of -3,129 ft. This value is based on the maximum negative WRI value observed for the juvenile migration life stage of spring and fall-run Chinook salmon in the summer and fall of year 1. USACE will mitigate for -3,129 ft of equivalent habitat as described above in Section 4.0.

There were no initial construction impact negative WRI values for the juvenile rearing life stage of Chinook salmon in the winter and spring water levels on the American and Sacramento River reaches. A possible explanation is that the SAM ECT does not produce an output at Year-0. It does not calculate the difference from the

baseline to with-Project results. SAM at Year-0 is zero. The relative response for Year-1 is actually the Year-0 results+Year-1 results divided by 2, see pages 5-29 to 5-31 in the SAM Certification Update for SAM formula detailed explanation. In Year-0 revetment will be added, vegetation will be removed and slope will have a positive change. In Year-1 IWM will be added, soil and planting on the bench will occur, and the VVR will kick in. Year-0 habitat deficits would be more than the Year-1 deficits where the positive and negative deficits are equal.

In the Sacramento Bypass SAM analysis reach negative WRI values are due to short and long term removal of aquatic vegetation and overhanging shade for the upstream extension of the Sacramento Bypass Weir. The SAM analysis indicates that repair and removal actions would result in a maximum negative WRI value of -146 ft. This value is based on the maximum negative WRI value observed for juvenile migration of Chinook salmon in the winter of year 1. USACE will mitigate for -146 ft of equivalent habitat as described above in Section 4.0.

4.2 Steelhead

Impacts to steelhead were analyzed for the Sacramento River SAM analysis reach, American River SAM analysis reach, and the Sacramento Bypass SAM analysis reach. The Sacramento River SAM analysis indicates that repair actions would result in maximum negative WRI values of -3,985 ft. This value is based on the maximum negative WRI value observed for the juvenile migration life stage of steelhead in the fall of year 10.

The American River SAM analysis ARN_AB and ARS_ABC indicates that repair actions would result in negative WRI values of -3,061 ft. This negative WRI is expected to be adequately compensated through mitigation of a greater negative WRI for Chinook salmon.

There were no initial construction impact negative WRI values for the juvenile rearing life stage of steelhead in the winter and spring water levels on the Sacramento River reaches. A possible explanation is that the SAM ECT does not produce an output at Year-0. It does not calculate the difference from the baseline to with-Project results. SAM at Year-0 is zero. The relative response for Year-1 is actually the Year-0 results+Year-1 results divided by 2, see pages 5-29 to 5-31 in the SAM Certification Update for SAM formula detailed explanation. In Year-0 revetment will be added, vegetation will be removed and slope will have a positive change. In Year-1 IWM will be added, soil and planting on the bench will occur, and the VVR will kick in. Year-0 habitat deficits would be more than the Year-1 habitat deficits where the positive and negative deficits are equal.

The Sacramento Bypass SAM analysis indicates that repair actions would result in maximum negative WRI values of -174 ft. This value is based on the maximum

\negative WRI value observed for the juvenile migration life stage of steelhead in the spring of year 4. This negative WRI is expected to be adequately compensated through mitigation of a greater negative WRI for Chinook salmon.

4.3 Green Sturgeon

Impacts to green sturgeon were analyzed for the Sacramento and American River SAM and Sacramento Bypass analysis reaches. Green sturgeon critical habitat in the American River extends from the confluence of the Sacramento River to the Highway 160 bridge (ARS_C). Additional SAM elements were incorporated to address potential green sturgeon effects in the American River reaches (ARN_AB and ARS_AB), as per NMFS request, even though use of these reaches by green sturgeon has not been documented. Recently a white sturgeon (161mm) was collected in a rotary screw trap (RST) by the U.S. Fish and Wildlife Service (USFWS) at the Watt Avenue bridge, the first such documented catch of a sturgeon since records have been kept dating back to approximately 1996. There have been no green sturgeon collected, and the correlation of green sturgeon presence to white sturgeon presence is not well understood for larval life stages in this region of the river. This additional analysis allowed for a more conservative estimate of impacts and may not necessarily reflect the true impacts from the project.

The habitat requirements of green sturgeon are not well understood; assumptions built into the SAM on fish response to shoreline features were based on limited information. Habitat use of the American River, Sacramento River, and Sacramento Bypass project reaches by green sturgeon are likely limited to use as a migration corridor by adults and potential rearing area by juvenile life stages. Although the SAM indicates negative response to habitat by adult life stages, it is unlikely that shoreline repair activities would significantly impact the river for residence or as a migration corridor. SRBPP style repairs are designed to mimic naturally occurring habitat types and are not expected to significantly alter the width of the river. USACE does not expect any significant impacts to the adult residence or adult migration life stages in the American or Sacramento River and does not propose any additional mitigation.

No suitable spawning habitat exists in the Sacramento River, American River, and Sacramento Bypass project reaches. Green sturgeon spawning with concurrent egg incubation and early life history primarily takes place upriver of Colusa on the Sacramento River and in the lower Feather River outside of the project area. Because no suitable spawning habitat is present in the project reaches under existing conditions, USACE does not expect any significant impacts to the spawning and egg incubation life stage of green sturgeon and does not propose any additional mitigation.

The American River SAM analysis ARN_AB and ARS_ABC indicates that repair actions would result in a maximum negative WRI values of -7,118 ft. for fry and juvenile rearing in the summer of year one. The Sacramento River SAM analysis ARS_DEFG

indicates that repair actions would result in a maximum negative WRI values of -5,009 for fry and juvenile rearing in the summer of year one.

The Sacramento Bypass SAM analysis indicates that repair actions would result in maximum negative WRI values of -8 ft in response to the removal of aquatic vegetation and SRA for the expansion of the Sacramento Bypass and Weir. This value is based on the maximum negative WRI values observed for the adult residence life stage of green sturgeon in the winter/spring /summer of year 1 continuing through the life of the project to year 50.

Little is known about the fry and juvenile rearing and juvenile migration life stages of green sturgeon. The SAM does not evaluate response to specific habitat attributes for the juvenile migration life stage. For the purpose of this analysis it is assumed that these life stages exhibit similar responses to analogous life stages of Chinook and steelhead. This approach assumes that fry and juvenile rearing and juvenile migration life stages of green sturgeon will exhibit a positive response to “good riparian habitat” (*i.e.* increased shoreline coverage of overhanging shade, aquatic vegetation, and IWM). During the planning and design phase of the project, opportunities for the incorporation of additional onsite mitigative features will be evaluated in coordination with resource agencies to ensure the projected longer term impacts are appropriately compensated for green sturgeon. Potential onsite mitigative features include the planting of vegetation at the low water line, the incorporation of additional IWM, and limitations in instream revetment.

Table 6
SAM data summary of existing conditions at site Lower American River RM 10.0L and 10.6L (ARN_AB).

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2024	18,576	18,576	18,576	18,576
	2074	18,576	18,576	18,576	18,576
Bank Slope (dH:dV) [2]	2024	2	2	2	2
	2074	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	2.5	2.5	2.5	2.5
	2074	2.5	2.5	2.5	2.5
Instream Structure (% shoreline) [5]	2024	31	31	31	31
	2074	31	31	31	31
Vegetation (% shoreline) [6]	2024	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [7]	2024	60	15	45	60
	2074	60	15	45	60

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 2 SRBPP repair sites modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 7

SAM data summary of with-project conditions at site Lower American River RM 10.0L and 10.6L (ARN_AB).

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2024	18,576	18,576	18,576	18,576
	2074	18,576	18,576	18,576	18,576
Bank Slope (dH:dV) [2]	2024	2	3	3	3
	2025	3	10	10	3
	2074	3	10	10	3
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	2.5	18	18	18
	2025	18	0.25	0.25	18
	2074	18	0.25	0.25	18
Instream Structure (% shoreline) [5]	2024	31	0	0	0
	2025	40	40	40	40
	2074	40	40	40	40
Vegetation (% shoreline) [6]	2024	0	0	0	0
	2025	0	25	50	0
	2029	0	88	88	0
	2039	0	88	88	0
	2049	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [6]	2024	0	13	38	0
	2025	0	13	40	0
	2029	0	25	75	0
	2039	100	25	75	100
	2049	100	25	75	100
	2074	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 18 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee.

Table 8
SAM data summary of existing conditions at site Lower American River RM 10.0L and 10.6L (ARS_A).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2020	14,345	14,345	14,345	14,345
	2070	14,345	14,345	14,345	14,345
Bank Slope (dH:dV) [2]	2020	2.00	2.00	2.00	2.00
	2070	2.00	2.00	2.00	2.00
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	1.2	1.2	1.2	1.2
	2070	1.2	1.2	1.2	1.2
Instream Structure (% shoreline) [5]	2020	1.7	1.7	1.7	1.7
	2070	1.7	1.7	1.7	1.7
Vegetation (% shoreline) [6]	2020	0	63	63	0
	2070	0	63	63	0
Shade (% shoreline) [7]	2020	42	11	32	42
	2070	42	11	32	42

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 2 SRBPP repair sites modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 9

SAM data summary of with-project conditions at site Lower American River RM 10.0L and 10.6L (ARS_A).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2020	14,345	14,345	14,345	14,345
	2070	14,345	14,345	14,345	14,345
Bank Slope (dH:dV) [2]	2020	2.0	3.0	3.0	3.0
	2021	3.0	10.0	10.0	3.0
	2070	3.0	10.0	10.0	3.0
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	1.2	18	18	18
	2021	18	0.25	0.25	18
	2070	18	0.25	0.25	18
Instream Structure (% shoreline) [5]	2020	1.7	0.0	0.0	0
	2021	40	40	40	40
	2070	40	40	40	40
Vegetation (% shoreline) [6]	2020	0	0	0	0
	2021	0	25	50	0
	2025	0	88	88	0
	2035	0	88	88	0
	2045	0	88	88	0
	2070	0	88	88	0
Shade (% shoreline) [6]	2020	0	9	27	0
	2021	0	9	29	0
	2025	0	24	74	0
	2035	100	25	75	100
	2045	100	25	75	100
	2070	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 18 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 10
SAM data summary of existing conditions at site Lower American River RM 2.8L (ARS_B).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2023	5,472	5,472	5,472	5,472
	2073	5,472	5,472	5,472	5,472
Bank Slope (dH:dV) [2]	2023	2	2	2	2
	2073	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2023	1	1	1	1
	2073	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2023	1.5	1.5	1.5	1.5
	2073	1.5	1.5	1.5	1.5
Instream Structure (% shoreline) [5]	2023	5	5	5	5
	2073	5	5	5	5
Vegetation (% shoreline) [6]	2023	0	65	65	0
	2073	0	65	65	0
Shade (% shoreline) [7]	2023	30	7	22	30
	2073	30	7	22	30

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 1 SRBPP repair site modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 11

SAM data summary of with-project conditions at site Lower American River RM 2.8L (ARS_B).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2023	5,472	5,472	5,472	5,472
	2073	5,472	5,472	5,472	5,472
Bank Slope (dH:dV) [2]	2023	2	3	3	3
	2024	3	10	10	3
	2073	3	10	10	3
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2023	1	1	1	1
	2073	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2023	1.5	18	18	18
	2024	18	0.25	0.25	18
	2073	18	0.25	0.25	18
Instream Structure (% shoreline) [5]	2023	5	0	0	0
	2024	40	40	40	40
	2073	40	40	40	40
Vegetation (% shoreline) [6]	2023	0	0	0	0
	2024	0	25	50	0
	2028	0	88	88	0
	2038	0	88	88	0
	2048	0	88	88	0
	2073	0	88	88	0
Shade (% shoreline) [6]	2023	0	7	20	0
	2024	0	7	22	0
	2028	0	22	67	0
	2038	100	25	75	100
	2048	100	25	75	100
	2073	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 18 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 12

SAM data summary of existing conditions at site Lower American River RM 0.3L (ARS_C).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2026	3,988	3,988	3,988	3,988
	2076	3,988	3,988	3,988	3,988
Bank Slope (dH:dV) [2]	2026	2	2	2	2
	2076	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2026	1	1	1	1
	2076	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2026	0.25	0.25	0.25	0.25
	2076	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [5]	2026	5	5	5	5
	2076	5	5	5	5
Vegetation (% shoreline) [6]	2026	0	88	88	0
	2076	0	88	88	0
Shade (% shoreline) [7]	2026	67	16	50	67
	2076	67	16	50	67

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 1 SRBPP repair site modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 13
SAM data summary of with-project conditions at site Lower American River RM 0.3L (ARS_C).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2026	3,988	3,988	3,988	3,988
	2076	3,988	3,988	3,988	3,988
Bank Slope (dH:dV) [2]	2026	2	3	3	3
	2027	3	10	10	3
	2076	3	10	10	3
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2026	1	1	1	1
	2076	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2026	0.25	18	18	18
	2027	18	0.25	0.25	18
	2076	18	0.25	0.25	18
Instream Structure (% shoreline) [5]	2026	5	0	0	0
	2027	40	40	40	40
	2076	40	40	40	40
Vegetation (% shoreline) [6]	2026	0	0	0	0
	2027	0	25	50	0
	2031	0	88	88	0
	2041	0	88	88	0
	2051	0	88	88	0
	2076	0	88	88	0
Shade (% shoreline) [6]	2026	0	14	42	0
	2027	0	14	44	0
	2031	0	25	75	0
	2041	100	25	75	100
	2051	100	25	75	100
	2076	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.
[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.
[5] Assume installation of rock revetment at summer/fall (D_{50} of 18 in) and natural substrate at winter/spring (D_{50} of 0.25 in).
[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.
[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 14

SAM data summary of existing conditions at site Sacramento River RM 56.7L (ARS_D).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2025	9,131	9,131	9,131	9,131
	2075	9,131	9,131	9,131	9,131
Bank Slope (dH:dV) [2]	2025	1.8	1.8	1.8	1.8
	2075	1.8	1.8	1.8	1.8
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2025	1	1	1	1
	2075	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2025	7.6	7.6	7.6	7.6
	2075	7.6	7.6	7.6	7.6
Instream Structure (% shoreline) [5]	2025	22	22	22	22
	2075	22	22	22	22
Vegetation (% shoreline) [6]	2025	0	88	88	0
	2075	0	88	88	0
Shade (% shoreline) [7]	2025	40	10	30	40
	2075	40	10	30	40

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 1 SRBPP repair site modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 15

SAM data summary of with-project conditions at site Sacramento River RM 56.7L (ARS_D).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2025	9,131	9,131	9,131	9,131
	2075	9,131	9,131	9,131	9,131
Bank Slope (dH:dV) [2]	2025	2.5	1.5	1.5	1.5
	2026	1.5	6.5	6.5	1.5
	2075	1.5	6.5	6.5	1.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2025	1	1	1	1
	2075	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2025	7.6	12	12	12
	2026	12	0.25	0.25	12
	2075	12	0.25	0.25	12
Instream Structure (% shoreline) [5]	2025	22	0	0	0
	2026	0	0	0	0
	2075	0	0	0	0
Vegetation (% shoreline) [6]	2025	0	0	0	0
	2026	0	0	0	0
	2030	10	60	60	10
	2040	10	88	88	10
	2050	10	88	88	10
	2075	10	88	88	10
Shade (% shoreline) [6]	2025	0	8	24	0
	2026	0	8	25	0
	2030	0	9	35	0
	2040	61	13	66	61
	2050	97	15	75	97
	2075	99	15	75	99

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 12 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume no installation of shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 16

SAM data summary of existing conditions at site Sacramento River RM 53.1L and RM 53.5R (ARS_E).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2021	9,149	9,149	9,149	9,149
	2071	9,149	9,149	9,149	9,149
Bank Slope (dH:dV) [2]	2021	1.7	1.7	1.7	1.7
	2071	1.7	1.7	1.7	1.7
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2021	1	1	1	1
	2071	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2021	7	7	7	7
	2071	7	7	7	7
Instream Structure (% shoreline) [5]	2021	30	30	30	30
	2071	30	30	30	30
Vegetation (% shoreline) [6]	2021	0	88	88	0
	2071	0	88	88	0
Shade (% shoreline) [7]	2021	60	15	45	60
	2071	60	15	45	60

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 2 SRBPP repair sites modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 17
SAM data summary of with-project conditions at site Sacramento River RM 53.1L and 53.5R (ARS_E).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2021	9,149	9,149	9,149	9,149
	2071	9,149	9,149	9,149	9,149
Bank Slope (dH:dV) [2]	2021	1.7	2	2	2
	2022	2	6	6	2
	2071	2	6	6	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2021	1	1	1	1
	2071	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2021	7	12	12	12
	2022	12	0.25	0.25	12
	2071	12	0.25	0.25	12
Instream Structure (% shoreline) [5]	2021	30	0	0	0
	2022	40	40	40	40
	2071	40	40	40	40
Vegetation (% shoreline) [6]	2021	0	0	0	0
	2022	0	50	50	0
	2026	0	88	88	0
	2036	0	88	88	0
	2046	0	88	88	0
	2071	0	88	88	0
Shade (% shoreline) [6]	2021	0	12	36	0
	2022	0	12	37	0
	2026	0	13	42	0
	2036	61	17	75	61
	2046	97	19	75	97
	2071	99	19	75	99

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.
[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.
[5] Assume installation of rock revetment at summer/fall (D_{50} of 12 in) and natural substrate at winter/spring (D_{50} of 0.25 in).
[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.
[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 18

SAM data summary of existing conditions at site Sacramento River RM 48.2L-52.4L (ARS_F).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2020	21,379	21,379	21,379	21,379
	2070	21,379	21,379	21,379	21,379
Bank Slope (dH:dV) [2]	2020	1.8	1.8	1.8	1.8
	2070	1.8	1.8	1.8	1.8
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	8.7	8.7	8.7	8.7
	2070	8.7	8.7	8.7	8.7
Instream Structure (% shoreline) [5]	2020	17	17	17	17
	2070	17	17	17	17
Vegetation (% shoreline) [6]	2020	0	88	88	0
	2070	0	88	88	0
Shade (% shoreline) [7]	2020	73	18	54	73
	2070	73	18	54	73

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 10 SRBPP repair sites modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 19

SAM data summary of with-project conditions at site Sacramento River RM 48.2L-52.4L (ARS_F).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2020	21,379	21,379	21,379	21,379
	2070	21,379	21,379	21,379	21,379
Bank Slope (dH:dV) [2]	2020	1.8	2.0	2.0	2
	2021	2	6	6	2
	2070	2	6	6	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	8.7	12	12	12
	2021	12	0.25	0.25	12
	2070	12	0.25	0.25	12
Instream Structure (% shoreline) [5]	2020	17	0	0	0
	2021	40	40	40	40
	2070	40	40	40	40
Vegetation (% shoreline) [6]	2020	0	0	0	0
	2021	0	50	50	0
	2025	0	88	88	0
	2035	0	88	88	0
	2045	0	88	88	0
	2070	0	88	88	0
Shade (% shoreline) [6]	2020	0	14	43	0
	2021	0	14	44	0
	2025	0	15	54	0
	2035	61	19	75	61
	2045	97	21	75	97
	2070	99	21	75	99

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 12 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 20

SAM data summary of existing conditions at site Sacramento River RM 47.0L and 47.9R (ARS_G).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2024	11,066	11,066	11,066	11,066
	2074	11,066	11,066	11,066	11,066
Bank Slope (dH:dV) [2]	2024	2	2	2	2
	2074	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	9.40	9.40	9.40	9.40
	2074	9.40	9.40	9.40	9.40
Instream Structure (% shoreline) [5]	2024	5.5	5.5	5.5	5.5
	2074	5.5	5.5	5.5	5.5
Vegetation (% shoreline) [6]	2024	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [7]	2024	90	22	67	90
	2074	90	22	67	90

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Existing slopes taken from 2 SRBPP repair sites modeled by SAM.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of one for all seasons in all ARCF GRR Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 21

SAM data summary of with-project conditions at site Sacramento River RM 47.0L and 47.9R (ARS_G).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Shoreline Length (feet) [1]	2024	11,066	11,066	11,066	11,066
	2074	11,066	11,066	11,066	11,066
Bank Slope (dH:dV) [2]	2024	2.5	3	3	3
	2025	3	10	10	3
	2074	3	10	10	3
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	9.4	12	12	12
	2025	12	0.25	0.25	12
	2074	12	0.25	0.25	12
Instream Structure (% shoreline) [5]	2024	5.5	0	0	0
	2025	40	40	40	40
	2074	40	40	40	40
Vegetation (% shoreline) [6]	2024	0	0	0	0
	2025	0	50	50	0
	2029	0	88	88	0
	2039	0	88	88	0
	2049	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [6]	2024	0	18	54	0
	2025	0	18	55	0
	2029	0	19	65	0
	2039	100	23	75	100
	2049	100	25	75	100
	2074	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction.

[4] Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.

[5] Assume installation of rock revetment at summer/fall (D_{50} of 12 in) and natural substrate at winter/spring (D_{50} of 0.25 in).

[6] Assume installation of 40% shoreline coverage of IWM at summer/fall and winter/spring.

[6] Assume a variance in place allowing existing woody vegetation to remain in place on bottom 2/3 of levee

Table 22

SAM data summary of existing conditions at site Sacramento River 50.0L (SBP Levee).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Wetted Area (square feet) [1]	2012	8,799,296	8,799,296	8,799,296	8,799,296
	2062	8,799,296	8,799,296	8,799,296	8,799,296
Shoreline Length (feet) [2]	2012	9,047	9,047	9,047	9,047
	2062	9,047	9,047	9,047	9,047
Bank Slope (dH:dV) [3]	2012	2	2	2	2
	2062	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [4]	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [5]	2012	2.4	2.4	2.4	2.4
	2062	2.4	2.4	2.4	2.4
Instream Structure (% shoreline) [6]	2012	3.9	3.9	3.9	3.9
	2062	3.9	3.9	3.9	3.9
Vegetation (% shoreline) [7]	2012	0	71	71	0
	2062	0	71	71	0
Shade (% shoreline) [8]	2012	48	12	36	48
	2062	48	12	36	48

[1] Wetted area estimated from aerial images in Google Earth Pro. Length x Width
[2] USACE Revetment Database (2007) and Google Earth Pro.
[3] Repairs not expected to affect slope, assume slope of 2 for consistency with USACE standards.
[4] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.
[5] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[6] Instream Structure data taken from USACE Revetment Database (2007).
[7] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[8] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 23
SAM data summary of with-project conditions at site Sacramento River RM 50.0L (SBP Levee).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Wetted Area (square feet) [1]	2012	23,022,296	23,022,296	23,022,296	23,022,296
	2062	23,022,296	23,022,296	23,022,296	23,022,296
Shoreline Length (feet) [2]	2012	9,047	9,047	9,047	9,047
	2062	9,047	9,047	9,047	9,047
Bank Slope (dH:dV)	2012	2.5	2.5	2.5	2.5
	2013	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg)	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [3]	2012	2.4	2.4	2.4	2.4
	2013	2.4	2.4	2.4	2.4
	2062	2.4	2.4	2.4	2.4
Instream Structure (% shoreline) [3]	2012	3.9	3.9	3.9	3.9
	2013	3.9	3.9	3.9	3.9
	2062	3.9	3.9	3.9	3.9
Vegetation (% shoreline) [3]	2012	0	71	71	0
	2013	0	71	71	0
	2017	0	71	71	0
	2027	0	71	71	0
	2037	0	71	71	0
	2062	0	71	71	0
Shade (% shoreline)[3]	2012	48	12	36	48
	2013	48	12	36	48
	2017	48	12	36	48
	2027	48	12	36	48
	2037	48	12	36	48
	2062	48	12	36	48

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Wetted area calculated by aerial images and a length x width with-project conditions

[2] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[3] Assumed to stay the same due to only degrading and moving levee

Table 24
SAM data summary of existing conditions at site Sacramento River RM 50.0L (SBP Weir).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Wetted Area (square feet) [1]	2012	283,968	283,968	283,968	283,968
	2062	283,968	283,968	283,968	283,968
Shoreline Length (feet) [2]	2012	1,500	1,500	1,500	1,500
	2062	1,500	1,500	1,500	1,500
Bank Slope (dH:dV) [3]	2012	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [4]	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [5]	2012	10	10	10	10
	2062	10	10	10	10
Instream Structure (% shoreline) [6]	2012	0	0	0	0
	2062	0	0	0	0
Vegetation (% shoreline) [7]	2012	0	88	88	0
	2062	0	88	88	0
Shade (% shoreline) [8]	2012	48	12	36	48
	2062	48	12	36	48

[1] Wetted area estimated from aerial images in Google Earth Pro. Length x Width
[2] USACE Revetment Database (2007) and Google Earth Pro.
[3] Repairs not expected to affect slope, assume slope of 2 for consistency with USACE standards.
[4] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.
[5] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[6] Instream Structure data taken from USACE Revetment Database (2007).
[7] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[8] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation

Table 25
SAM data summary of with-project conditions at site Sacramento River RM 50.0L (SBP Weir).

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Wetted Area (square feet) [1]	2012	742,968	742,968	742,968	742,968
	2062	742,968	742,968	742,968	742,968
Shoreline Length (feet) [2]	2012	1,500	1,500	1,500	1,500
	2062	1,500	1,500	1,500	1,500
Bank Slope (dH:dV) [3]	2012	2.5	2.5	2.5	2.5
	2013	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [4]	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [5]	2012	10	10	10	10
	2013	10	10	10	10
	2062	10	10	10	10
Instream Structure (% shoreline) [6]	2012	0	0	0	0
	2013	0	0	0	0
	2062	0	0	0	0
Vegetation (% shoreline) [6]	2012	0	0	0	0
	2013	0	0	0	0
	2017	0	0	0	0
	2027	0	0	0	0
	2037	0	0	0	0
	2062	0	0	0	0
Shade (% shoreline) [6]	2012	0	0	0	0
	2013	0	0	0	0
	2017	0	0	0	0
	2027	0	0	0	0
	2037	0	0	0	0
	2062	0	0	0	0

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Wetted area calculated by aerial images and a length x width with-project conditions
[2] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[3] Repairs not expected to affect slope, assume slope of 2.5 for consistency with USACE standards.
[4] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all ARCF GRR Reaches.
[5] Assume installation of rock revetment at summer/fall (D_{50} of 12 in) and natural substrate at winter/spring (D_{50} of 0.25 in).
[6] Assume no vegetation variance and no placement of IWM and O&M activities

Table 26
American River SAM Analysis Reach
ARN_AB
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
0			0	0				0	0				0					0		
1			-366	-1,945				59	-3,002				124					-421		
2			-365	-2,166				411	-1,357				634					-392		
3			-365	-2,240				564	-662				827					-383		
4			-364	-2,277				667	-201				941					-378		
5			-364	-2,299				751	167				1,024					-375		
6			-361	-2,303				816	450				1,085					-370		
7			-353	-2,288				863	653				1,129					-360		
8			-341	-2,260				897	805				1,161					-348		
9			-328	-2,225				925	924				1,187					-334		
10			-314	-2,183				946	1,018				1,207					-319		
11			-298	-2,138				964	1,096				1,224					-303		
12			-282	-2,089				979	1,160				1,238					-287		
13			-265	-2,038				991	1,215				1,250					-270		
14			-248	-1,985				1,002	1,261				1,260					-252		
15			-230	-1,930				1,011	1,302				1,268					-234		
25			-124	-1,600				1,063	1,529				1,317					-126		
50			-44	-1,352				1,102	1,699				1,354					-45		
Fall-run Chinook																				
0	0	0	0	0		0	0	0	0			0	0	0					0	
1	-877	0	-366	-1,945		-759	0	59	-3,002			0	124	-2,681					-3,129	
2	-853	0	-365	-2,166		-339	0	411	-1,357			0	634	-755					-2,759	
3	-845	0	-365	-2,240		-180	0	564	-662			0	827	-80					-2,635	
4	-841	0	-364	-2,277		-87	0	667	-201			0	941	282					-2,573	
5	-839	0	-364	-2,299		-20	0	751	167			0	1,024	519					-2,536	
6	-828	0	-361	-2,303		29	0	816	450			0	1,085	686					-2,501	
7	-804	0	-353	-2,288		64	0	863	653			0	1,129	805					-2,457	
8	-773	0	-341	-2,260		90	0	897	805			0	1,161	894					-2,408	
9	-736	0	-328	-2,225		111	0	925	924			0	1,187	963					-2,356	
10	-695	0	-314	-2,183		127	0	946	1,018			0	1,207	1,018					-2,302	
11	-652	0	-298	-2,138		141	0	964	1,096			0	1,224	1,064					-2,245	
12	-606	0	-282	-2,089		152	0	979	1,160			0	1,238	1,102					-2,188	
13	-559	0	-265	-2,038		161	0	991	1,215			0	1,250	1,134					-2,129	
14	-511	0	-248	-1,985		170	0	1,002	1,261			0	1,260	1,161					-2,069	
15	-462	0	-230	-1,930		177	0	1,011	1,302			0	1,268	1,185					-2,009	
25	-164	0	-124	-1,600		216	0	1,063	1,529			0	1,317	1,318					-1,647	
50	59	0	-44	-1,352		245	0	1,102	1,699			0	1,354	1,418					-1,375	

4.0 defaults used for all response curves
Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 26 (cont.)
American River SAM Analysis Reach
ARN_AB
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Steelhead																				
0	0		0		0	0	0	0		0	0	0	0	0	0			0	0	0
1	-1,554		-701		-1,554	-1,558	0	-36		-1,558	-1,635	0	-1	-2,096	-1,635			-833	-3,013	-3,061
2	-1,508		-708		-1,508	-701	0	519		-701	-739	0	734	-520	-739			-774	-2,634	-2,262
3	-1,493		-711		-1,493	-381	0	750		-381	-411	0	1,009	23	-411			-755	-2,507	-1,996
4	-1,486		-712		-1,486	-195	0	900		-195	-225	0	1,168	309	-225			-745	-2,444	-1,862
5	-1,481		-712		-1,481	-63	0	1,018		-63	-96	0	1,282	491	-96			-739	-2,406	-1,782
6	-1,463		-707		-1,463	34	0	1,109		34	-3	0	1,365	617	-3			-729	-2,369	-1,714
7	-1,423		-693		-1,423	103	0	1,174		103	63	0	1,424	708	63			-712	-2,323	-1,639
8	-1,371		-674		-1,371	155	0	1,222		155	113	0	1,469	775	113			-691	-2,271	-1,559
9	-1,309		-651		-1,309	196	0	1,260		196	152	0	1,504	828	152			-666	-2,215	-1,477
10	-1,242		-626		-1,242	228	0	1,290		228	183	0	1,531	870	183			-639	-2,156	-1,392
11	-1,170		-599		-1,170	254	0	1,315		254	209	0	1,554	904	209			-611	-2,095	-1,307
12	-1,095		-571		-1,095	276	0	1,335		276	230	0	1,573	933	230			-582	-2,033	-1,220
13	-1,017		-541		-1,017	295	0	1,353		295	248	0	1,589	957	248			-551	-1,970	-1,133
14	-937		-511		-937	311	0	1,367		311	263	0	1,603	978	263			-520	-1,906	-1,044
15	-855		-480		-855	325	0	1,380		325	276	0	1,615	996	276			-489	-1,841	-956
25	-362		-293		-362	402	0	1,453		402	351	0	1,681	1,097	351			-298	-1,450	-422
50	8		-153		8	460	0	1,507		460	407	0	1,731	1,173	407			-156	-1,157	-22
Green Sturgeon																				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	-3,250	-2,873	0	-11	0	-3,250	-5,020	0	-2,750	0	-3,250	-5,020	0	-2,750	0	-6,500	-7,118	0	-942
2	0	-4,875	-4,304	0	-16	0	-1,625	-3,280	0	-3,194	0	-1,625	-3,280	0	-3,194	0	-6,500	-6,426	0	-482
3	0	-5,417	-4,781	0	-18	0	-1,083	-2,699	0	-3,343	0	-1,083	-2,699	0	-3,343	0	-6,500	-6,196	0	-328
4	0	-5,688	-5,019	0	-19	0	-812	-2,409	0	-3,417	0	-812	-2,409	0	-3,417	0	-6,500	-6,081	0	-252
5	0	-5,850	-5,162	0	-20	0	-650	-2,235	0	-3,461	0	-650	-2,235	0	-3,461	0	-6,500	-6,011	0	-206
6	0	-5,958	-5,258	0	-20	0	-541	-2,119	0	-3,491	0	-541	-2,119	0	-3,491	0	-6,500	-5,965	0	-175
7	0	-6,036	-5,326	0	-20	0	-464	-2,036	0	-3,512	0	-464	-2,036	0	-3,512	0	-6,500	-5,932	0	-153
8	0	-6,094	-5,377	0	-20	0	-406	-1,974	0	-3,528	0	-406	-1,974	0	-3,528	0	-6,500	-5,908	0	-137
9	0	-6,139	-5,417	0	-20	0	-361	-1,926	0	-3,540	0	-361	-1,926	0	-3,540	0	-6,500	-5,888	0	-124
10	0	-6,175	-5,448	0	-21	0	-325	-1,887	0	-3,550	0	-325	-1,887	0	-3,550	0	-6,500	-5,873	0	-114
11	0	-6,205	-5,475	0	-21	0	-295	-1,855	0	-3,558	0	-295	-1,855	0	-3,558	0	-6,500	-5,860	0	-105
12	0	-6,229	-5,496	0	-21	0	-271	-1,829	0	-3,565	0	-271	-1,829	0	-3,565	0	-6,500	-5,850	0	-98
13	0	-6,250	-5,515	0	-21	0	-250	-1,807	0	-3,570	0	-250	-1,807	0	-3,570	0	-6,500	-5,841	0	-92
14	0	-6,268	-5,530	0	-21	0	-232	-1,787	0	-3,575	0	-232	-1,787	0	-3,575	0	-6,500	-5,833	0	-87
15	0	-6,283	-5,544	0	-21	0	-216	-1,771	0	-3,579	0	-216	-1,771	0	-3,579	0	-6,500	-5,827	0	-83
25	0	-6,370	-5,620	0	-21	0	-130	-1,678	0	-3,603	0	-130	-1,678	0	-3,603	0	-6,500	-5,790	0	-58
50	0	-6,435	-5,677	0	-21	0	-65	-1,608	0	-3,621	0	-65	-1,608	0	-3,621	0	-6,500	-5,762	0	-40

4.0 defaults used for all response curves

Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

4.0 defaults used for all response curves
Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 27
American River SAM Analysis Reach
ARS_ABC
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
0			0	0				0	0				0					0		
1			-200	-620				114	-333				194					-229		
2			-192	-507				366	912				561					-207		
3			-201	-522				467	1,280				689					-214		
4			-212	-557				571	1,647				816					-225		
5			-217	-568				691	2,137				965					-228		
6			-224	-588				779	2,453				1,068					-234		
7			-229	-602				861	2,736				1,169					-239		
8			-229	-595				947	3,058				1,278					-237		
9			-224	-577				1,019	3,328				1,368					-232		
10			-216	-549				1,079	3,554				1,441					-223		
11			-206	-513				1,131	3,748				1,502					-212		
12			-193	-471				1,175	3,915				1,553					-199		
13			-179	-422				1,213	4,056				1,596					-184		
14			-163	-369				1,246	4,177				1,634					-167		
15			-145	-312				1,275	4,283				1,666					-150		
25			-11	126				1,440	4,881				1,849					-14		
50			100	488				1,564	5,329				1,986					99		
Fall-run Chinook																				
0	0	0	0	0		0	0	0	0			0	0	0					0	
1	9	0	-200	-620		456	0	114	-333			0	194	52					-967	
2	284	0	-192	-507		783	0	366	912			0	561	1,529					-681	
3	347	0	-201	-522		886	0	467	1,280			0	689	1,860					-694	
4	399	0	-212	-557		994	0	571	1,647			0	816	2,176					-728	
5	463	0	-217	-568		1,119	0	691	2,137			0	965	2,612					-705	
6	497	0	-224	-588		1,202	0	779	2,453			0	1,068	2,845					-723	
7	536	0	-229	-602		1,282	0	861	2,736			0	1,169	3,072					-735	
8	592	0	-229	-595		1,367	0	947	3,058			0	1,278	3,353					-712	
9	646	0	-224	-577		1,436	0	1,019	3,328			0	1,368	3,577					-681	
10	701	0	-216	-549		1,492	0	1,079	3,554			0	1,441	3,758					-642	
11	758	0	-206	-513		1,539	0	1,131	3,748			0	1,502	3,908					-598	
12	815	0	-193	-471		1,580	0	1,175	3,915			0	1,553	4,034					-548	
13	875	0	-179	-422		1,614	0	1,213	4,056			0	1,596	4,141					-494	
14	936	0	-163	-369		1,643	0	1,246	4,177			0	1,634	4,232					-436	
15	999	0	-145	-312		1,669	0	1,275	4,283			0	1,666	4,311					-374	
25	1,452	0	-11	126		1,815	0	1,440	4,881			0	1,849	4,755					89	
50	1,821	0	100	488		1,926	0	1,564	5,329			0	1,986	5,088					469	

4.0 defaults used for all response curves
Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 27 (cont.)
American River SAM Analysis Reach
ARS_ABC
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Steelhead																				
0	0		0		0	0	0	0		0	0	0	0	0	0			0	0	0
1	203		-406		203	979	0	83		979	1,019	0	146	-10	1,019			-482	-970	90
2	763		-399		763	1,642	0	489		1,642	1,715	0	686	1,201	1,715			-437	-677	707
3	899		-419		899	1,857	0	633		1,857	1,938	0	857	1,465	1,938			-454	-688	821
4	1,016		-444		1,016	2,080	0	779		2,080	2,169	0	1,026	1,715	2,169			-477	-720	926
5	1,156		-458		1,156	2,337	0	955		2,337	2,437	0	1,231	2,066	2,437			-485	-694	1,084
6	1,235		-474		1,235	2,507	0	1,077		2,507	2,615	0	1,366	2,250	2,615			-500	-711	1,160
7	1,325		-487		1,325	2,673	0	1,190		2,673	2,789	0	1,497	2,431	2,789			-512	-722	1,248
8	1,442		-489		1,442	2,849	0	1,312		2,849	2,974	0	1,643	2,656	2,974			-511	-697	1,375
9	1,552		-484		1,552	2,990	0	1,414		2,990	3,122	0	1,762	2,835	3,122			-504	-663	1,492
10	1,660		-472		1,660	3,106	0	1,499		3,106	3,243	0	1,859	2,980	3,243			-490	-621	1,606
11	1,765		-456		1,765	3,203	0	1,571		3,203	3,343	0	1,939	3,099	3,343			-472	-573	1,716
12	1,872		-435		1,872	3,286	0	1,634		3,286	3,427	0	2,007	3,198	3,427			-450	-519	1,827
13	1,980		-411		1,980	3,356	0	1,687		3,356	3,499	0	2,065	3,283	3,499			-425	-460	1,938
14	2,089		-384		2,089	3,416	0	1,732		3,416	3,560	0	2,114	3,355	3,560			-396	-397	2,051
15	2,200		-354		2,200	3,468	0	1,773		3,468	3,614	0	2,157	3,418	3,614			-366	-330	2,164
25	2,988		-124		2,988	3,766	0	2,002		3,766	3,914	0	2,399	3,769	3,914			-131	171	2,967
50	3,627		67		3,627	3,991	0	2,175		3,991	4,140	0	2,581	4,033	4,140			64	583	3,616
Green Sturgeon																				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	-2,510	-714	0	564	0	-2,510	-876	0	-980	0	-2,510	-876	0	-980	0	-5,020	-2,496	0	417
2	0	-3,765	-1,071	0	846	0	-1,255	468	0	-1,323	0	-1,255	468	0	-1,323	0	-5,020	-1,962	0	772
3	0	-4,183	-1,190	0	940	0	-1,156	654	0	-1,482	0	-1,156	654	0	-1,482	0	-5,339	-2,046	0	846
4	0	-4,632	-1,344	0	1,021	0	-1,106	807	0	-1,661	0	-1,106	807	0	-1,661	0	-5,738	-2,183	0	916
5	0	-5,092	-1,512	0	1,096	0	-885	1,104	0	-1,821	0	-885	1,104	0	-1,821	0	-5,977	-2,183	0	1,013
6	0	-5,399	-1,624	0	1,147	0	-854	1,249	0	-1,943	0	-854	1,249	0	-1,943	0	-6,253	-2,236	0	1,061
7	0	-5,718	-1,707	0	1,197	0	-831	1,416	0	-2,072	0	-831	1,416	0	-2,072	0	-6,550	-2,276	0	1,109
8	0	-6,045	-1,771	0	1,247	0	-727	1,634	0	-2,193	0	-727	1,634	0	-2,193	0	-6,772	-2,268	0	1,171
9	0	-6,299	-1,820	0	1,286	0	-647	1,803	0	-2,287	0	-647	1,803	0	-2,287	0	-6,945	-2,263	0	1,218
10	0	-6,502	-1,860	0	1,317	0	-582	1,939	0	-2,362	0	-582	1,939	0	-2,362	0	-7,084	-2,258	0	1,256
11	0	-6,668	-1,893	0	1,343	0	-529	2,050	0	-2,423	0	-529	2,050	0	-2,423	0	-7,197	-2,254	0	1,287
12	0	-6,807	-1,920	0	1,364	0	-485	2,142	0	-2,475	0	-485	2,142	0	-2,475	0	-7,292	-2,251	0	1,313
13	0	-6,924	-1,943	0	1,382	0	-448	2,220	0	-2,518	0	-448	2,220	0	-2,518	0	-7,371	-2,249	0	1,335
14	0	-7,024	-1,962	0	1,397	0	-416	2,287	0	-2,555	0	-416	2,287	0	-2,555	0	-7,440	-2,247	0	1,354
15	0	-7,111	-1,979	0	1,411	0	-388	2,346	0	-2,587	0	-388	2,346	0	-2,587	0	-7,499	-2,245	0	1,370
25	0	-7,599	-2,075	0	1,486	0	-233	2,671	0	-2,767	0	-233	2,671	0	-2,767	0	-7,832	-2,234	0	1,461
50	0	-7,964	-2,146	0	1,542	0	-116	2,915	0	-2,902	0	-116	2,915	0	-2,902	0	-8,081	-2,226	0	1,529

4.0 defaults used for all response curves

Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 28
Sacramento River SAM Analysis Reach
ARS_DEFG
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
0	0		0	0		0		0	0		0		0	0		0		0	0	
1	-1,101		-400	-2,119		-892		97	-3,451		-946		193	-3,484		-2,136		-460	-3,759	
2	-1,075		-427	-2,526		-415		571	-1,306		-453		900	-1,147		-1,776		-468	-3,638	
3	-1,058		-434	-2,738		-121		836	15		-141		1,302	289		-1,525		-462	-3,479	
4	-1,125		-459	-2,923		-16		940	430		-23		1,470	753		-1,514		-483	-3,555	
5	-1,197		-498	-3,127		44		1,046	642		47		1,638	990		-1,604		-526	-3,809	
6	-1,266		-532	-3,373		110		1,183	999		124		1,847	1,366		-1,659		-559	-4,037	
7	-1,342		-551	-3,601		160		1,296	1,340		187		2,017	1,726		-1,679		-575	-4,171	
8	-1,381		-558	-3,738		200		1,390	1,645		241		2,159	2,045		-1,676		-578	-4,237	
9	-1,394		-555	-3,815		233		1,472	1,926		289		2,282	2,337		-1,656		-573	-4,258	
10	-1,385		-544	-3,845		261		1,545	2,187		333		2,393	2,608		-1,621		-561	-4,244	
11	-1,357		-527	-3,838		286		1,611	2,421		374		2,490	2,847		-1,571		-542	-4,201	
12	-1,311		-504	-3,806		308		1,668	2,621		411		2,574	3,047		-1,507		-518	-4,138	
13	-1,252		-478	-3,752		329		1,719	2,797		446		2,648	3,218		-1,433		-490	-4,059	
14	-1,183		-448	-3,683		348		1,765	2,952		480		2,714	3,366		-1,351		-459	-3,968	
15	-1,105		-415	-3,602		366		1,807	3,091		512		2,774	3,495		-1,263		-426	-3,867	
25	-396		-144	-2,879		497		2,094	3,968		731		3,136	4,242		-491		-150	-3,038	
50	298		94	-2,269		631		2,366	4,728		914		3,419	4,810		251		91	-2,349	
Fall-run Chinook																				
0	0		0	0		0		0	0				0	0		0		0	0	
1	-1,101		-400	-2,119		-892		97	-3,451				193	-3,484		-2,136		-460	-3,759	
2	-1,075		-427	-2,526		-415		571	-1,306				900	-1,147		-1,776		-468	-3,638	
3	-1,058		-434	-2,738		-121		836	15				1,302	289		-1,525		-462	-3,479	
4	-1,125		-459	-2,923		-16		940	430				1,470	753		-1,514		-483	-3,555	
5	-1,197		-498	-3,127		44		1,046	642				1,638	990		-1,604		-526	-3,809	
6	-1,266		-532	-3,373		110		1,183	999				1,847	1,366		-1,659		-559	-4,037	
7	-1,342		-551	-3,601		160		1,296	1,340				2,017	1,726		-1,679		-575	-4,171	
8	-1,381		-558	-3,738		200		1,390	1,645				2,159	2,045		-1,676		-578	-4,237	
9	-1,394		-555	-3,815		233		1,472	1,926				2,282	2,337		-1,656		-573	-4,258	
10	-1,385		-544	-3,845		261		1,545	2,187				2,393	2,608		-1,621		-561	-4,244	
11	-1,357		-527	-3,838		286		1,611	2,421				2,490	2,847		-1,571		-542	-4,201	
12	-1,311		-504	-3,806		308		1,668	2,621				2,574	3,047		-1,507		-518	-4,138	
13	-1,252		-478	-3,752		329		1,719	2,797				2,648	3,218		-1,433		-490	-4,059	
14	-1,183		-448	-3,683		348		1,765	2,952				2,714	3,366		-1,351		-459	-3,968	
15	-1,105		-415	-3,602		366		1,807	3,091				2,774	3,495		-1,263		-426	-3,867	
25	-396		-144	-2,879		497		2,094	3,968				3,136	4,242		-491		-150	-3,038	
50	298		94	-2,269		631		2,366	4,728				3,419	4,810		251		91	-2,349	

4.0 defaults used for all response curves
Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 28 (cont.)
Sacramento River SAM Analysis Reach
ARS_DEFG
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Late-fall-run Chinook																				
0	0		0	0		0		0	0		0		0					0		
1	-1,101		-400	-2,119		-892		97	-3,451		-946		193					-460		
2	-1,075		-427	-2,526		-415		571	-1,306		-453		900					-468		
3	-1,058		-434	-2,738		-121		836	15		-141		1,302					-462		
4	-1,125		-459	-2,923		-16		940	430		-23		1,470					-483		
5	-1,197		-498	-3,127		44		1,046	642		47		1,638					-526		
6	-1,266		-532	-3,373		110		1,183	999		124		1,847					-559		
7	-1,342		-551	-3,601		160		1,296	1,340		187		2,017					-575		
8	-1,381		-558	-3,738		200		1,390	1,645		241		2,159					-578		
9	-1,394		-555	-3,815		233		1,472	1,926		289		2,282					-573		
10	-1,385		-544	-3,845		261		1,545	2,187		333		2,393					-561		
11	-1,357		-527	-3,838		286		1,611	2,421		374		2,490					-542		
12	-1,311		-504	-3,806		308		1,668	2,621		411		2,574					-518		
13	-1,252		-478	-3,752		329		1,719	2,797		446		2,648					-490		
14	-1,183		-448	-3,683		348		1,765	2,952		480		2,714					-459		
15	-1,105		-415	-3,602		366		1,807	3,091		512		2,774					-426		
25	-396		-144	-2,879		497		2,094	3,968		731		3,136					-150		
50	298		94	-2,269		631		2,366	4,728		914		3,419					91		
Winter-run Chinook																				
0	0		0	0		0		0	0		0		0	0		0		0		
1	-1,101		-400	-2,119		-892		97	-3,451		-946		193	-3,484		-2,136		-460		
2	-1,075		-427	-2,526		-415		571	-1,306		-453		900	-1,147		-1,776		-468		
3	-1,058		-434	-2,738		-121		836	15		-141		1,302	289		-1,525		-462		
4	-1,125		-459	-2,923		-16		940	430		-23		1,470	753		-1,514		-483		
5	-1,197		-498	-3,127		44		1,046	642		47		1,638	990		-1,604		-526		
6	-1,266		-532	-3,373		110		1,183	999		124		1,847	1,366		-1,659		-559		
7	-1,342		-551	-3,601		160		1,296	1,340		187		2,017	1,726		-1,679		-575		
8	-1,381		-558	-3,738		200		1,390	1,645		241		2,159	2,045		-1,676		-578		
9	-1,394		-555	-3,815		233		1,472	1,926		289		2,282	2,337		-1,656		-573		
10	-1,385		-544	-3,845		261		1,545	2,187		333		2,393	2,608		-1,621		-561		
11	-1,357		-527	-3,838		286		1,611	2,421		374		2,490	2,847		-1,571		-542		
12	-1,311		-504	-3,806		308		1,668	2,621		411		2,574	3,047		-1,507		-518		
13	-1,252		-478	-3,752		329		1,719	2,797		446		2,648	3,218		-1,433		-490		
14	-1,183		-448	-3,683		348		1,765	2,952		480		2,714	3,366		-1,351		-459		
15	-1,105		-415	-3,602		366		1,807	3,091		512		2,774	3,495		-1,263		-426		
25	-396		-144	-2,879		497		2,094	3,968		731		3,136	4,242		-491		-150		
50	298		94	-2,269		631		2,366	4,728		914		3,419	4,810		251		91		

4.0 defaults used for all response curves
Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 28 (cont.)
Sacramento River SAM Analysis Reach
ARS_DEFG
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Steelhead																				
0	0		0	0	0	0		0	0	0	0		0	0	0	0		0		0
1	-1,747		-820	-2,239	-1,747	-1,747		-77	-3,044	-1,747	-1,801		-36	-3,082	-1,801	-3,793		-964		-3,793
2	-1,656		-871	-2,645	-1,656	-772		649	-1,266	-772	-774		946	-1,173	-774	-3,047		-970		-3,047
3	-1,609		-887	-2,848	-1,609	-170		1,060	-188	-170	-132		1,508	-16	-132	-2,536		-952		-2,536
4	-1,702		-938	-3,038	-1,702	56		1,206	116	56	119		1,722	324	119	-2,465		-998		-2,465
5	-1,780		-1,021	-3,256	-1,780	195		1,339	234	195	280		1,917	463	280	-2,574		-1,089		-2,574
6	-1,865		-1,094	-3,513	-1,865	345		1,525	482	345	450		2,177	731	450	-2,634		-1,161		-2,634
7	-1,984		-1,139	-3,749	-1,984	457		1,684	735	457	581		2,397	1,002	581	-2,644		-1,196		-2,644
8	-2,040		-1,156	-3,887	-2,040	545		1,818	961	545	688		2,583	1,244	688	-2,617		-1,206		-2,617
9	-2,053		-1,154	-3,961	-2,053	617		1,936	1,170	617	779		2,747	1,467	779	-2,566		-1,199		-2,566
10	-2,030		-1,137	-3,985	-2,030	678		2,042	1,367	678	858		2,896	1,675	858	-2,492		-1,177		-2,492
11	-1,974		-1,106	-3,971	-1,974	732		2,137	1,544	732	928		3,027	1,861	928	-2,394		-1,143		-2,394
12	-1,890		-1,065	-3,929	-1,890	780		2,220	1,696	780	991		3,141	2,017	991	-2,274		-1,098		-2,274
13	-1,784		-1,016	-3,866	-1,784	824		2,293	1,828	824	1,048		3,240	2,152	1,048	-2,139		-1,047		-2,139
14	-1,661		-960	-3,786	-1,661	864		2,359	1,946	864	1,101		3,329	2,269	1,101	-1,990		-989		-1,990
15	-1,524		-900	-3,692	-1,524	901		2,420	2,051	901	1,151		3,409	2,372	1,151	-1,832		-926		-1,832
25	-343		-391	-2,871	-343	1,167		2,823	2,718	1,167	1,472		3,899	2,973	1,472	-528		-407		-528
50	734		58	-2,166	734	1,431		3,200	3,301	1,431	1,733		4,282	3,433	1,733	641		50		641
Green Sturgeon																				
0			0	0		0		0		0	0		0	0	0	0		0	0	0
1			-708	0		0		-4,397		-1,551	0		-4,397	0	-1,551	0		-5,009	0	-1,298
2			-1,391	0		0		-3,248		-1,199	0		-3,248	0	-1,199	0		-4,297	0	-765
3			-1,830	0		0		-2,485		-966	0		-2,485	0	-966	0		-3,767	0	-436
4			-2,032	0		0		-2,310		-923	0		-2,310	0	-923	0		-3,709	0	-344
5			-2,076	0		0		-2,380		-1,146	0		-2,380	0	-1,146	0		-3,899	0	-323
6			-2,305	0		0		-2,394		-1,476	0		-2,394	0	-1,476	0		-4,077	0	-288
7			-2,685	0		0		-2,368		-1,731	0		-2,368	0	-1,731	0		-4,203	0	-264
8			-2,970	0		0		-2,348		-1,923	0		-2,348	0	-1,923	0		-4,298	0	-245
9			-3,191	0		0		-2,333		-2,072	0		-2,333	0	-2,072	0		-4,372	0	-231
10			-3,369	0		0		-2,321		-2,191	0		-2,321	0	-2,191	0		-4,431	0	-220
11			-3,514	0		0		-2,311		-2,288	0		-2,311	0	-2,288	0		-4,480	0	-210
12			-3,634	0		0		-2,302		-2,369	0		-2,302	0	-2,369	0		-4,520	0	-203
13			-3,737	0		0		-2,295		-2,438	0		-2,295	0	-2,438	0		-4,554	0	-196
14			-3,824	0		0		-2,289		-2,497	0		-2,289	0	-2,497	0		-4,583	0	-190
15			-3,900	0		0		-2,284		-2,548	0		-2,284	0	-2,548	0		-4,609	0	-185
25			-4,326	0		0		-2,255		-2,834	0		-2,255	0	-2,834	0		-4,751	0	-158
50			-4,645	0		0		-2,233		-3,048	0		-2,233	0	-3,048	0		-4,857	0	-138

4.0 defaults used for all response curves
Non-default timing tables (see sheet [Custom Timing Tables] in this workbook)

Table 29
Sacramento Bypass Levee and Weir SAM Analysis Reach
SBP Weir and Levee
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
0	0		0	0		0		0	0		0		0	0		0		0	0	
1	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
2	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
3	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
4	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
5	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
6	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
7	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
8	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
9	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
10	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
11	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
12	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
13	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
14	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
15	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
25	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
50	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Fall-run Chinook																				
0	0		0			0		0	0				0			0		0		
1	-60		-4			-21		-9	-146				-21			-60		-4		
2	-60		-4			-21		-9	-146				-21			-60		-4		
3	-60		-4			-21		-9	-146				-21			-60		-4		
4	-60		-4			-21		-9	-146				-21			-60		-4		
5	-60		-4			-21		-9	-146				-21			-60		-4		
6	-60		-4			-21		-9	-146				-21			-60		-4		
7	-60		-4			-21		-9	-146				-21			-60		-4		
8	-60		-4			-21		-9	-146				-21			-60		-4		
9	-60		-4			-21		-9	-146				-21			-60		-4		
10	-60		-4			-21		-9	-146				-21			-60		-4		
11	-60		-4			-21		-9	-146				-21			-60		-4		
12	-60		-4			-21		-9	-146				-21			-60		-4		
13	-60		-4			-21		-9	-146				-21			-60		-4		
14	-60		-4			-21		-9	-146				-21			-60		-4		
15	-60		-4			-21		-9	-146				-21			-60		-4		
25	-60		-4			-21		-9	-146				-21			-60		-4		
50	-60		-4			-21		-9	-146				-21			-60		-4		

4.0 defaults used for all response curves
4.0 defaults used for all timing tables

Table 29 (cont.)
Sacramento Bypass Levee and Weir SAM Analysis Reach
SBP Weir and Levee
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Late-fall-run Chinook																				
0	0		0	0		0		0	0		0		0					0		
1	-60		-4	-26		-21		-9	-146		-51		-21					-4		
2	-60		-4	-26		-21		-9	-146		-51		-21					-4		
3	-60		-4	-26		-21		-9	-146		-51		-21					-4		
4	-60		-4	-26		-21		-9	-146		-51		-21					-4		
5	-60		-4	-26		-21		-9	-146		-51		-21					-4		
6	-60		-4	-26		-21		-9	-146		-51		-21					-4		
7	-60		-4	-26		-21		-9	-146		-51		-21					-4		
8	-60		-4	-26		-21		-9	-146		-51		-21					-4		
9	-60		-4	-26		-21		-9	-146		-51		-21					-4		
10	-60		-4	-26		-21		-9	-146		-51		-21					-4		
11	-60		-4	-26		-21		-9	-146		-51		-21					-4		
12	-60		-4	-26		-21		-9	-146		-51		-21					-4		
13	-60		-4	-26		-21		-9	-146		-51		-21					-4		
14	-60		-4	-26		-21		-9	-146		-51		-21					-4		
15	-60		-4	-26		-21		-9	-146		-51		-21					-4		
25	-60		-4	-26		-21		-9	-146		-51		-21					-4		
50	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Winter-run Chinook																				
0	0		0	0		0		0	0		0		0	0		0		0		
1	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
2	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
3	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
4	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
5	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
6	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
7	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
8	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
9	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
10	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
11	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
12	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
13	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
14	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
15	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
25	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
50	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		

4.0 defaults used for all response curves
4.0 defaults used for all timing tables

Table 29 (cont.)
Sacramento Bypass Levee and Weir SAM Analysis Reach
SBP Weir and Levee
Bankline weighted relative response (feet)

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Steelhead																				
0	0		0	0	0	0		0	0	0	0		0	0	0	0		0		0
1	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
2	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
3	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
4	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
5	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
6	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
7	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
8	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
9	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
10	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
11	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
12	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
13	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
14	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
15	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
25	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
50	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Green Sturgeon																				
0			0	0		0		0		0	0	0	0	0	0	0	0	0	0	0
1			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
2			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
3			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
4			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
5			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
6			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
7			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
8			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
9			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
10			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
11			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
12			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
13			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
14			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
15			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
25			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
50			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8

4.0 defaults used for all response curves
4.0 defaults used for all timing tables

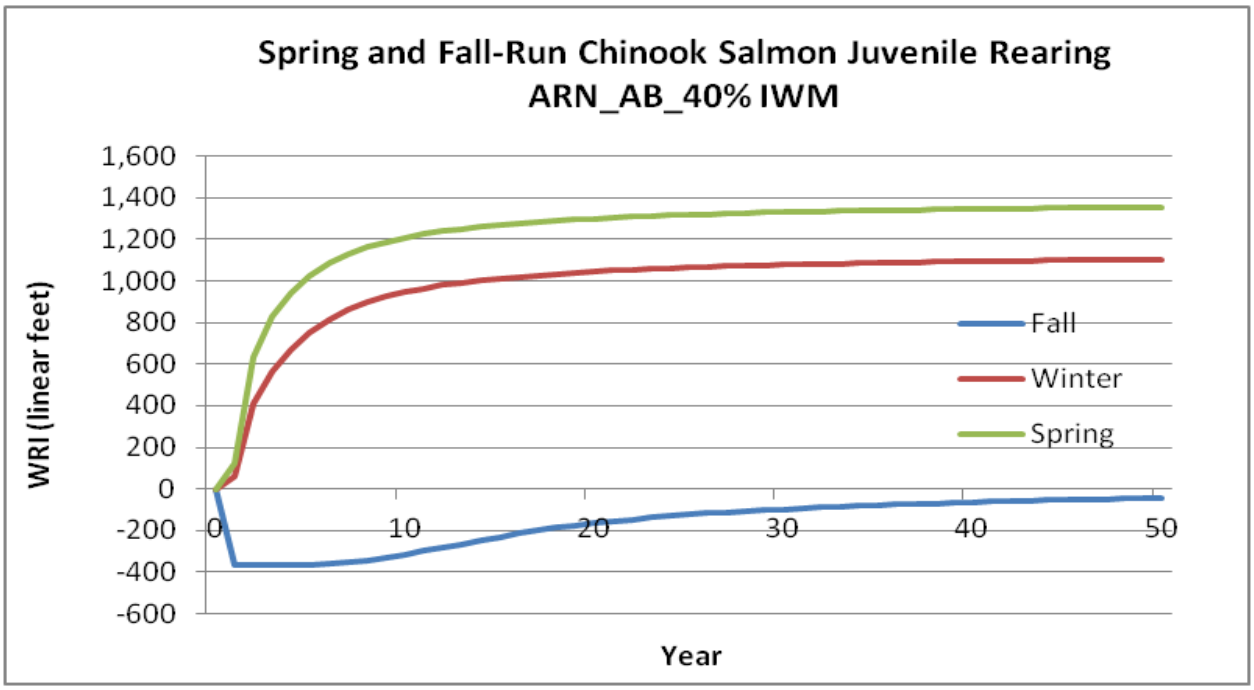


Figure 2. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for spring and fall-run Chinook salmon juvenile rearing.

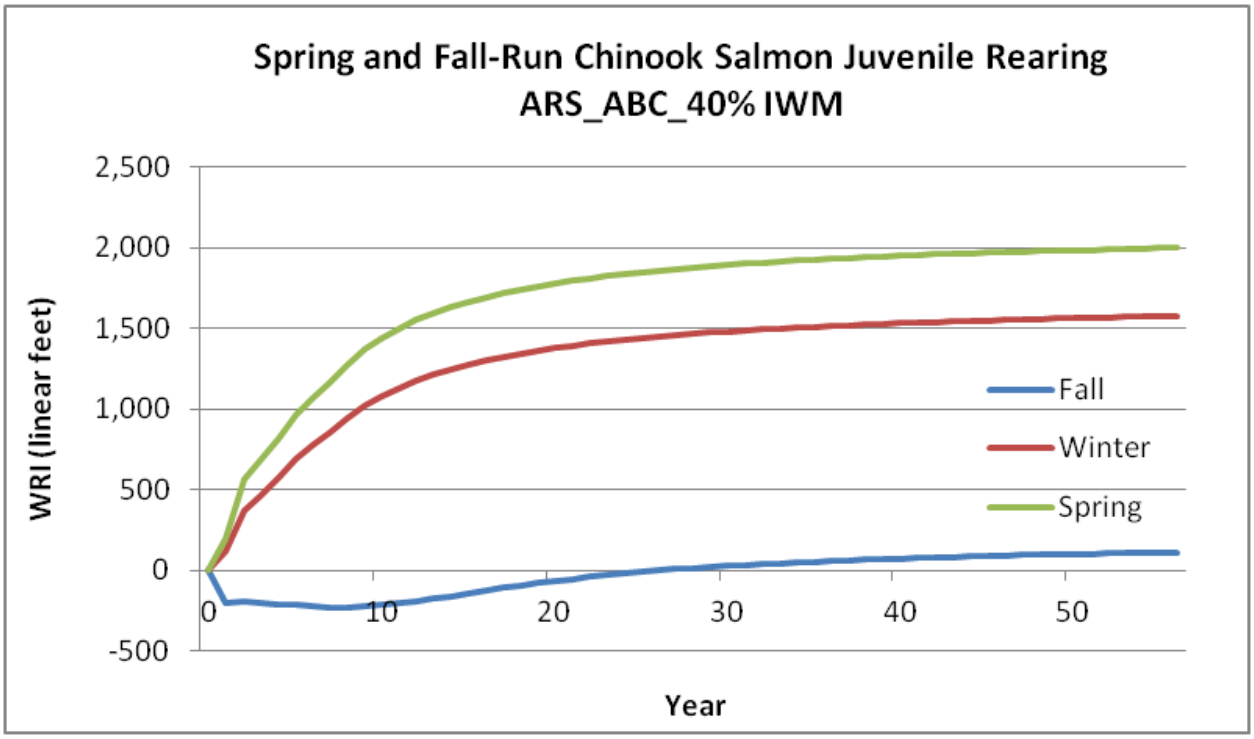


Figure 3. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for spring and fall-run Chinook salmon juvenile rearing.

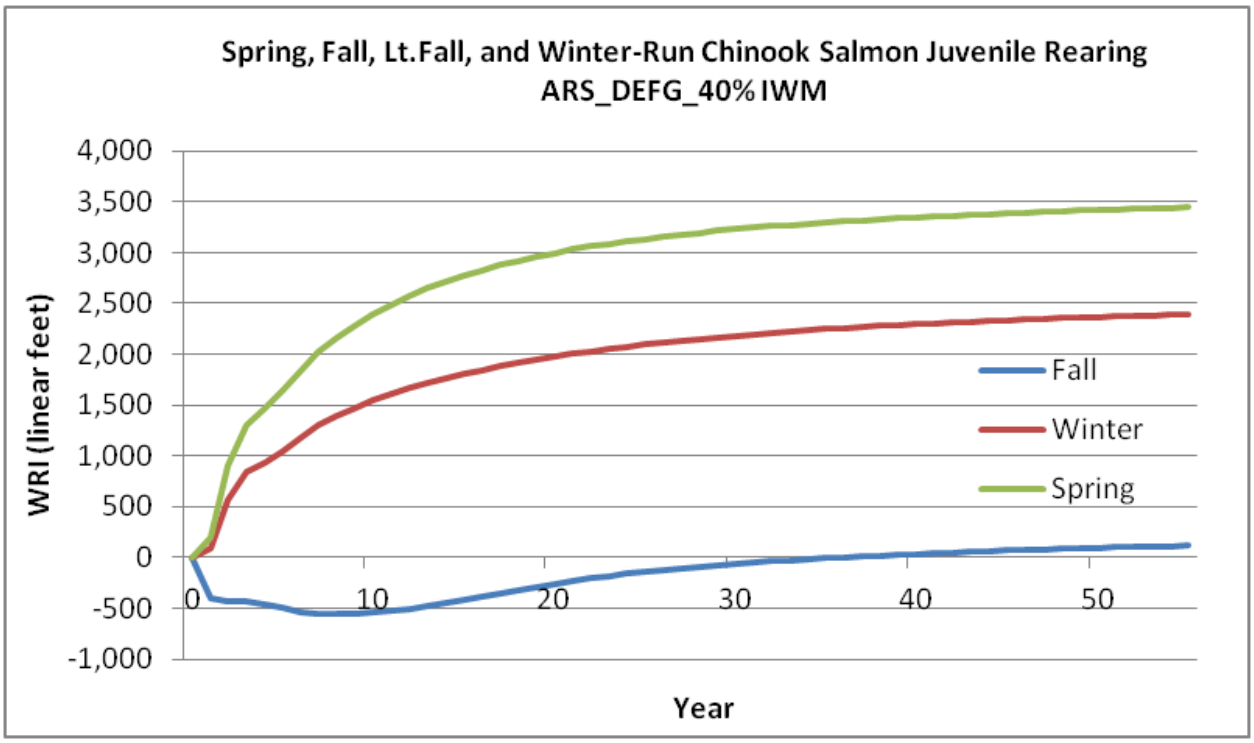


Figure 4. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for Chinook salmon juvenile rearing.

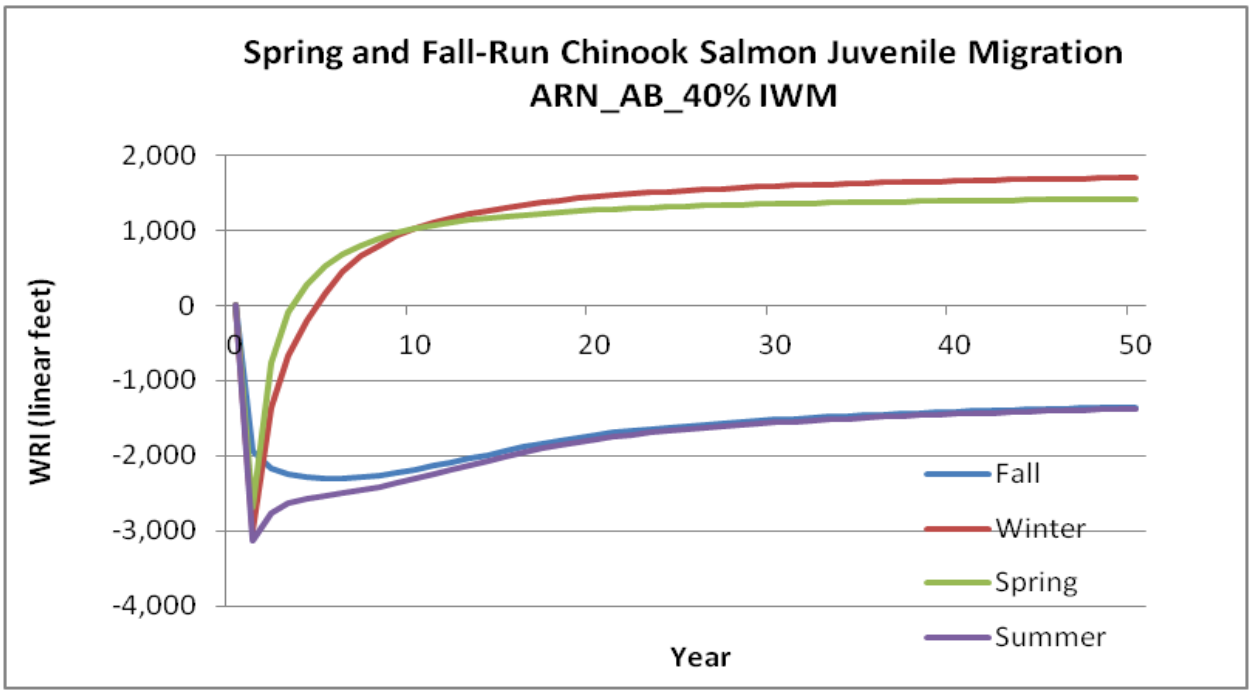


Figure 5. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for spring and fall-run Chinook salmon juvenile migration.

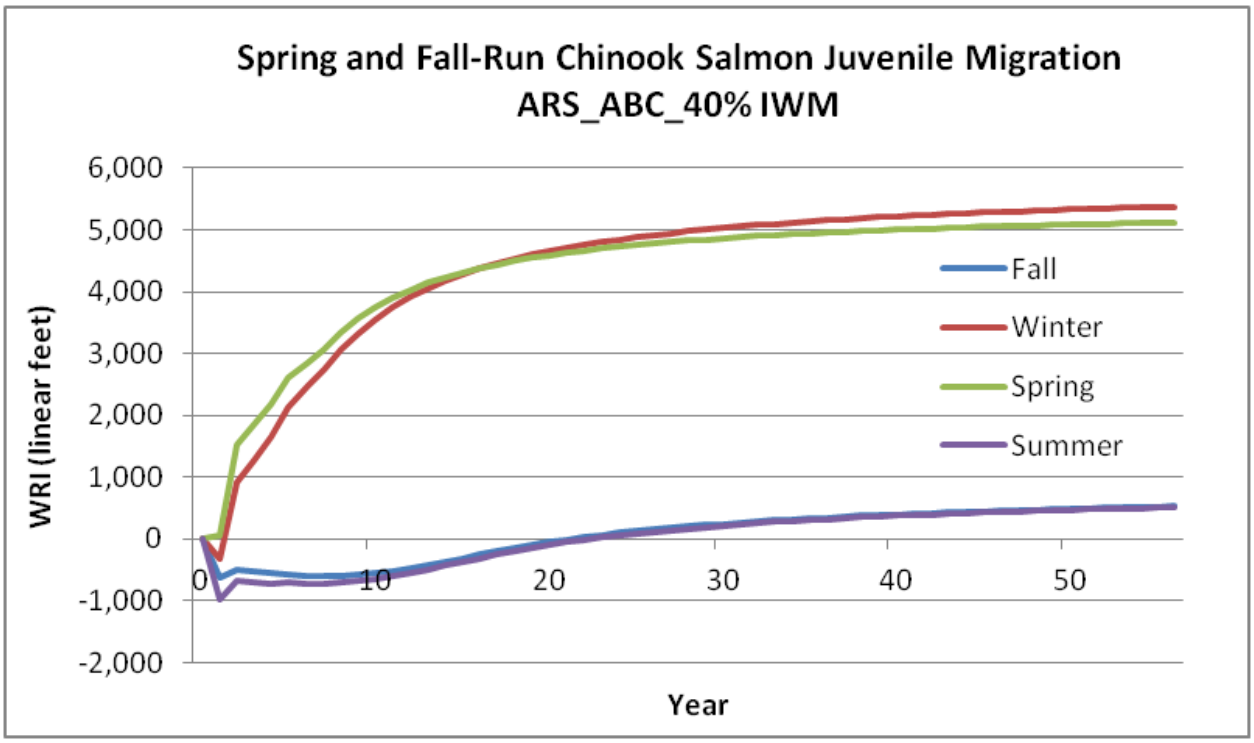


Figure 6. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for spring and fall-run Chinook salmon juvenile migration.

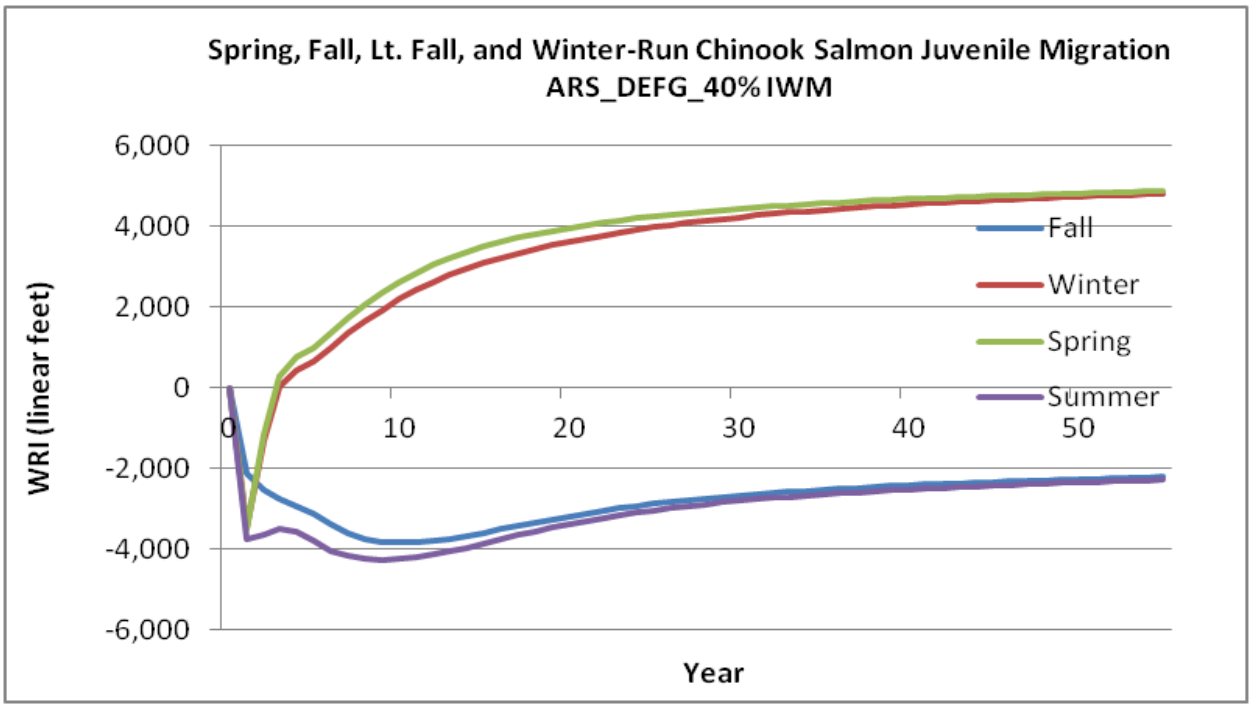


Figure 7. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for Chinook salmon juvenile migration.

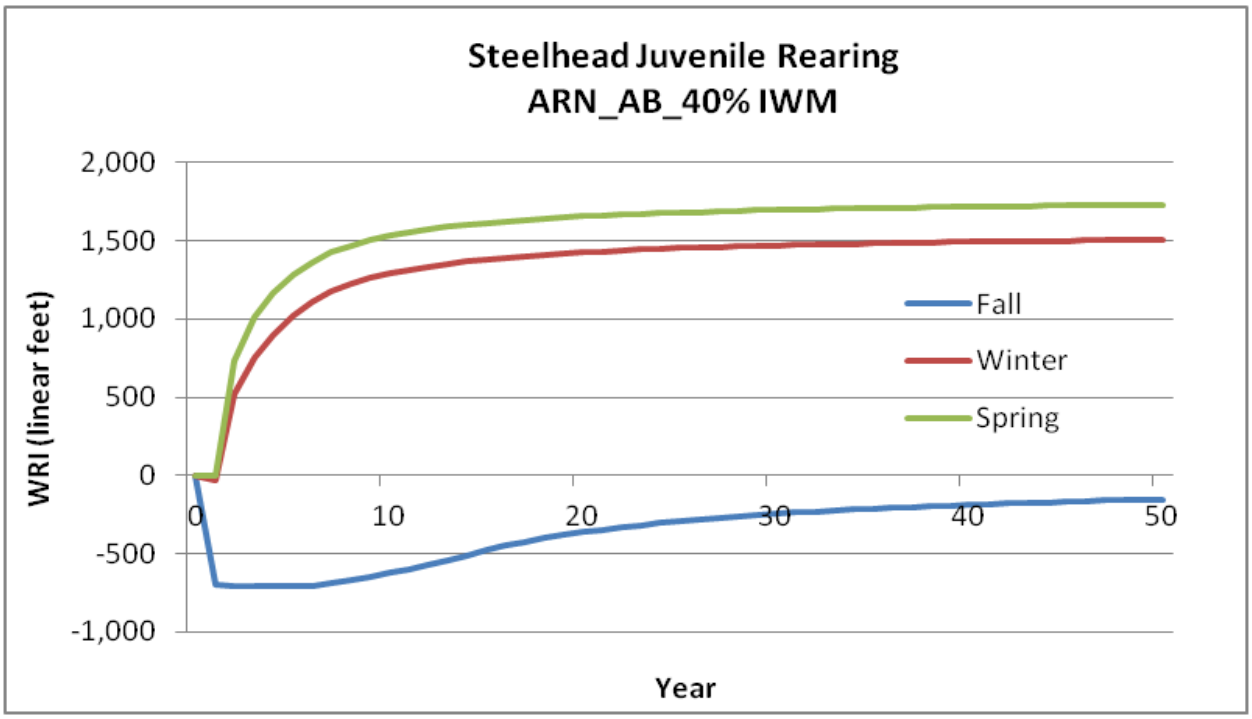


Figure 8. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for steelhead juvenile rearing.

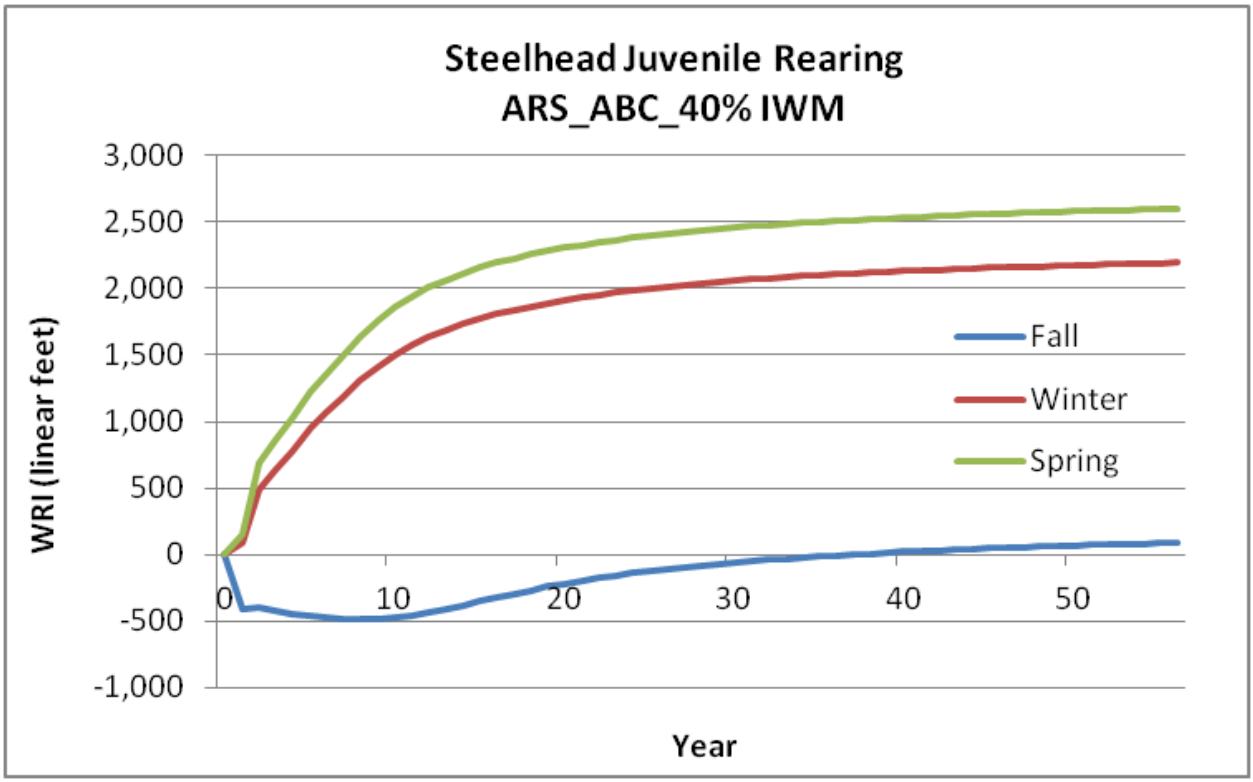


Figure 9. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for steelhead juvenile rearing.

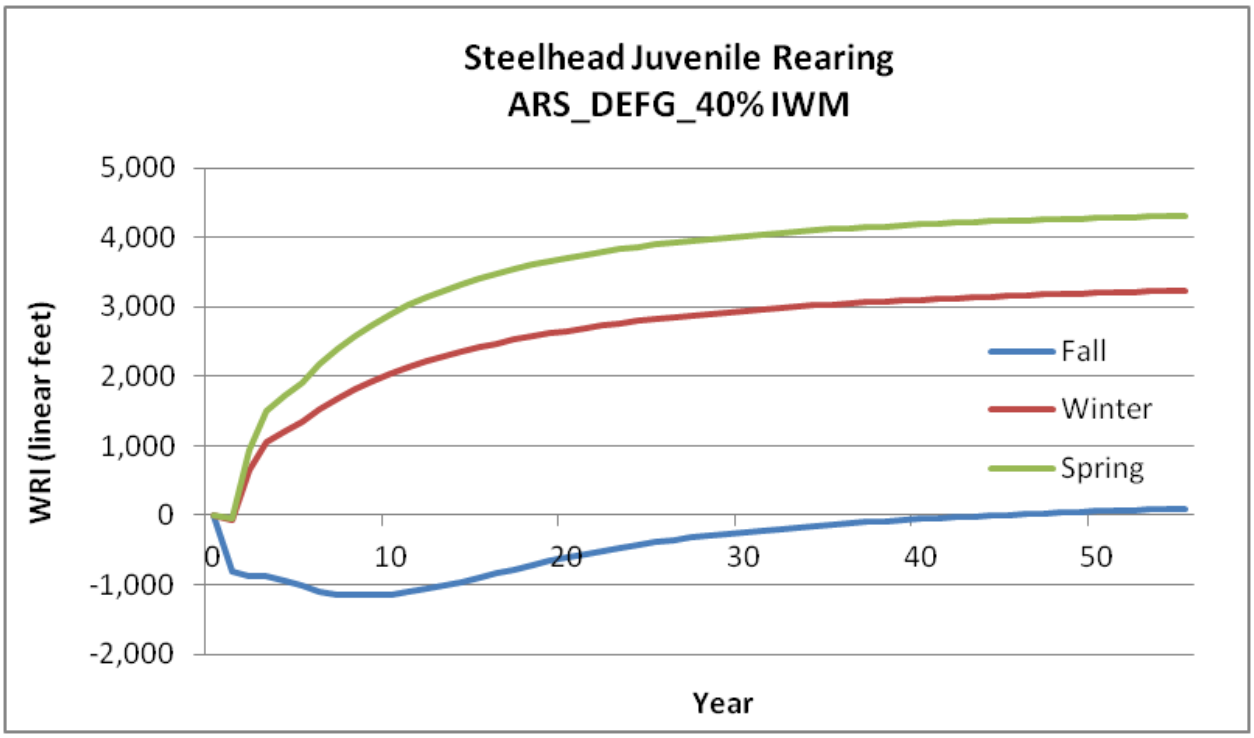


Figure 10. Weighted response indices at 40% IWM placement on the American River (ARS_DEFG) for steelhead juvenile rearing.

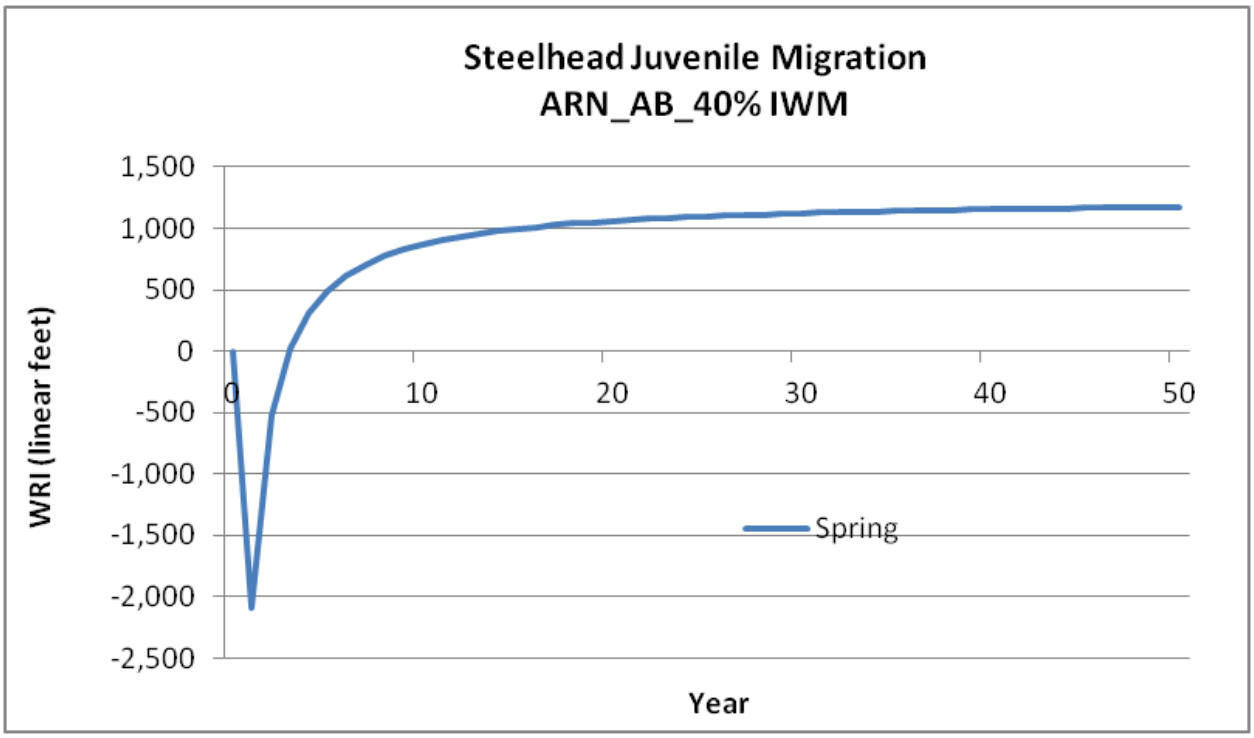


Figure 11. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for steelhead juvenile migration.

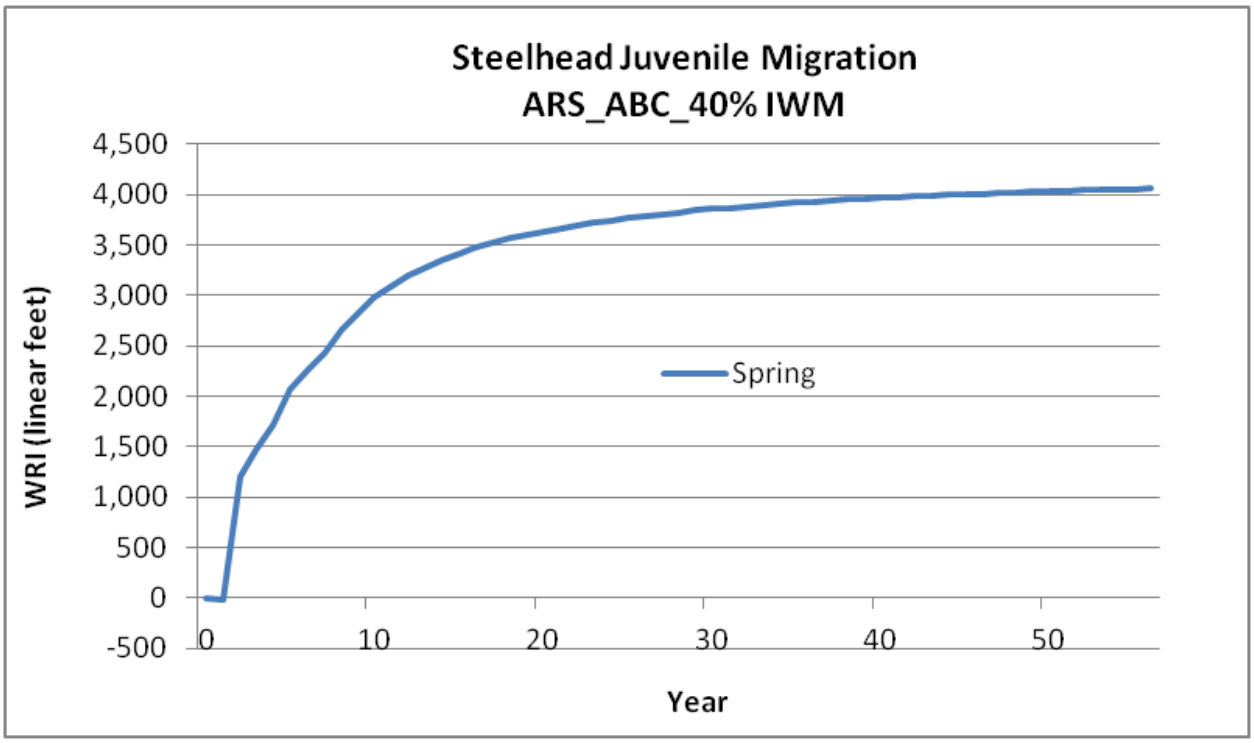


Figure 12. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for steelhead juvenile migration.

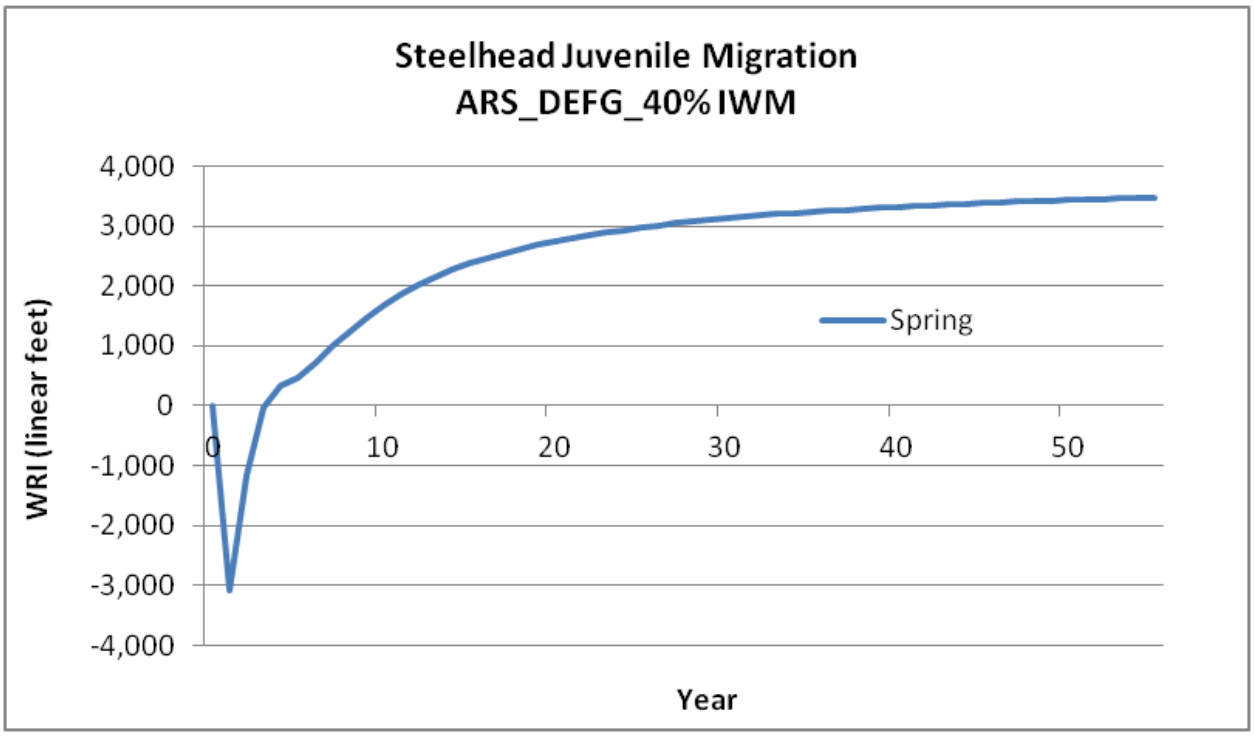


Figure 13. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for steelhead juvenile migration.

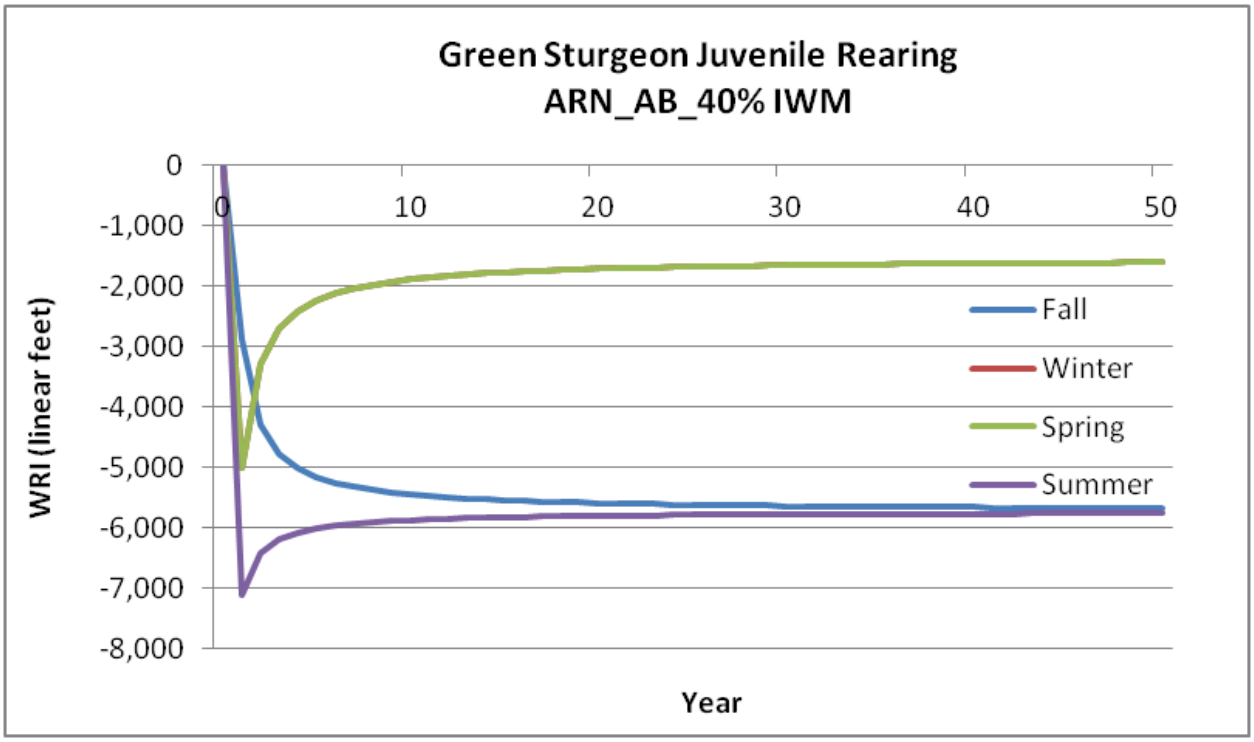


Figure 14. Weighted response indices at 40% IWM placement on the American River (ARN_AB) for green sturgeon juvenile rearing.

Figure 15. Weighted response indices at 40% IWM placement on the American River (ARS_ABC) for green sturgeon juvenile rearing.

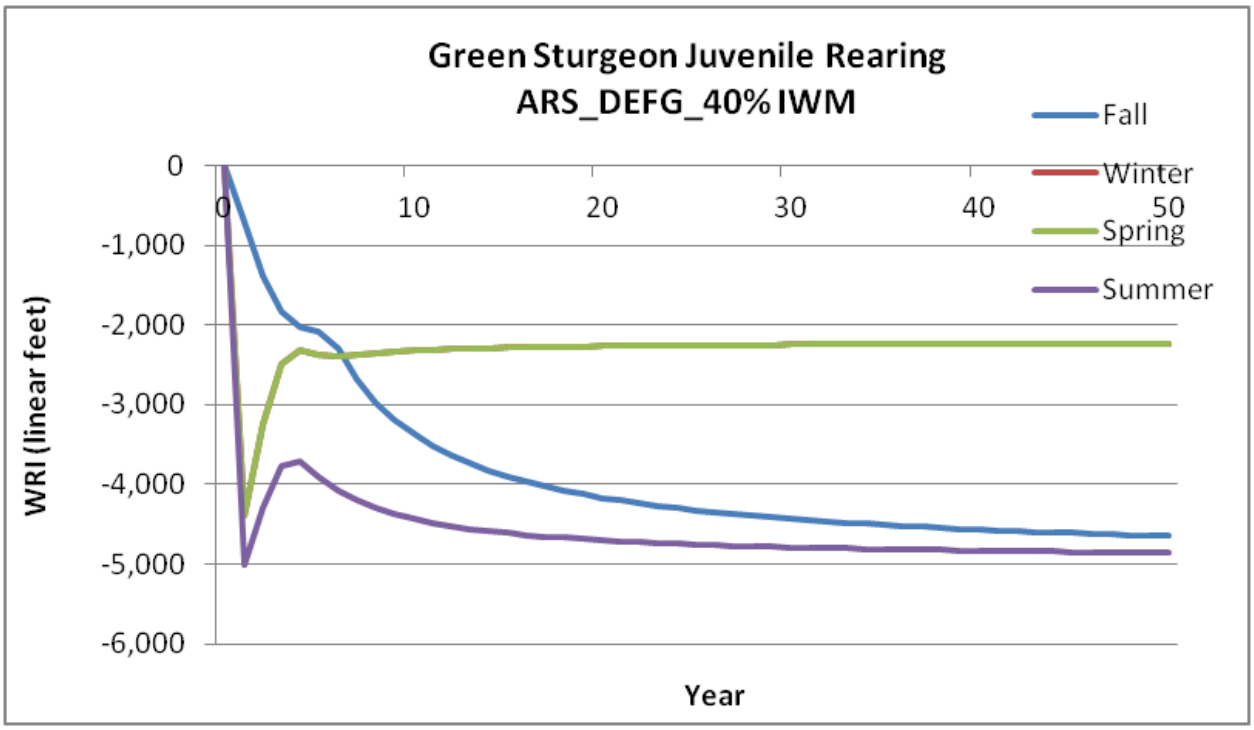


Figure 16. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for green sturgeon juvenile rearing.

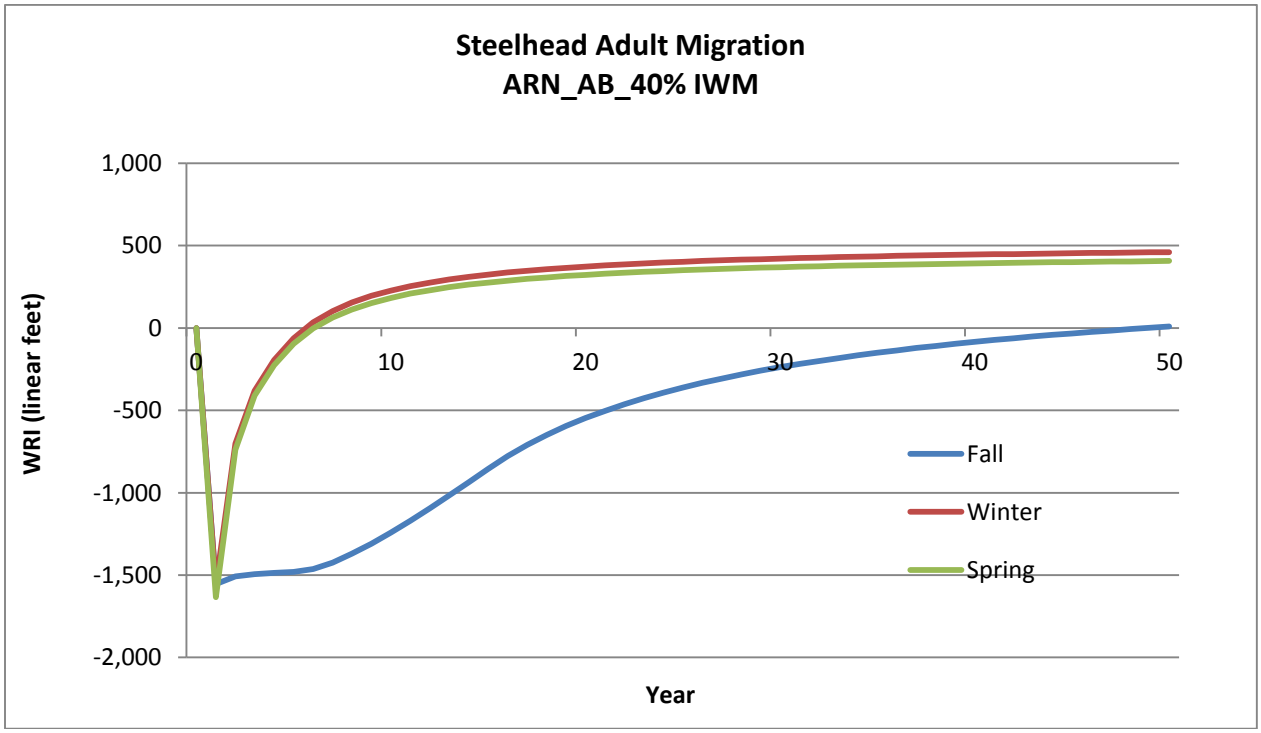


Figure 17. Weighted response indices at 40% IWM placement on the Sacramento River (ARN_AB) for steelhead adult migration.

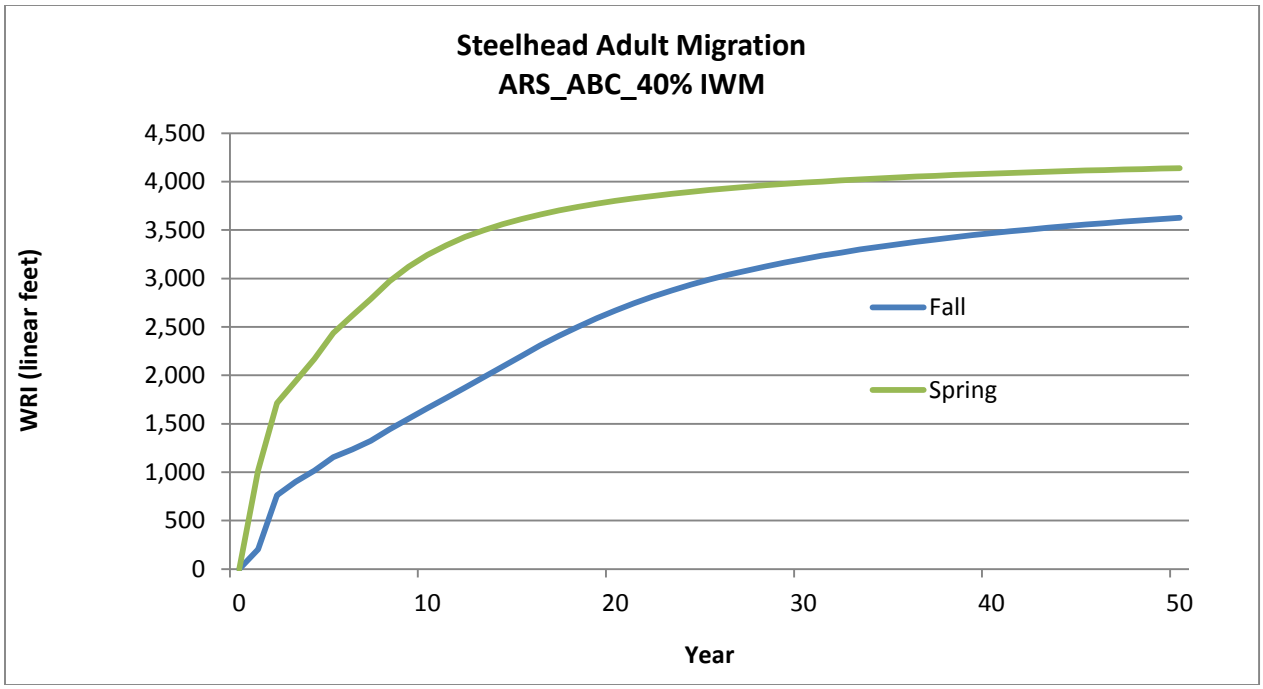


Figure 18. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_ABC) for steelhead adult migration.

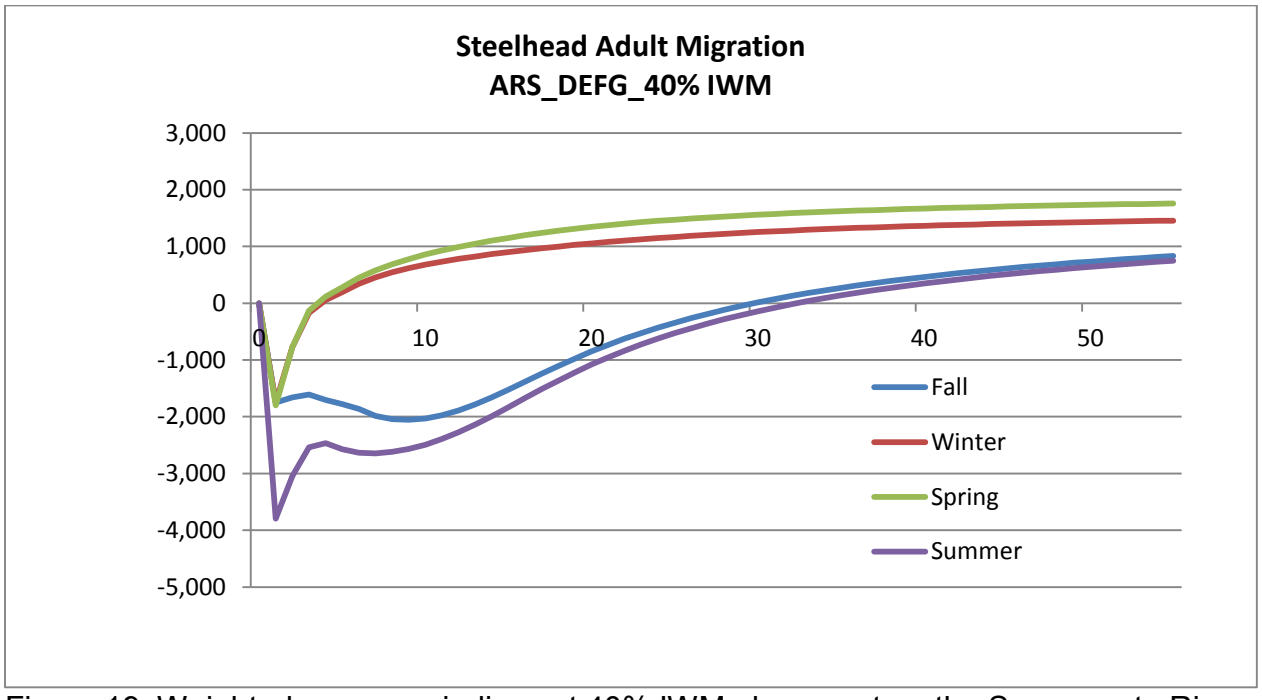


Figure 19. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for steelhead adult migration.

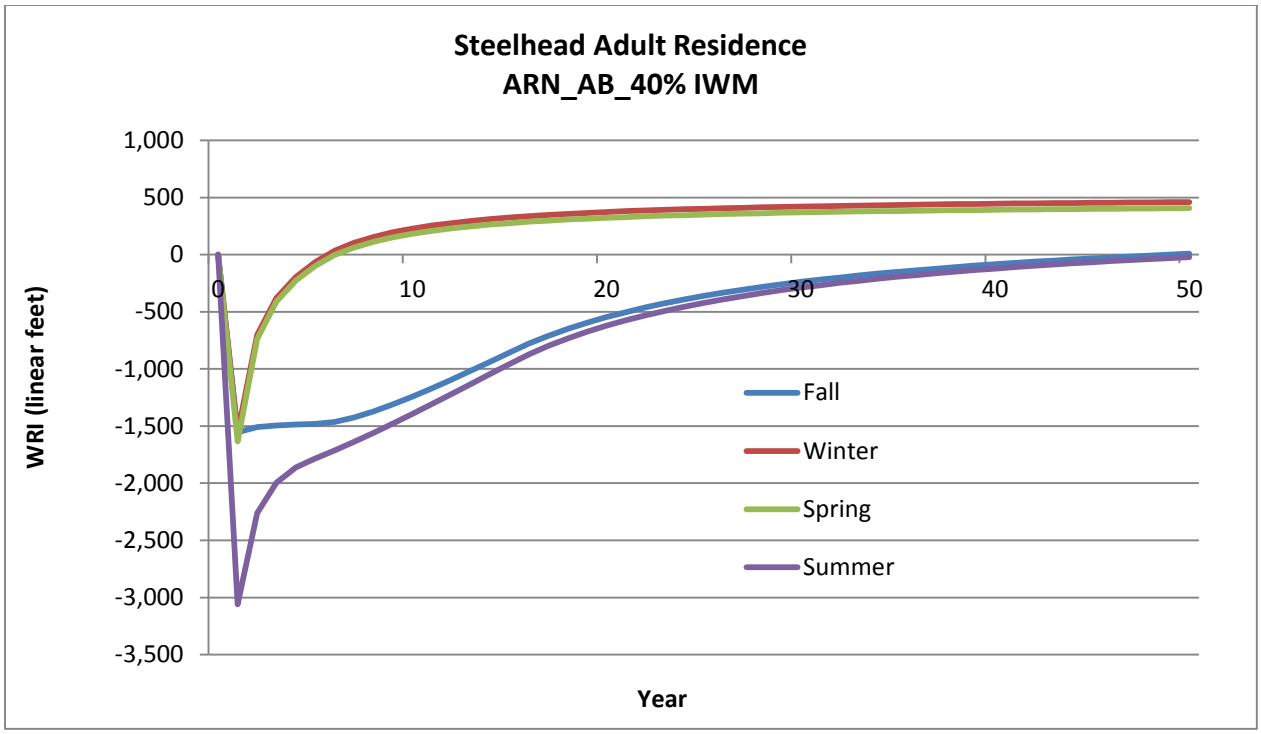


Figure 20. Weighted response indices at 40% IWM placement on the Sacramento River (ARN_AB) for steelhead adult residence.

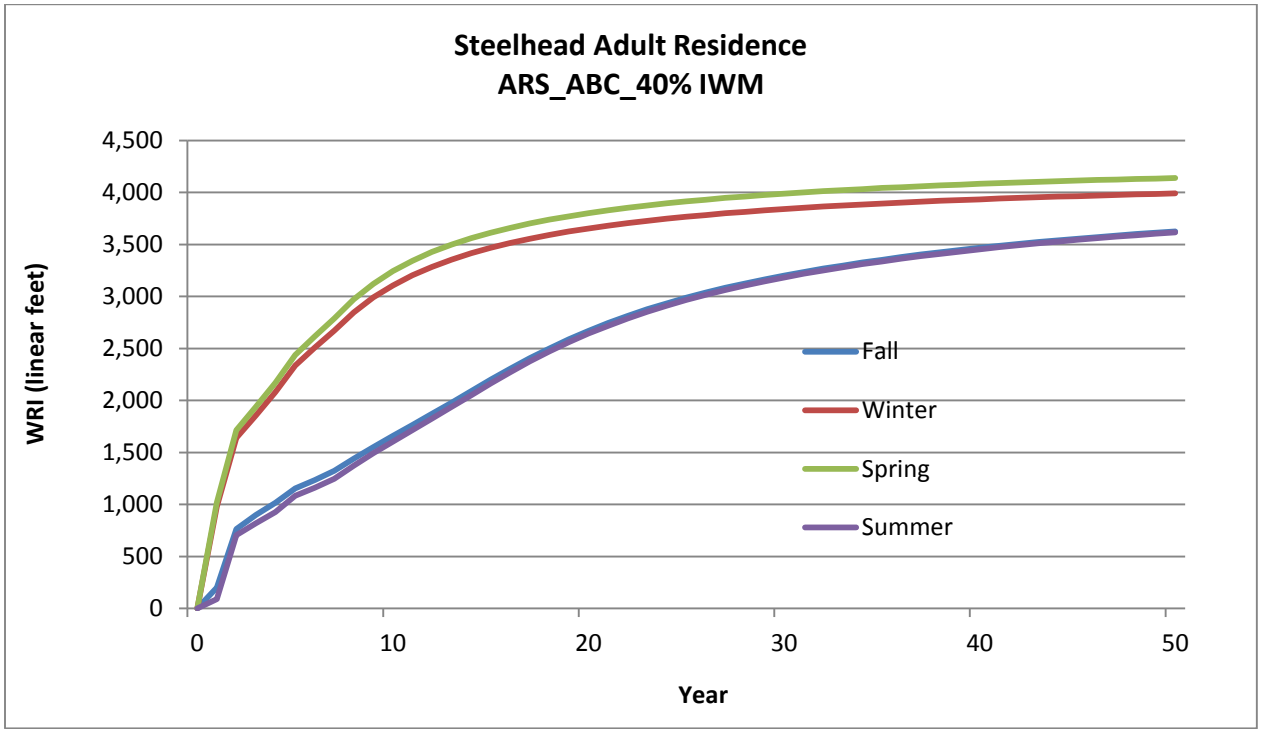


Figure 21. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_ABC) for steelhead adult residence.

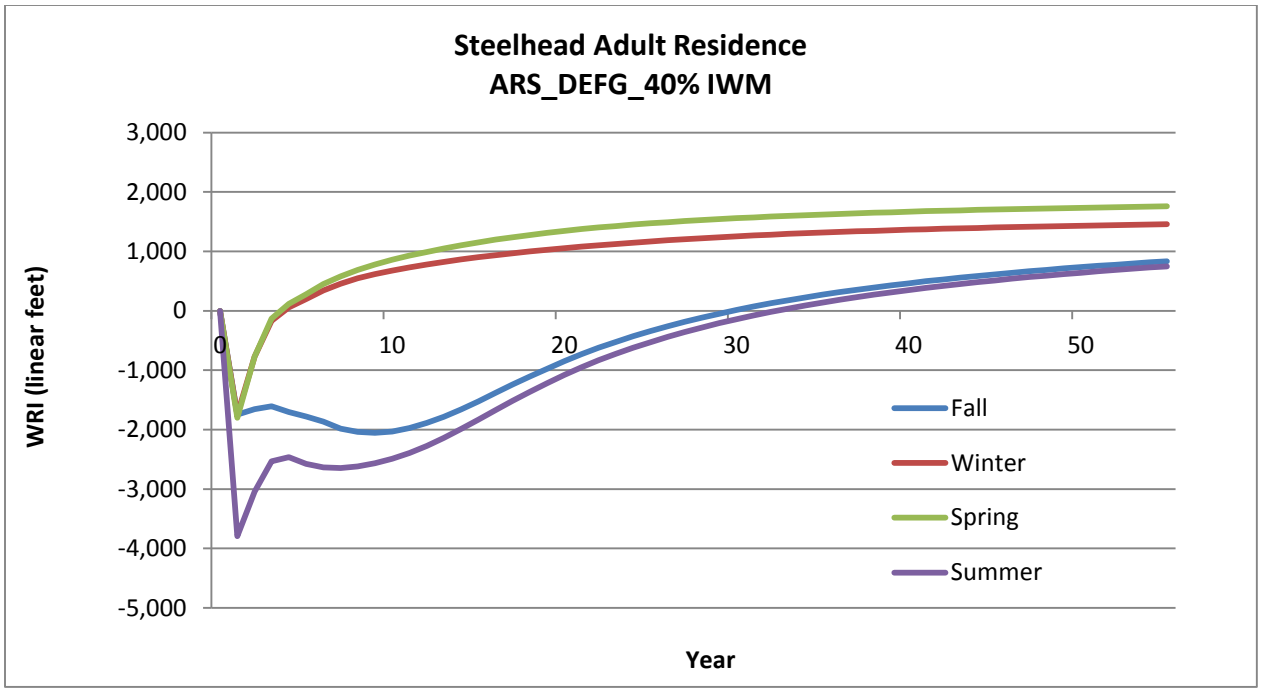


Figure 22. Weighted response indices at 40% IWM placement on the Sacramento River (ARS_DEFG) for steelhead adult residence.

Table 30
ARN_AB_40% IWM

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-366	50	0
	Juvenile Migration	-2,303	50	0
Winter	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,102
	Juvenile Migration	-3,002	2	1,699
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,354
	Juvenile Migration	-2,681	4	1,699
Summer	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-421	50	0
	Juvenile Migration	-3,129	50	0
Fall-Run Chinook Salmon				
Fall	Adult Migration	-877	39	59
	Fry and Juvenile Rearing	-366	50	0
	Juvenile Migration	-2,303	50	0
Winter	Adult Migration	-759	5	245
	Fry and Juvenile Rearing	0	0	1,102
	Juvenile Migration	-3,002	4	1,699
Spring	Adult Migration	**	**	**
	Fry and Juvenile Rearing	0	0	1,354
	Juvenile Migration	-2,681	3	1,418
Summer	Adult Migration	**	**	**
	Fry and Juvenile Rearing	-421	50	0
	Juvenile Migration	-3,129	50	0
Steelhead				
Fall	Adult Migration	-1,554	48	8
	Fry and Juvenile Rearing	-712	50	0
	Juvenile Migration	***	***	***
	Adult Residence	-1,554	48	8
Winter	Adult Migration	-1,558	5	460
	Fry and Juvenile Rearing	-36	1	1,507
	Juvenile Migration	***	***	***

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Adult Residence	-1,558	5	460
Spring	Adult Migration	-1,635	6	407
	Fry and Juvenile Rearing	-1	1	1,731
	Juvenile Migration	-2,096	2	1,173
	Adult Residence	-1,635	6	407
Summer	Fry and Juvenile Rearing	-833	50	0
	Juvenile Migration	-3,013	50	0
	Adult Residence	-3,061	50	0
Green Sturgeon				
Fall	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-5,677	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-21	50	0
Winter	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-5,020	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-3,621	50	0
Spring	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-5,020	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-3,621	50	0
Summer	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-7,118	0	0
	Juvenile Migration	0	0	0
	Adult Residence	-942	50	0

* Not applicable, adult spring-run Chinook salmon are not present on the American River

** Not applicable, adult migration of fall-run Chinook begins in early fall.

*** Not applicable, historically juvenile steelhead migration occurs in spring and summer.

Table 31
ARS_ABC_40% IWM

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-229	26	112
	Juvenile Migration	-620	21	526
Winter	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	1,578
	Juvenile Migration	-333	1	5,377
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	2,001
	Juvenile Migration	0	0	5,123
Summer	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-239	26	111
	Juvenile Migration	-967	22	510
Fall-Run Chinook Salmon				
Fall	Adult Migration	0	0	1,860
	Fry and Juvenile Rearing	-229	26	112
	Juvenile Migration	-620	21	526
Winter	Adult Migration	0	0	1,937
	Fry and Juvenile Rearing	0	0	1,578
	Juvenile Migration	-333	1	5,377
Spring	Adult Migration	**	**	**
	Fry and Juvenile Rearing	0	0	965
	Juvenile Migration	0	0	5,123
Summer	Adult Migration	**	**	**
	Fry and Juvenile Rearing	-239	26	111
	Juvenile Migration	-967	22	510
Steelhead				
Fall	Adult Migration	0	0	3,696
	Fry and Juvenile Rearing	-489	36	88
	Juvenile Migration	***	***	***
	Adult Residence	0	0	3,696
Winter	Adult Migration	0	0	4,015
	Fry and Juvenile Rearing	0	0	2,194
	Juvenile Migration	***	***	***

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Adult Residence	0	0	4,015
Spring	Adult Migration	0	0	4,164
	Fry and Juvenile Rearing	0	0	2,601
	Juvenile Migration	0	0	4,061
	Adult Residence	0	0	4,164
Green Sturgeon				
Fall	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-2,154	50	0
	Juvenile Migration	0	0	0
	Adult Residence	0	0	1,548
Winter	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-876	1	2,941
	Juvenile Migration	0	0	0
	Adult Residence	-2,917	50	0
Spring	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-876	1	2,941
	Juvenile Migration	0	0	0
	Adult Residence	-2,917	50	0
Summer	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-2,496	50	0
	Juvenile Migration	0	0	0
	Adult Residence	0	0	1,537

* Not applicable, adult spring-run Chinook salmon are not present on the American River

** Not applicable, adult migration of fall-run Chinook begins in early fall.

*** Not applicable, historically juvenile steelhead migration occurs in spring and summer.

Table 32
ARS_DEFG_40% IWM

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Adult Migration	-2,136	37	319
	Fry and Juvenile Rearing	-578	36	113
	Juvenile Migration	-4,258	50	0
Fall-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	*	*	*
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Fry and Juvenile Rearing	-578	36	113
	Juvenile Migration	-4,258	50	0
Late-Fall-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Fry and Juvenile Rearing	0	0	3,445
Summer	Fry and Juvenile Rearing	-578	36	113
Winter-Run Chinook Salmon				
Fall	Adult Migration	-1,394	35	362
	Fry and Juvenile Rearing	-558	35	116
	Juvenile Migration	-3,845	50	0
Winter	Adult Migration	-892	4	643
	Fry and Juvenile Rearing	0	0	2,390
	Juvenile Migration	-3,451	2	4,797
Spring	Adult Migration	-946	4	931
	Fry and Juvenile Rearing	0	0	3,445
	Juvenile Migration	-3,484	2	4,862
Summer	Adult Migration	-2,136	37	319
	Fry and Juvenile Rearing	-578	36	113
Steelhead				
Fall	Adult Migration	-2,053	29	832
	Fry and Juvenile Rearing	-1,156	44	99
	Juvenile Migration	-3,985	50	0
	Adult Residence	-2,053	29	832
Winter	Adult Migration	-1,747	3	1,455
	Fry and Juvenile Rearing	-77	1	3,234
	Juvenile Migration	-3,044	3	3,355
	Adult Residence	-1,747	3	1,455
Spring	Adult Migration	-1,801	3	1,757
	Fry and Juvenile Rearing	-36	1	4,317
	Juvenile Migration	-3,082	3	3,474
	Adult Residence	-1,801	3	1,757
Summer	Adult Migration	-3,793	32	748
	Fry and Juvenile Rearing	-1,206	45	92
	Adult Residence	-3,793	32	748
sDPS Green Sturgeon				
Fall	Fry and Juvenile Rearing	-4,674	50	0

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
	Juvenile Migration	0	0	0
Winter	Adult Migration	0	0	0
	Fry and Juvenile Rearing	-4,397	50	0
	Adult Residence	-3,068	50	0
Spring	Fry and Juvenile Rearing	-4,397	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-3,068	50	0
	Adult Migration	0	0	0
Summer	Fry and Juvenile Rearing	-5,009	50	0
	Juvenile Migration	0	0	0
	Adult Residence	-1,298	50	0

* Not applicable because adult fall-run Chinook salmon migrate in early fall.

Table 33
SBP

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Spring-Run Chinook Salmon				
Fall	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-4	50	0
	Juvenile Migration	-26	50	0
Winter	Adult Migration	*	*	*
	Fry and Juvenile Rearing	-9	50	0
	Juvenile Migration	-146	50	0
Spring	Adult Migration	-51	50	0
	Fry and Juvenile Rearing	-21	50	0
	Juvenile Migration	-188	50	0
Winter-Run Chinook Salmon				
Fall	Adult Migration	**	**	**
	Fry and Juvenile Rearing	-4	50	0
	Juvenile Migration	-26	50	0
Winter	Adult Migration	-21	50	0
	Fry and Juvenile Rearing	-9	50	0
	Juvenile Migration	-146	50	0
Spring	Adult Migration	-51	50	0
	Fry and Juvenile Rearing	-21	50	0
	Juvenile Migration	-188	50	0
Fall-Run Chinook Salmon				
Fall	Adult Migration	-60	50	0
	Fry and Juvenile Rearing	-4	50	0
	Juvenile Migration	-26	50	0
Winter	Adult Migration	-21	50	0
	Fry and Juvenile Rearing	-9	50	0
	Juvenile Migration	-146	50	0
Spring	Adult Migration	***	***	***
	Fry and Juvenile Rearing	-21	50	0
	Juvenile Migration	-188	50	0
Late-Fall-Run Chinook Salmon				
Fall	Adult Migration	-60	50	0
	Fry and Juvenile Rearing	-4	50	0
	Juvenile Migration	-26	50	0

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Benefits
Winter	Adult Migration	-21	50	0
	Fry and Juvenile Rearing	-9	50	0
	Juvenile Migration	-146	50	0
Spring	Adult Migration	****	****	****
	Fry and Juvenile Rearing	-21	50	0
	Juvenile Migration	-188	50	0
Steelhead				
Fall	Adult Migration	-100	50	0
	Fry and Juvenile Rearing	-17	50	0
	Juvenile Migration	-35	50	0
Winter	Adult Migration	-40	50	0
	Fry and Juvenile Rearing	-29	50	0
	Juvenile Migration	-127	50	0
Spring	Adult Migration	-87	50	0
	Fry and Juvenile Rearing	-55	50	0
	Juvenile Migration	-174	50	0
sDPS Green Sturgeon				
Fall	Fry and Juvenile Rearing	0	0	115
	Juvenile Migration	0	0	0
Winter	Adult Migration	0	0	0
	Fry and Juvenile Rearing	0	0	115
Spring	Adult Migration	0	0	0
	Fry and Juvenile Rearing	0	0	115
	Juvenile Migration	0	0	0

* Not applicable, adult spring-run Chinook salmon migrate upstream in the spring

** Not applicable, adult winter-run Chinook salmon migrate upstream in the winter

*** Not applicable, adult fall-run Chinook salmon migrate upstream in the fall

**** Not applicable, adult lt.fall-run Chinook salmon migrate upstream in the late fall and winter

7.0 References

USACE (U. S. Army Corps of Engineers). 2008. Standard assessment methodology (SAM) analysis of 29 constructed bank repair sites for the Sacramento River Bank Protection Project. Final. Contract No. W91238-07-C-0002. Prepared by Stillwater Sciences, Berkeley, California for USACE, Sacramento District, Sacramento, California. July.

USACE (U. S. Army Corps of Engineers). 2012. Standard Assessment Methodology for the Sacramento River Bank Protection Project, 2010–2012 Certification Update, Final. Prepared for U.S. Army Corps of Engineers, Sacramento District by Stillwater Sciences, Berkeley, California. Contract W91238-09-P-0249 Task Order 3.

USACE (U. S. Army Corps of Engineers). 2013. Standard Assessment Methodology (SAM) for the Sacramento River Bank Protection Project (SRBPP), Cumulative Analysis of 22 Sites. Final June 2013.

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request	
Name of Project American River Common Features	Federal Agency Involved U.S. Army Corps of Engineers	
Proposed Land Use Floodway	County and State Sacramento County, CA	
PART II *(To be completed by NRCS)*	Date Request Received By NRCS	Person Completing Form:

Does the site contain Prime, Unique, Statewide or Local Important Farmland? *(If no, the FPPA does not apply - do not complete additional parts of this form)*	YES ☐ NO ☐	Acres Irrigated	Average Farm Size
Major Crop(s)	Farmable Land In Govt. Jurisdiction Acres: %	Amount of Farmland As Defined in FPPA Acres: %	
Name of Land Evaluation System Used	Name of State or Local Site Assessment System	Date Land Evaluation Returned by NRCS	

PART III *(To be completed by Federal Agency)*	Alternative Site Rating			
	Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	0	427.7		
B. Total Acres To Be Converted Indirectly	0	0		
C. Total Acres In Site	0	427.7		
PART IV *(To be completed by NRCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland				
B. Total Acres Statewide Important or Local Important Farmland				
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted				
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value				
PART V (To be completed by NRCS) Land Evaluation Criterion Relative Value of Farmland To Be Converted (Scale of 0 to 100 Points)				

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(Criteria are explained in 7 CFR 658.5 b. For Corridor project use form NRCS-CPA-106)*	**Maximum Points**	Site A	Site B	Site C	Site D
1. Area In Non-urban Use	(15)		10		
2. Perimeter In Non-urban Use	(10)		10		
3. Percent Of Site Being Farmed	(20)		20		
4. Protection Provided By State and Local Government	(20)		20		
5. Distance From Urban Built-up Area	(15)		5		
6. Distance To Urban Support Services	(15)		10		
7. Size Of Present Farm Unit Compared To Average	(10)		10		
8. Creation Of Non-farmable Farmland	(10)		5		
9. Availability Of Farm Support Services	(5)		5		
10. On-Farm Investments	(20)		15		
11. Effects Of Conversion On Farm Support Services	(10)		1		
12. Compatibility With Existing Agricultural Use	(10)		0		
TOTAL SITE ASSESSMENT POINTS	160	0	111	0	0
PART VII ***(To be completed by Federal Agency)***					
Relative Value Of Farmland *(From Part V)*	100	0	0	0	0
Total Site Assessment *(From Part VI above or local site assessment)*	160	0	111	0	0
TOTAL POINTS ***(Total of above 2 lines)***	260	0	111	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? YES ☐ NO ☐

Reason For Selection:

Name of Federal agency representative completing this form: U.S. Army Corps of Engineers | Date: 9/9/15

(See Instructions on reverse side) **Form AD-1006 (03-02)**

STEPS IN THE PROCESSING THE FARMLAND AND CONVERSION IMPACT RATING FORM

Step 1 - Federal agencies (or Federally funded projects) involved in proposed projects that may convert farmland, as defined in the Farmland Protection Policy Act (FPPA) to nonagricultural uses, will initially complete Parts I and III of the form. For Corridor type projects, the Federal agency shall use form NRCS-CPA-106 in place of form AD-1006. The Land Evaluation and Site Assessment (LESA) process may also be accessed by visiting the FPPA website, http://fppa.nrcs.usda.gov/lesa/.

Step 2 - Originator (Federal Agency) will send one original copy of the form together with appropriate scaled maps indicating location(s)of project site(s), to the Natural Resources Conservation Service (NRCS) local Field Office or USDA Service Center and retain a copy for their files. (NRCS has offices in most counties in the U.S. The USDA Office Information Locator may be found at http://offices.usda.gov/scripts/ndISAPI.dll/oip_public/USA_map**,** or the offices can usually be found in the Phone Book under U.S. Government, Department of Agriculture. A list of field offices is available from the NRCS State Conservationist and State Office in each State.)

Step 3 - NRCS will, within 10 working days after receipt of the completed form, make a determination as to whether the site(s) of the proposed project contains prime, unique, statewide or local important farmland. (When a site visit or land evaluation system design is needed, NRCS will respond within 30 working days.

Step 4 - For sites where farmland covered by the FPPA will be converted by the proposed project, NRCS will complete Parts II, IV and V of the form.

Step 5 - NRCS will return the original copy of the form to the Federal agency involved in the project, and retain a file copy for NRCS records.

Step 6 - The Federal agency involved in the proposed project will complete Parts VI and VII of the form and return the form with the final selected site to the servicing NRCS office.

Step 7 - The Federal agency providing financial or technical assistance to the proposed project will make a determination as to whether the proposed conversion is consistent with the FPPA.

INSTRUCTIONS FOR COMPLETING THE FARMLAND CONVERSION IMPACT RATING FORM

(For Federal Agency)

Part I: When completing the "County and State" questions, list all the local governments that are responsible for local land use controls where site(s) are to be evaluated.

Part III: When completing item B (Total Acres To Be Converted Indirectly), include the following:

1. Acres not being directly converted but that would no longer be capable of being farmed after the conversion, because the conversion would restrict access to them or other major change in the ability to use the land for agriculture.
2. Acres planned to receive services from an infrastructure project as indicated in the project justification (e.g. highways, utilities planned build out capacity) that will cause a direct conversion.

Part VI: Do not complete Part VI using the standard format if a State or Local site assessment is used. With local and NRCS assistance, use the local Land Evaluation and Site Assessment (LESA).

1. Assign the maximum points for each site assessment criterion as shown in § 658.5(b) of CFR. In cases of corridor-type project such as transportation, power line and flood control, criteria #5 and #6 will not apply and will, be weighted zero, however, criterion #8 will be weighed a maximum of 25 points and criterion #11 a maximum of 25 points.

2. Federal agencies may assign relative weights among the 12 site assessment criteria other than those shown on the FPPA rule after submitting individual agency FPPA policy for review and comment to NRCS. In all cases where other weights are assigned, relative adjustments must be made to maintain the maximum total points at 160. For project sites where the total points equal or exceed 160, consider alternative actions, as appropriate, that could reduce adverse impacts (e.g. Alternative Sites, Modifications or Mitigation).

Part VII: In computing the "Total Site Assessment Points" where a State or local site assessment is used and the total maximum number of points is other than 160, convert the site assessment points to a base of 160.
Example: if the Site Assessment maximum is 200 points, and the alternative Site "A" is rated 180 points:

$$\frac{\text{Total points assigned Site A}}{\text{Maximum points possible}} = \frac{180}{200} \text{ X } 160 = 144 \text{ points for Site A}$$

For assistance in completing this form or FPPA process, contact the local NRCS Field Office or USDA Service Center.

NRCS employees, consult the FPPA Manual and/or policy for additional instructions to complete the AD-1006 form.

MITIGATION, MONITORING, AND REPORTING PLAN

AMERICAN RIVER WATERSHED COMMON FEATURES

GENERAL REEVALUATION REPORT

SACRAMENTO COUNTY, CALIFORNIA

This mitigation monitoring or reporting plan (MMRP) is designed to fulfill Section 21081.6 (a) of the California Environmental Quality Act (CEQA). Which requires public agencies to adopt a reporting or monitoring program whenever a project or program is approved that includes mitigation measures identified in an environmental document for which the agency makes a finding pursuant to CEQA Section 21081 (a) (1). The mitigation measures and strategies described below and in the attached table are to be used to avoid, minimize, or reduce any potentially significant environmental impacts.

The MMRP table includes the following:

- Section and Impacts – identifies the issue area section of the EIR/EIS and corresponding impact.
- Mitigation Measures – lists the adopted mitigation measures from the EIR/EIS.
- Implementation Timing – identifies the timing of implementation of the action described in the mitigation measures.
- Responsible for Implementation – identifies the agency/party responsible for implementing the actions described in the mitigation measures.
- Responsible for Monitoring/Reporting Action – identifies the agency/party responsible for monitoring implementation of the actions described in the mitigation measures. Verification will be carried-out during the project and an MMRP completion report will be submitted to the CVFPB staff upon completion of the project.

Section and Impacts	Mitigation Measures	Implementation Timing	Responsible for Mitigation	Responsible for Monitoring/ Reporting Action
3.2 Geologic Resources Alternative 1 Excavation for borrow material or during construction could increase soil erosion or permanent loss of topsoil. Alternative 2 Similar impact as alternative 1, but a greater magnitude.	Both Alternatives Prior to construction, USACE or its contractor would be required to acquire all applicable permits for construction. Prior to construction, a Stormwater Pollution Protection Plan (SWPPP) would be prepared, and best management practices (BMPs) would be proposed to reduce potential erosion and runoff during rain events. Minimize ground and vegetation disturbance during project construction by establishing designated equipment staging areas, ingress and egress corridors, spoils disposal and soil stockpile areas, and equipment exclusion zones prior to the commencement of any grading operations. Stockpile soil on the landside of the levee reaches, and install sediment barriers (e.g., silt fences, fiber rolls, and straw bales) around the base of stockpiles to intercept runoff and sediment during storm events. If necessary, cover stockpiles with geotextile fabric to provide further protection against wind and water erosion.	D,P,C	USACE	CVFPB Monitor measures applicable to site: Verify that all required permits have been acquired. Verify that SWPPP and BMP's have been prepared. Review plans to see that stockpiles will be on landside. Monitor construction periodically to assure ground and vegetation

Notes:
D: To be implemented or included as part of project design. Includes pre-project permitting and agency coordination
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	Install sediment barriers on graded or otherwise disturbed slopes as needed to prevent sediment from leaving the project site and entering nearby surface waters. Install plant materials to stabilize cut and fill slopes and other disturbed areas once construction is complete. Temporary structural BMPs, such as sediment barriers, erosion control blankets, mulch, and mulch tackifier, could be installed as needed to stabilize disturbed areas until vegetation becomes established.			disturbance is minimal. Verify use of sediment barriers and instillation of stabilizing plant materials. Verify establishment of vegetation.
3.3 Land Use Alternative 1 Acquisition of properties for levee easements along the Sacramento River and Arcade Creek. Alternative 2 Acquisition of properties for levee easements along the Sacramento River and Arcade Creek (fewer properties impacted than Alternative 1). Conversion of agricultural lands to floodway.	Coordination with Sacramento County Department of Parks and Recreation, the National Park Service, the other Federal and State agencies responsible for managing the resources of the Parkway, and non-governmental stakeholders will ensure consistency with existing plans. All property acquisitions would be conducted in compliance with Federal and State relocation law, and relocation services would be accomplished in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1960. Mitigation for the lands converted from parkway land to flood control uses will be mitigated by paying fees to the County under the Habitat Restoration Program Fees (HRP).	D	USACE	CVFPB Coordinate with stakeholders to ensure consistency. Verify that acquisitions are conducted in accordance with Uniform Relocation Act. Verify payment of fees.
3.4 Hydrology and Hydraulics				

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Alternative 1 No impact Alternative 2 Reduce water surface elevation in the Sacramento River downstream of the confluence of the American River without significantly increasing water surface elevation in the Yolo Bypass downstream of the confluence of the Sacramento Bypass.	None required.	D	USACE	CVFPB
3.5 Water Quality and Groundwater Resources Alternative 1 Increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction. Rock revetment placement in open water would result in significant indirect effects as the sediment and turbidity plume drifts further downstream and later effect the water qualify in those areas found further downstream of the project area. Alternative 2 Same impacts as alternative 1 plus, a potential for water quality impacts to occur if the weir is constructed in a way that debris or other construction materials could enter the Sacramento River.	Monitor turbidity in the adjacent water bodies, where applicable criteria apply, to determine whether turbidity is being affected by construction and to ensure that construction does not result in a rise in turbidity levels above ambient conditions, in accordance with the Central Valley RWQCB Basin Plan turbidity objectives Prepare a SWPPP, Spill Prevention Control and Countermeasures Plan (SPCCP), and a bentonite slurry spill contingency plan (BSSCP) • Conduct earthwork during low flow periods (July 1 through November 30). • To the extent possible, stage construction equipment and materials on the landside of the subject levee reaches in areas that have already been disturbed.	P, C	USACE	CVFPB Verify coordination with RWQCB. Review SWPPP, SPCCP, and BSSCP. Verify measures are in place during construction.

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	• Minimize ground and vegetation disturbance during project construction by establishing designated equipment staging areas, ingress and egress corridors, spoils disposal and soil stockpile areas, and equipment exclusion zones prior to the commencement of any grading operations. • Stockpile soil on the landside of the levee reaches, and install sediment barriers (e.g., silt fences, fiber rolls, and straw bales) around the base of stockpiles to intercept runoff and sediment during storm events • Install sediment barriers on graded or otherwise disturbed slopes as needed to prevent sediment from leaving the project site and entering nearby surface waters. • Install plant materials to stabilize cut and fill slopes and other disturbed areas once construction is complete. Plant materials could include an erosion control seed mixture or shrub and tree container stock. Temporary structural BMPs, such as sediment barriers, erosion control blankets, mulch, and mulch tackifier, could be installed as needed to stabilize disturbed areas until vegetation becomes established. • Conduct water quality tests specifically for increases in turbidity and sedimentation caused by construction activities.			

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	• Water samples for determining background levels shall be collected in the adjacent water body for each erosion construction site. • During working hours, the construction activity shall not cause the turbidity in the adjacent water body down current from the construction sites to exceed the Basin Plan turbidity objectives.			
3.6 Vegetation and Wildlife Alternative 1 The launchable rock trenches would result in the removal of a maximum of 65 acres of riparian habitats within the American River Parkway. Bank protection measure would result in impacts to a maximum of 31,000 linear feet of SRA habitat. The existing levee structure would be degraded by one half to create a working platform for slurry wall installation. As the levee is degraded, all vegetation located in the degraded area would be removed. The maximum degraded area (the upper one half of the levee) is approximately 110 acres and contains about 750 trees of various sizes and species. On the landside of the levee, where levee raises are required, all trees would	During the design refinement phase, plans will be evaluated to reduce the impact on vegetation and wildlife to the extent practicable. Refinements that could be implemented to reduce the loss of riparian habitat include: reduced footprint, constructing bank protection rather than launchable rock trench whenever feasible, and designing planting berms in areas where significant riparian habitat exists adjacent to the levee toe. To compensate for the removal of a maximum of 65 acres of riparian habitat, approximately 130 acres of replacement habitat would be created to account for the temporal loss of habitat while newly created habitat is growing. Surveys would be conducted prior to construction to determine if any birds are nesting within 0.5 miles of the construction activities. If nests are located within the vicinity of construction for any given year, coordination with the appropriate resource agencies would occur to determine what	D, P, C	USACE	CVFPB Verify impact refinement for smaller footprint. Verify replacement habitat creation. Verify and participate in nesting bird surveys. Verify that tree removal occurs outside of nesting season. Verify vegetation

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be removed from the levee slope and within 15 feet of the levee toe to construct the levee raise. A landside maintenance easement would be required along the levee toe within the 8 miles of levee raise. This easement will be left in place after construction as access. There are approximately 1,300 trees of various species and size within this landside easement that once removed would not be replaced on-site. There would be a maximum of 200 trees removed from both the landside and waterside to construct the project. These trees compose approximately 2 acres of oak woodland habitat on NEMDC, and approximately 10.5 acres of riparian on Arcade Creek. Alternative2 Because the amount of levee raising is significantly reduced under Alternative 2 due to the widening of the Sacramento Weir and Bypass, effects to the landside vegetation on the levees would be less than under implementation of Alternative 1. This would result in the removal of approximately 750 trees of various species	action should be taken to reduce impacts. Trees would not be removed if an active nest is found; however, once the young have fledged, the tree can be removed for construction. If survey results determine that no nests are in the vicinity of construction scheduled for that year, construction may commence without further coordination on this issue. Avoidance and minimization measures incorporated as part of the Sacramento River design include: compliance with the USACE vegetation policy through a vegetation variance, installation of a planting berm where erosion protection is required, and narrowing of the levee footprint by construction of a retaining wall, when feasible. The vegetation variance would allow waterside trees on the lower half of the slope to remain in place. This would allow approximately 930 trees along 10 miles of the Sacramento River to continue to provide habitat for fish and wildlife species. Along with retaining the trees, additional plantings of small vegetation would be done on the newly constructed berm. Species of plants would be coordinated with NMFS, USFWS, and State and local partners. Off-Site mitigation for the removal of 50 trees in the Arcade Creek area would be done in compliance with the Sacramento City tree ordinance. It is estimated that 2 acres would be required to accommodate the planting of			variance is in place to minimize tree removal. Verify mitigation area for trees planted off-site.

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	approximately 450 trees. Alternative 2 Compensation was determined by evaluating other projects with similar impacts in the Central Valley, coordination with resource agencies, and evaluation of compensation plantings' ability to provide similar wildlife habitat. A total of 16 acres would be needed to compensate for the removal of the vegetation along the Sacramento River and within the new weir footprint, due to the temporal loss of habitat while the new habitat is establishing. Plantings could be accomplished within the expanded bypass, other nearby available lands, or through the purchase of credits at an approved mitigation bank.			
3.7 Fisheries Alternative 1 Rock placement would most likely disturb the native resident fish by increasing noise, water turbulence, and turbidity, causing them to move away from the area of placement. In some pelagic native juvenile species utilizing the near shore habitat for cover, moving away from that cover could put them at a slight risk of predation. Construction during the project may disturb soils and the nearshore	Mitigation measures for vegetation and wildlife, and water quality will also apply for fisheries. Additionally; • In-water construction would be restricted to the general estimated work window of August 1 through November 30. For the purpose of this study however, during PED, the work window will be adjusted on a site specific basis taking into account periods of low fish abundance, and in-water construction outside the principal spawning and migration season. Typical construction season generally corresponds to the dry	D, P, C	USACE	CVFPB Verify implementation of vegetation and wildlife mitigation measures. Verify implementation of water quality mitigation measures.

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environment, leading to increases in sediment in the nearshore aquatic habitat. This in turn may increase sedimentation (i.e., deposition of sediment on the substrate), suspended sediments, and turbidity. Alternative 2 By widening the Sacramento Weir and Bypass, the project would create additional floodplain habitat within the Sacramento Bypass, which could benefit native fish.	season, but construction may occur outside the limits of the dry season, only as allowed by applicable permit conditions. • Due to the deleterious effects of numerous chemicals on native resident fish used in construction, if a hazardous materials spill does occur, a detailed analysis will be performed immediately by a registered environmental assessor or professional engineer to identify the likely cause and extent of contamination. This analysis will conform to American Society for Testing and Materials standards, and will include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, the USACE and its contractors will select and implement measures to control contamination, with a performance standard that surface water quality and groundwater quality must be returned to baseline conditions. • If mitigation or compensation sites are planned within the Sacramento Bypass for the overall ARCF project, information gained from the 2013 Knaggs Ranch Pilot Study would be reviewed for potential beneficial habitat for native fish species to be			

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	incorporated into the sites.			
3.8 Special Status Species Alternative 1 <u>Valley Elderberry Longhorn Beetle</u> Within the surveyed study area, approximately 250 shrubs were located along the American River Parkway and 50 shrubs were located along the Sacramento River. Prior to project construction, a qualified biologist would conduct focused surveys of elderberry shrubs within 100 feet of the project area for construction in accordance with the USFWS guidelines.	Mitigation measures are similar for both Alternatives 1 and 2 <u>Valley Elderberry Longhorn Beetle</u> The following is a summary of measures that would be implemented during construction based on the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (USFWS 1999a). These measures will be implemented to minimize any potential effects on valley elderberry longhorn beetles or their habitat, including restoration and maintenance activities, long-term, protection, and compensation if shrubs cannot be avoided: • When a 100-foot (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed. • Where encroachment on the 100-foot buffer has been approved by the USFWS, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible. • During construction activities, all areas to be avoided will be fenced and flagged. • Contractors will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with	D, P, C , M	USACE	CVFPB Verify that all BMP's and mitigation measures are followed during construction. Verify setback distances Verify that environmental awareness training has been implemented

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VELB continued	these requirements. • Signs will be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area. • Any damage done to the buffer area will be restored. • Buffer areas will continue to be protected after construction. • No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas. • Trimming of elderberry plants will be subject to mitigation measures. • Elderberry compensation would be planted in the American River Parkway. The USACE has six existing sites which are offsetting previous USACE flood control projects along the lower American River and near Folsom Dam. The USACE will find areas within the lower American River parkway which will either expand existing compensation areas or provide for connectivity between conserved valley elderberry longhorn beetle habitat. Sites within the Parkway will be coordinated with County Parks and the Service during the design phase of the project. Sites will be designed and developed prior to any effects to valley elderberry longhorn beetle habitat. The USACE will create 69.91 acres of riparian habitat which supports valley elderberry longhorn beetle within the lower American			Verify sign placement.

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VELB continued Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp There is approximately 0.25 acre of land within the construction footprint of the new levee and floodwall that could potentially include vernal pool habitat. This 0.25 acre could be adversely affected from ground disturbing activities, operation of construction	River parkway. • If possible, elderberry shrubs would be transplanted during their dormant season (approximately November, after they have lost their leaves, through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation ratios will apply. • Any areas that receive transplanted elderberry shrubs and elderberry cuttings will be protected in perpetuity. • The USACE will work to develop off-site compensation areas prior to or concurrent with any take of valley elderberry longhorn beetle habitat. • Management of these lands will include all measures specified in USFWS's conservation guidelines (1999a) related to weed and litter control, fencing, and the placement of signs. • Monitoring will occur for ten consecutive years or for seven non-consecutive years over a 15-year period. Annual monitoring reports will be submitted to USFWS. Vernal Pool Fairy Shrimp and Tadpole Shrimp The following measures from the 2004 Biological Opinion from the Magpie Creek Flood Control Project would be implemented to avoid and minimize impacts to potential vernal pools in the vicinity of the Magpie Creek construction area: • Preservation component: For every acre of			

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vehicles, by construction of the new levee and maintenance road, or due to the alteration of the natural flows of the area due to construction of the new levee. Prior to initiation of any construction activities, field surveys and a wetland delineation would occur to verify the occurrence of vernal pools in the construction footprint and to determine if any nearby vernal pools could be indirectly affected by construction.	habitat directly or indirectly affected, at least two vernal pool credits will be dedicated within a Service-approved ecosystem preservation bank or, based on Service evaluation of site-specific conservation values, three acres of vernal pool habitat may be preserved on the project site or another nonbank site as approved by the Service. • Creation component: For every acre of habitat directly affected, at least one vernal pool creation credit will be dedicated within a Service-approved habitat creation bank or, based on Service evaluation of site-specific conservation values, two acres of vernal pool habitat will be created and monitored on the project site or another non-bank site as approved by the Service. • Listed vernal pool crustacean habitat and associated uplands utilized as on-site compensation will be protected from adverse effects and managed in perpetuity or until the USACE, the applicant, and the Service agree on a process to exchange such areas for credits within a Service-approved conservation banking system. Off-site conservation at a Service-approved non-bank location will be protected and managed in perpetuity through a Service-approved conservation easement, Service-approved management plan, and a sufficient endowment fund to manage the site in perpetuity in accordance with the management plan. • If habitat is avoided (preserved) on site, then a Service-approved biologist (monitor) will			Verify that preconstruction bird surveys have occurred.

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Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp continued	inspect any construction-related activities at the proposed project site to ensure that no unnecessary take of listed species or destruction of their habitat occurs. The biologist will have the authority to stop all activities that may result in such take or destruction until appropriate corrective measures have been completed. The biologist also will be required to immediately report any unauthorized impacts to the Service and the California Department of Fish and Game. • Adequate fencing will be placed and maintained around any avoided (preserved) vernal pool habitat to prevent impacts from vehicles. • All on-site construction personnel will receive instruction regarding the presence of listed species and the importance of avoiding impacts to these species and their habitat. • The applicant will ensure that activities that are inconsistent with the maintenance of the suitability of remaining habitat and associated on-site watershed are prohibited. This includes, but is not limited to: (i) alteration of existing topography or any other alteration or uses for any purposes, including the exploration for or development of mineral extraction; (ii) placement of any new structures on these parcels; (iii) dumping, burning, and/or burying of rubbish, garbage, or any other wastes or fill materials; (iv) building of any new roads or trails; (v) killing, removal, alteration, or replacement of any existing native vegetation; (vi) placement of storm			

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<u>Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp continued</u>	water drains; (vii) fire protection activities not required to protect existing structures at the project site; and (viii) use of pesticides or other toxic chemicals. The proposed project will result in 0.25 acre of indirect effects to vernal pools/swales of potentially suitable vernal pool shrimp and vernal pool tadpole shrimp habitat. The applicant has identified and agreed to purchase 0.5 vernal pool preservation credits at a Service-approved conservation bank or Service-approved fund. Credits will be purchased prior to the effect on any vernal pool habitat. The agreed upon conservation responsibilities of the applicant are as follows: • Prior to any earth-moving activities at the proposed project site, the applicant shall purchase at least 0.5 vernal pool preservation credits within a Service-approved ecosystem preservation bank or fund account.			
<u>Giant Garter Snake (GGS)</u> The East Side Tributaries (NEMDC, Magpie Creek, and Arcade Creek) have some potential GGS habitat, however, the creeks in this area lack year round water and connectivity to rice fields, a major component of GGS habitat. The closest rice fields are about 5 miles away up the NEMDC and above a pump plant	<u>Giant Garter Snake</u> The following measures will be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity. These measures are based on USFWS guidelines for restoration and standard avoidance measures included as appendices in USFWS (1997).			

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located on the NEMDC just above Dry/Robla Creek. Additionally, Arcade Creek and NEMDC both have segments that include large cover vegetation that would make them undesirable for GGS.	• Unless approved otherwise by USFWS, construction will be initiated only during the giant garter snakes' active period (May 1 to October 1, when they are able to move away from disturbance). • Construction personnel will participate in USFWS-approved worker environmental awareness program. • A giant garter snake survey would be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than two weeks, a biologist would survey the project area again no later than 24 hours prior to the restart of work. • Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own. • Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from giant garter snake aquatic habitat.			

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GGS continued	• Giant garter snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel. • Habitat temporarily affected for more than three or more seasons will be restored and twice as much habitat will be created. • The USACE has estimated that approximately 15 acres of aquatic habitat (drainage ditches and irrigation canals) and 30 acres of associated upland habitat would be permanently affected due to the widening of the Sacramento Weir and Bypass. Habitat permanently affected in the Sacramento Bypass will be compensated for through the purchase of 135 acres of credits at a USFWS-approved conservation bank. Due to the spatial and temporal loss of habitat, and the lack of permanent on-site replacement, the ecological value associated with doing all mitigation at an off-site location was reduced to an overall 70% habitat value. This reduction is offset by the increase of mitigation credits at ratios specified by USFWS in the Biological Opinion included as Appendix J.			

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GGS continued Western Yellow-Billed Cuckoo The project area is unlikely to support western yellow-billed cuckoo nesting habitat due to the narrow riparian corridors along the waterways, with the exception of the American River Parkway. However, migrant individuals are likely to pass through the area in transit to breeding sites along the Sacramento River north of Colusa. Potential long-term effects to the cuckoo could result from the loss of 65 acres of riparian habitat in the footprint of the rock trench sites within the American River Parkway. For the American River, impacts to trees would be the width of the launchable rock trenches (currently proposed at approximately 40-feet wide) for a total of approximately 65 acres. Additionally, approximately 110 acres of riparian habitat would be impacted along the Sacramento River. Swainson's Hawks	• One year of monitoring will be conducted for the 80.5 acres that are temporarily affected. • The USACE will purchase credits at a conservation bank prior to any permanent disturbance of giant garter snake habitat. Western Yellow-Billed Cuckoo, Swainson's Hawk, White-Tailed Kite, and Purple Martin The following BMPs will be implemented: • Before ground disturbance, all construction personnel would participate in a CDFW-approved worker environmental awareness program. A qualified biologist would inform all construction personnel about the life history of Swainson's hawk and the importance of nest sites and foraging habitat. • A breeding season survey for nesting birds would be conducted for all trees and shrubs that would be removed or disturbed which are located within 500 feet (0.5 mile for Swainson's hawk) of construction activities, including grading. Swainson's hawk surveys would be completed during at least two of the following survey periods: January 1 to March 20, March 20 to April 5, April 5 to April 20, and June 10 to July 30 with no fewer than three surveys completed in at least two survey periods, and with at least one of these surveys occurring immediately prior to project initiation (Swainson's Hawk Technical Advisory Committee 2000). Other			

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Approximately 175 acres of riparian habitat used by Swainson's hawk for roosting and nesting could be affected by project construction. Additionally, approximately 2.5 acres of non-native grassland intermixed with barren ground would be removed or disturbed as a result of construction activities at levees. Much of this habitat is within the Sacramento urban area, where Swainson's hawks nest and forage along the American and Sacramento Rivers. <u>White-Tailed Kite</u> Construction activities conducted during nesting season, including vegetation removal, could significantly impact the white-tailed kite by removing nesting habitat or causing the species to abandon any active nests. In addition, the short-term loss of approximately 175 acres of riparian habitat on the landside of the levees that could support white-tailed kite nesting and foraging could result in significant effects to this species. <u>Purple Martin</u> Construction activities conducted during	migratory bird nest surveys could be conducted concurrent with Swainson's hawk surveys with at least one survey to be conducted no more than 48 hours from the initiation of project activities to confirm the absence of nesting. If the biologist determines that the area surveyed does not contain any active nests, construction activities, including removal or pruning of trees and shrubs, could commence without any further mitigation. • If active nests are found, the USACE would maintain a 0.25-mile buffer between construction activities and the active nest(s). In addition, a qualified biologist would be present on-site during construction activities to ensure the buffer distance is adequate and the birds are not showing any signs of stress. If signs of stress that could cause nest abandonment are noted, construction activities would cease until a qualified biologist determines that fledglings have left an active nest. • Tree and shrub removal, and other areas scheduled for vegetation clearing, grading, or other construction activities would not be conducted during the nesting season (generally February 15 through August 31 depending on the species and environmental conditions for any given year) . These construction activities could affect them by removing or causing abandonment of active nests of migratory birds protected under the Migratory Bird Treaty Act and California Fish			

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nesting season, including vegetation removal, could significantly impact the purple martin by removing nesting habitat or causing the species to abandon any active nests. In addition, the short-term loss of approximately 175 acres of riparian habitat on the landside of the levees that could support purple martin nesting and foraging could result in significant effects to this species. <u>Burrowing Owl</u> Construction activities, including grading and clearing activities within or adjacent to potential burrowing owl habitat, could result in nesting failure, death of nestlings, or loss of eggs. In addition, the short-term loss of approximately 175 acres of riparian habitat on the landside of the levees that could support burrowing owl nesting and foraging could result in significant effects to this species.	and Game Code To reduce the impact on migratory birds habitat the USACE will seek a vegetation variance on lower half of the waterside levee slope. Additionally, where bank protection work is performed the sites would be planted with vegetation and trees that over time will provide habitat for the hawks. To compensate for the removal of 134 acres of riparian habitat supporting Western yellow-billed cuckoos, Swainson's hawks, and other migratory birds approximately 268 acres of replacement habitat will be created, as discussed in the vegetation and wildlife section. <u>Burrowing Owl</u> • Prior to the implementation of construction, surveys will be conducted to determine the presence of burrows or signs of burrowing owl presence within the project area. The survey would be conducted in accordance with Appendix D of CDFW's Staff Report on Burrowing Owl Mitigation (CDFG 2012). • If burrowing owls are observed, coordination would occur with CDFW to determine the appropriate actions to take or any additional avoidance and minimization measures that may need to occur. These measures may include creating a protective buffer around occupied burrows during the duration of the breeding season and biological monitoring of			

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	active burrows to ensure that construction activities do not result in adverse effects on nesting burrowing owls. • If potential burrows are present, all on-site construction personnel shall be instructed regarded the potential presence of burrowing owls, identification of these owls and their habitat, and the importance of minimizing impacts on burrowing owls and their habitat.			
<u>Listed Fish Species:</u> <u>Winter-Run Chinook Salmon</u> Implementation of the bank erosion protection measures may result in adverse effects to juvenile and smolt winter-run Chinook salmon, their critical habitat, and EFH. Construction activities that increase noise, turbidity, and suspended sediment may disrupt feeding or temporarily displace fish from preferred habitat. Physical damage or harassment to listed fish species would be low during the months of construction. Winter-run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River and American River SAM analysis reaches over the lifetime of the project when both IWM and planted benches are incorporated into the with-project conditions. Chinook	<u>Listed Fish Species</u> USACE proposes to develop a green sturgeon habitat, mitigation, and monitoring plan (HMMP) (Appendix I) to address the long-term negative impacts to green sturgeon designated critical habitat with the specific elements that are described below: • The green sturgeon HMMP shall be developed in coordination with the Interagency Ecological Program (IEP) green sturgeon project work team and consulted on with NMFS prior to the construction of any work within the designated critical habitat of sDPS green sturgeon related to the ARCF GRR. • The USACE shall either refine the SAM or develop an alternative green sturgeon survival and growth response model based on using and updating the existing Hydrologic Engineering Center Ecosystem Function Model (HEC-EFM) that reflects			

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salmon should exhibit a positive response by year 5 in the winter-spring when most juvenile Chinook salmon are expected in the ARCF GRR project area. <u>Spring-run Chinook Salmon</u> Adult spring-run Chinook salmon migrate up the Sacramento River from March through September although most individuals have entered tributary streams by mid-June and will not be affected by construction activities. Therefore, potential for construction-related ARCF GRR project effects will be similar to that described for winter-run Chinook salmon. <u>Central Valley Fall-/Late Fall–Run Chinook Salmon</u> Fall-/Late Fall-Run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River and American River SAM analysis reaches over the lifetime of the project when both IWM and planted benches are incorporated into the with-project conditions. Chinook salmon should exhibit a positive response by year 5 in the winter-spring	green sturgeon's preference for benthic habitat. • The green sturgeon HMMP shall also be developed with measurable objectives for completely offsetting all adverse impacts to all life stages of sDPS green sturgeon (as modeled using refined approaches described above and considering design refinements that occur in the PED phase of project implementation. • The HMMP shall also, restore or compensate for the number of acres of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This mitigation shall be coordinated with the Interagency Working Group (IWG) or a Bank Protection Working Group (BPWG) and must be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. • Mitigation actions shall be initiated prior to the construction activities affecting sDPS green sturgeon and their critical habitat. • The sDPS green sturgeon HMMP will include measurable performance standards at agreed upon intervals and will be monitored for a period of at least ten years following construction. The following additional conservation measures would be implemented to reduce the adverse effects to listed Chinook, steelhead, delta smelt, and green sturgeon:			

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when most juvenile Chinook salmon are expected in the ARCF GRR project area. <u>Central Valley Steelhead</u> Steelhead are expected to show a long term positive response to project actions in the Sacramento River and American River SAM analysis reaches over the lifetime of the project. Steelhead should exhibit a positive response by year 4 in the winter-spring when most juvenile steelhead will be migrating and rearing through the project area. <u>Green Sturgeon</u> If larvae or juveniles are present during construction, in-water activities could result in localized displacement and possible injury or mortality to individuals that do not readily move away from the channel or nearshore areas. Project actions associated with bank protection measures may increase sediment, silt, and pollutants, which could adversely affect rearing habitat or reduce food production, such as aquatic invertebrates, for larval and juvenile green sturgeon.	• In-water construction activities (e.g., placement of rock revetment) will be limited to the work window of August 1 through November 30. If the USACE wants to work outside of this window they will consult with USFWS and NMFS. • The USACE will purchase delta smelt credits from a USFWS-approved conservation bank to off-set the loss of 14 acres of shallow water habitat, and 13 acres of spawning habitat. This mitigation is assumed to occur through the purchase of credits at a mitigation bank due to the lack of available real estate in the study area for on-site mitigation. Due to the spatial and temporal loss of habitat, the ecological value associated with doing all mitigation at an off site location was reduced to an overall 70% habitat value. This reduction is offset by the increase of mitigation credits at ratios specified by USFWS and NMFS in the Biological Opinions. The USACE proposes to purchase a total of 72 credits to ensure that impacts to Delta smelt are fully mitigated. • Erosion control measures will be implemented (BMPs), including Storm Water Pollution Prevention Program and Water Pollution Control Program, that minimize soil or sediment from entering the river. BMPs shall be followed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to Federally listed fish and their designated			

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Due to these adverse effects to juvenile green sturgeon, USACE is proposing to adaptively manage the project in a number of ways in order to minimize impacts to this species. In particular, preconstruction physical modeling is proposed to assist in determining potential methods of implementing the proposed measures to minimize impacts to salmon. Additionally, new habitat modeling is proposed to better define what those impacts may be. Monitoring would be conducted during and post-construction in order to confirm the impacts estimated to result from the project, and to allow for improvement in minimizing impacts for future construction throughout the estimated 10 year construction period. <u>Delta Smelt</u> Potential spawning habitat includes shallow channel edge waters in the Delta and Sacramento River. Construction-related effects include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, and alteration of spawning and incubation habitat. As a result, potential construction-related effects to delta smelt physical habitat would include disruption of spawning activities, disturbance or mortality of	critical habitat. • Screen any water pump intakes, as specified by NMFS and USFWS screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt. • No grading or altering of the lands within the existing Sacramento Bypass will occur as part of the project. • The USACE shall participate in an existing IWG or work with other agencies to participate in a new BPWG to coordinate stakeholder input into future flood risk reduction actions associated with the ARCF GRR. • The USACE shall coordinate with NMFS during PED as future flood risk reduction actions are designed to ensure conservation measures are incorporated to the extent practicable and feasible and projects are designed to maximize ecological benefits. • The USACE shall include as part of the Project, a Riparian Corridor Improvement Plan with the overall goal of maximizing the ecological function and value of the existing levee system within the Sacramento Metropolitan Area. • The USACE shall develop a HMMP with an overall goal of ensuring the conservation measures achieve a high level of ecological function and value. The HMMP shall include:			

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eggs and newly hatched larvae, alteration of spawning and incubation habitat, and loss of shallow water habitat for spawning. Juvenile delta smelt may be subject to disturbance or displacement caused by construction activities that increase noise, turbidity, and suspended sediment. Delta smelt may not be readily able to move away from channel or nearshore areas that are directly affected by construction activities (i.e., placement of rock revetment). Larvae may be disrupted during summer months as they migrate downstream to rear in the Delta. Incidental take of delta smelt may occur from direct mortality or injury during a construction activity, or by the impairment of essential behavior patterns (i.e., feeding, escape from predators). In addition, physiological impairment could be caused by toxic substances (i.e., gasoline, lubricants, oil) entering the water. Construction related effects on delta smelt rearing and migration will be minimized by restricting in-water construction activities on the Sacramento River to a general estimated work window between August 1 and November 30. For the purpose of this study however, during PED, the work window will be adjusted on a site specific basis taking into account presence of juvenile and	▪ Specific goals and objectives and a clear strategy for maintaining all of the project conservation elements for the life of the project. ▪ Measures to be monitored by the USACE for 10 years following construction and shall update their O&M manual to ensure the HMMP is adopted by the local sponsor to ensure the goals and objectives of the conservation measures are met for the life of the project. ▪ Include specific goals and objectives and a clear strategy for achieving full compensation for all project-related impacts to listed fish species. ▪ The USACE shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP. ▪ The USACE shall host an annual meeting and issue annual reports for five years following completion of project construction. • The USACE shall ensure that, for salmon and			

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adult delta smelt as well as any other condition that could impact delta smelt rearing and migration. Listed Fish Species continued	steelhead, the maximum SAM WRI deficits for each seasonal water surface elevation as determined appropriate with input from the IWG or the BPWG are fully offset through the purchase of credits at a NMFS approved conservation bank (as described in this BA). • The USACE shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place. • The USACE shall ensure that the planting of native vegetation will occur as described in the HMMP. All plantings must be provided with the appropriate amount of water to ensure successful establishment. • The USACE shall provide a copy of the BO, or similar documentation, to the prime contractor, the prime contractor is responsible for implementing all requirements and obligations on behalf of USACE included in the documents and to educate and inform all other contractors involved in the project as to the requirements of the BO. • A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. Written documentation of the training will be submitted to NMFS within 30 days of the			

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Listed Fish Species continued	completion of training. • The USACE shall consider installing IWM along future flood risk reduction projects associated with the ARCF GRR at 40 to 80 percent shoreline coverage at all seasonal water surface elevations in coordination with the IWG or the BPWG. The purpose is to maximize the refugia and rearing habitats for juvenile fish. • The USACE shall protect in place all riparian vegetation on the lower waterside slope of any levee unless removal is specifically approved by NMFS. • The USACE shall develop a Vegetation Variance for all elements of the ARCF GRR that are adjacent to habitat that is occupied by federally listed salmon, steelhead and green sturgeon, including the main channel of the Sacramento River (as proposed) and the Sacramento Bypass. • The USACE shall ensure the widening of the Sacramento Bypass is designed and constructed to minimize stranding of fish in the depressions wound within the bypass though grading or construction of drainage channels. • The USACE, in coordination with the local sponsor, shall ensure that the Habitat Mitigation and Monitoring Plan for the Sacramento Bypass includes baseline post-project monitoring of fish stranding. The monitoring plan shall be developed in coordination with NMFS.			

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Listed Fish Species continued	• The USACE shall update the O&M manual to incorporate without detrimental effects to flood operations 1) operations of the Sacramento Weir include a plan that allows for ramp down flows in a manner that minimize juvenile fish stranding in the Sacramento Bypass, (2) integration of Sacramento Weir operations with the Yolo Bypass. • During Preconstruction Engineering and Design, the USACE, in coordination with the local sponsor, shall coordinate with NMFS to provide an operation of the Sacramento Weir to allow without detrimental effects to flood management operations, for controlled ramp down rates of water into the Sacramento Bypass following peak flows. • Additional concerns about mitigation, not considered in a SAM analysis, will be included in the MMP (See Appendix I) along the Sacramento Bypass reach, including potential adult and juvenile passage issues, loss of shoreline riparian vs. gain in floodplain, and contradicting ESA species habitat requirements. These issues will be considered and appropriate actions will be taken where possible in coordination with other agencies. For SRA habitat impacted by construction, the following measures would be implemented to compensate for the habitat loss:			

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Listed Fish Species continued	• Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to protected species from designated compensation sites. In general, compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] §§ 2201–2330). • For identified designated critical habitat, where feasible all efforts will be made to compensate for impacts where they have occurred or in close proximity. Impacts to designated critical habitat, SRA and instream components combined and the compensation value of replacement habitat will be based on the interagency approved Standard Assessment Model (SAM) used throughout the Sacramento River basin and Delta flood control system. • Compensation sites would be monitored and vegetation would be replaced as necessary based on performance standards in the Mitigation Monitoring Plan (MMP) as detailed in Appendix I of the EIS/EIR.			

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	Depending on the species of interest (e.g., delta smelt), the severity of the short-term habitat losses due to bank erosion repair actions may not be compensated by long-term gains, whereas longer lived species (e.g., steelhead, Chinook) have longer periods for compensation to be provided. The following compensation time periods (based loosely on life expectancy) should be considered as guidelines for compensation: • Green sturgeon, 15 years; • Chinook salmon, 5 years; • Central Valley steelhead, 4 years; and • Delta smelt, 1 year.			
<u>Special Status Plant Species: Sanford's Arrowhead</u> Sanford's arrowhead is known to occur in the Arcade Creek and NEMDC channels. Levee work in these reaches is proposed to remain within the levee prism and would not encroach into the channel; therefore, construction activities in this reach would not result in direct impacts to Sanford's arrowhead. Indirect effects to Sanford's arrowhead could occur during construction due to dust disturbance. However, the mitigation measures proposed in the air quality section.	<u>Special Status Plant Species</u> The following avoidance and minimization measures would be implemented during construction to reduce potentially significant effects to Sanford's arrowhead and wooly rose-mallow to less than significant. Additionally, the avoidance and minimization measures to address invasive plant species in Section 3.6.6 would also reduce potential impacts to special status plant species. • Preconstruction surveys would be conducted by a qualified botanist in suitable habitat to determine the presence of any special status plants. Surveys would be conducted at an			

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Wooly Rose-Mallow There are no known populations of wooly rose-mallow in the study area, however since they are known to occur on levee banks with riprap, they could potentially be adversely impacted by construction of the proposed project. Clearing and grubbing of the levee slopes, and some long-term O&M activities, such as mowing of the levees, could also remove populations of this plant, if present. **Alternative 2** A maximum of 15 acres of aquatic GGS habitat (drainage ditches and farm canals) would be permanently removed and incorporated into the Sacramento Bypass. To the east of the bypass, there are approximately 8 acres of riparian vegetation growing along the Sacramento River that would be removed to construct the new weir structure. The 8-acre area contains both the Old River Road and Union Pacific Railroad (UPRR) tracks. Prior to construction this area would be surveyed to determine if any avian species have nested in the area. If there is nesting Swainson's Hawks	appropriate time of year during which the species are likely to be detected, which would likely be during the blooming period. • If special status plant species are found during preconstruction surveys, the habitat would be marked or fenced as an avoidance area during construction. A buffer of 25 feet would be established. If a buffer of 25 feet is not possible, the next maximum possible distance would be fenced off as a buffer. • If special status plant species cannot be avoided during construction, the USACE would coordinate with the resource agencies to determine additional appropriate mitigation measures. **Alternative 2** Same mitigation ratios and BMPs as alternative 1			

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construction would be delayed until fledglings have left the nest. Fish in the area would likely disperse with the disturbance to the water. The expansion of the Sacramento Weir and Bypass could have a positive beneficial effect on special status wildlife such as the giant garter snake and its riparian vegetation once construction is complete and lands are converted from farming activities to open space where wetlands and shrubby riparian habitat is expected to naturally regenerate with the increased area that is periodically inundated from flooding during the rainy season. Widening of the weir and bypass will increase the entrainment and stranding exposure and rates of juvenile green sturgeon. When the weir is overtopping and water is flowing down the bypass, adult fish are attracted to the flow and follow it upstream in an attempt to reach their holding and spawning habitat. Widening the weir and bypass would increase the amount of water going over the weir and increase the attraction rate of sturgeon, salmon and steelhead.				
3.9 Cultural Resources The effects of the erosion repair on the	Avoidance of adverse effects to historic properties is the preferred treatment approach.	D, P, C	USACE	CVFPB

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American River, levee geometry measures, cutoff walls, and bank protection on the Sacramento River and construction of cutoff walls, correction of the levee geometry, installation of floodwalls, installation of a conduit or box culvert, raising of floodwalls and existing levees, construction of maintenance roads, installation of floodgates, and creation of a detention basin on the East Side Tributaries would likely result in an adverse effect to some historic properties located within the APE for the project. The records and literature search conducted for the project identified 69 known prehistoric and historic resources in the total project APE. For the purposes of this EIS/EIR, the USACE assumes that all of these resources would be impacted by the levee improvement alternatives. Site specific determinations of effect and impact cannot be made at this time because each site within the APE would need to be field checked, the previous recordation (included site boundary, associated features, integrity) verified, and each site would need to be considered for eligibility for listing in the NRHP. The process for field checking cultural resources sites and making determinations of eligibility for listing in	The USACE will consider design refinements of project elements in order to avoid historic properties and project effects that may be adverse. Avoidance of adverse effects to historic properties is a significant part of the USACE planning and cultural resources management for this project as described in the PA. The PA includes a framework to identify historic properties, evaluate NRHP eligibility, and assess effects. Although specific effects to historic properties cannot be determined at this time, effects could include, but is not limited to, the following: temporary visual and auditory effects caused by construction activities, temporary lack of access and/or privacy to areas traditionally used by Native American tribes for ceremonies, temporary and/or permanent effects to the viewshed of TCPs caused by construction activities and associated noise levels, vibration or compression effects caused by construction activities to historic properties located in proximity to construction activities, alteration or destruction of built environment resources, removal of trees and vegetation that may represent plants significant to Native American tribes and used in ceremonies or for other traditional uses.			Verify that the PA is in place

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the NRHP are outlined in the Programmatic Agreement (PA). Specific individual determinations of effect for historic properties that may be affected by Alternative 1 would be completed under the stipulations of the PA, which includes a framework to identify historic properties, evaluate NRHP eligibility, and assess effects. Although specific effects to historic properties cannot be determined at this time, effects could include, but is not limited to, the following: temporary visual and auditory effects caused by construction activities, temporary lack of access and/or privacy to areas traditionally used by Native American tribes for ceremonies, temporary and/or permanent effects to the viewshed of TCPs caused by construction activities and associated noise levels, vibration or compression effects caused by construction activities to historic properties located in proximity to construction activities, alteration or destruction of built environment resources, removal of trees and vegetation that may represent plants significant to Native American tribes and used in ceremonies or for other traditional uses. Alternative 2				

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Effects to cultural resources from the construction of levee improvements under Alternative 2 would be consistent with those analyzed for Alternative 1 with the addition of effects resulting from construction of the Sacramento Weir and Bypass widening. Effects to historic properties may also result from disturbance of cultural resources sites due to remediation of a hazardous, toxic, and radiological waste (HTRW) site near the existing north levee, which may consist of historic era debris.				
3.10 Transportation and Circulation Increased traffic on public roadways.	Preparation of a traffic control and Road Management Plan BMP's below will be implemented to reduce the impacts from traffic: • The contractor would be required to prepare a Traffic Control and Road Maintenance Plan. A traffic control plan describes the methods of traffic control to be used during construction. All on-street construction traffic would be required to comply with the local jurisdiction's standard construction specifications. The plan would reduce the effects of construction on the roadway system in the project area throughout the construction period.	P, C	USACE	CVFPB Verify traffic plan

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	• Construction contractors would follow the standard construction specifications of affected jurisdictions and obtain the appropriate encroachment permits, if required. The conditions of the encroachment permit would be incorporated into the construction contract and would be enforced by the agency that issues the encroachment permit. • If rock or other materials are transported by barge on the Sacramento River, appropriate water safety measures would be utilized in order to reduce impacts to recreational boaters. • The construction contractor would provide adequate parking for construction trucks, equipment, and construction workers within the designated staging areas throughout the construction period. If inadequate space for parking is available at a given work site, the construction contractor would provide an off-site staging area and, as needed, coordinate the daily transport of construction vehicles, equipment, and personnel to and from the work site. • Proposed lane closures would be coordinated with the appropriate jurisdiction and would be minimized to the extent possible during the morning and evening peak traffic periods. Standard construction specifications also typically limit lane closures during commuting hours. Lane closures will be kept as short as possible. If a road must be closed, detour routes and/or			Verify barge usage when appropriate.

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	temporary roads would be made to accommodate traffic flows. Detour signs would be provided to direct traffic through detours. Advance notice signs of upcoming construction activities would be posted at least 1 week in advance so that motorists are able to avoid traveling through the study area during these times. Within the Parkway, detours would be used to allow for continued use by bicycle commuters. • Safe pedestrian and bicyclist access would be maintained in or around the construction areas at all times. Construction areas would be secured as required by the applicable jurisdiction to prevent pedestrians and bicyclists from entering the work site, and all stationary equipment would be located as far away as possible from areas where bicyclists and pedestrians are present. • The construction contractor would notify and consult with emergency service providers to maintain emergency access and facilitate the passage of emergency vehicles on city streets. • Emergency vehicle access would be made available at all times. Coordination with local emergency responders by the contractor to inform them of the construction activities would be required by the contractor. • The construction contractor would assess damage to roadways used during construction and will repair all potholes, fractures, or other damages.			Verify pedestrian and cyclist detour routes.

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	• Trains utilizing the Yolo Shortline Railroad would be detoured to a different rail line during construction. If an alternative rail line is not available, railroad services would be continued by transporting goods on public roads using cargo trucks during the extent of closures required by the construction and realignment of the railroad on the new portion of the Sacramento Weir.			
3.11 Air Quality Emissions of criteria pollutants from construction equipment, haul trucks, and barges. Construction of the proposed project would result in short-term dust emissions from grading and earth moving activities at the project construction sites and the soil borrow sites. Construction of the proposed project would result in short-term diesel particulate emissions from onsite heavy duty equipment and on-road haul trucks. DPM, which is classified as a carcinogenic TAC by CARB, is the primary pollutant of concern with regard to indirect health risks to sensitive receptors. Nearby land uses, especially those residences and schools located downwind of the project sites could be exposed to DPM generated during construction activities, indirectly	SMAQMD's Basic Construction Emissions Control Practices The SMAQMD requires construction projects to implement basic construction emission control practices to control fugitive dust and diesel exhaust emissions (SMAQMD 2015). The USACE would comply with the following control measures for the project: • Water all exposed surfaces twice daily. Exposed surfaces include but are not limited to: soil piles, graded areas, unpaved parking areas, staging areas, and access roads. • Cover or maintain at least two feet of free board space on haul trucks transporting soil, sand, or other loose material on the site. Any haul trucks that would travel along freeways or major roadways should be covered. • Use wet power vacuum street sweepers to remove any visible trackout mud or dirt from adjacent public roads at least once a day.	D, P, C	USACE	CVFPB Verify that emissions control guidance is followed. Verify that dust control measures are in place.

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resulting in potential adverse health effects. The proposed project would not result in any major sources of odor, and the project would not involve operation of any of the common types of facilities that are known to produce odors (e.g., landfill, wastewater treatment facility). Odors associated with diesel exhaust emissions from the use of onsite construction equipment may be noticeable from time to time by adjacent receptors. Alternative 2 Construction of the Sacramento Weir and Bypass Widening would occur in YSAQMD and include clearing of trees and vegetation, construction of the new levee, construction of the new portion of the weir, construction of new sections of road and railroad on the top of the new portion of the weir and the new levee, relocation of utilities, degrading and excavating the existing levee, and delivery and installation of rip-rap on the waterside slope of the new levee. Materials for the construction of the new levee would be reused from the existing levee to the greatest extent possible.	Use of dry power sweeping is prohibited. • Complete all roadways, driveways, sidewalks, or parking lots to be paved as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used. • Minimize idling time either by shutting equipment off when not in use or reducing the time of idling to 5 minutes [required by California Code of Regulations, Title 13, sections 2449(d)(3) and 2485]. Provide clear signage that posts this requirement for workers at the site entrances. • Maintain all construction equipment in proper working condition according to the manufacturer's specifications. The equipment must be checked by a certified mechanic and determined to be running in proper condition before it is operated. <u>Fugitive Dust Emission Mitigation Measures</u> Fugitive dust mitigation would require the use of adequate measures during each construction activity and would include frequent water applications or application of soil additives, control of vehicle access, and vehicle speed restrictions. The USACE would implement the dust mitigation measures listed below. • Water exposed soil with adequate frequency for continued moist soil. • Suspend excavation, grading, and/or			

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	demolition activity when wind speeds exceed 20 mph. • Install wind breaks (e.g., plant trees, solid fencing) on windward side(s) of construction areas. • Plant vegetative ground cover (fast-germinating native grass seed) in disturbed areas as soon as possible. • Install wheel washers for all exiting trucks, or wash off all trucks and equipment leaving the site. • Treat site accesses to a distance of 100 feet from the paved road with a 6 to 12-inch layer of wood chips, mulch, or gravel to reduce generation of road dust and road dust carryout onto public roads. • Post a publicly visible sign with the telephone number and person to contact at the lead agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The phone number of the District shall also be visible to ensure compliance. The project will ensure that emissions from all off-road diesel powered equipment used on the project site do not exceed 40 percent opacity for more than three minutes in any one hour. The use of USEPA adopted Tier 3 and Tier 4 standards for newly-built marine engines in 2008 would be encouraged under the barge delivery scenario. The Tier 3 standards reflect the			

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	application of technologies to reduce engine PM and NO_X emission rates. Tier 4 standards reflect application of high-efficiency catalytic after-treatment technology enabled by the availability of ultra-low sulfur diesel. These Tier 4 standards would be phased in over time for marine engines beginning in 2014 (USEPA 2008). The USACE will require that all off-road construction equipment comply with SMAQMD's enhanced exhaust controls (20% NO_X and 45% PM reductions). The USACE will encourage their construction contractors to use off-road diesel-powered construction equipment greater than 50 horsepower that meets Tier-4 off-road emission standards under the barge delivery scenario. As of July 1, 2015, the mitigation fee rate is $18,030 per ton of emissions. The Contractor would provide payment of the appropriate SMAQMD-required NO_x mitigation fee to offset the project's NO_x emissions when they exceed SMAQMD's threshold of 85 lbs/day. The USACE would consult with the BAAQMD in good faith to enter into a mitigation contract for an emission reduction incentive program (e.g., TFCA or Carl Moyer Program). The current emissions limit is $17,080/weighted ton of criteria pollutants (NO_X + ROG + [20*PM]). An administrative fee of 5 percent would be paid to the BAAQMD to implement the program. The contractor would conduct daily and annual emissions monitoring to ensure onsite emissions			

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	reductions are achieved and no additional mitigation payments are required. The contractor would be required to ensure the requirement is met. This requirement would be incorporated into the construction contracts as part of the project's specifications.			
3.12 Climate Change Increased GHG emissions from construction equipment, haul trucks, and barges.	The following measures may be considered to lower GHG emissions during the construction: • Encourage and provide carpools, shuttle vans, transit passes and/or secure bicycle parking for construction worker commutes. • Recycle at least 75% of construction waste and demolition debris. • Purchase at least 20% of the building materials and imported soil from sources within 100 miles of the project site. • Minimize idling time either by shutting equipment off when not in use or reducing the time of idling to no more than 3 minutes (5 minute limit is required by the state airborne toxics control measure [Title 13, sections 2449(d)(3) and 2485 of the California Code of Regulations]). Provide clear signage that posts this requirement for workers at the entrances to the site. • Maintain all construction equipment in proper working condition according to manufacturer's specifications. The equipment must be checked by a certified	P, C	USACE	CVFPB Verify mitigation measures are being implemented.

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	mechanic and determined to be running in proper condition before it is operated. • Use equipment with new technologies (repowered engines, electric drive trains). • Perform on-site material hauling with trucks equipped with on-road engines (if determined to be less emissive than the off-road engines). • Use a CARB approved low carbon fuel for construction equipment. (NO_x emissions from the use of low carbon fuel must be reviewed and increases mitigated.) • Purchase GHG offset for program-wide GHG emissions (direct emissions plus indirect emissions from on-road haul trucks plus commute vehicles) exceeding SMAQMD or CEQ's significance thresholds applicable at the time of construction. Carbon offset credits shall be purchased from programs that have been approved by SMAQMD.			
3.13 Noise Construction activities in the American River Parkway, Sacramento River, East Side Tributaries and Sacramento Bypass could result in temporary significant impacts on residents, recreationists, and other noise sensitive groups.	During construction, noise-reduction measures would be employed in order to ensure that construction noise complies with local ordinances. Prior to the start of construction, a noise control plan would be prepared that would identify feasible measures to reduce construction noise, when necessary. The following measures would apply to construction activities within 500 feet of a sensitive receptor, including, but not limited to, residences. These measures may include, but are not limited to, the following:	P, C	USACE	CVFPB Verify noise control plan. Verify that residents have been notified in writing. Verify signage.

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	• Provide written notice to residents within 1,000 feet of the construction zone, advising them of the estimated construction schedule. This written notice would be provided within one week to one month of the start of construction at that location. • Display notices with information including, but not limited to, contractor contact telephone number(s) and proposed construction dates and times in a conspicuous manner, such as on construction site fences. • Schedule the loudest and most intrusive construction activities during daytime hours (7:00 a.m. to 7:00 p.m.), when feasible. • Require that construction equipment be equipped with factory-installed muffling devices, and that all equipment be operated and maintained in good working order to minimize noise generation. • Locate stationary noise-generating equipment as far as practicable from sensitive receptors. • Limit unnecessary engine idling (i.e., more than 5 minutes) as required by State air quality regulations. • Employ equipment that is specifically designed for low noise emission levels, when feasible. • Employ equipment that is powered by electric or natural gas engines, as opposed to those powered by gasoline fuel or diesel, when feasible.			

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	• If the construction zone is within 500 feet of a sensitive receptor, place temporary barriers between stationary noise equipment and noise sensitive receptors to block noise transmission, when feasible, or take advantage of existing barrier features, such as existing terrain or structures, when feasible. • If the construction zone is within 500 feet of a sensitive receptor, prohibit use of backup alarms and provide an alternate warning system, such as a flagman or radar-based alarm that is compliant with State and Federal worker safety regulations. • Locate construction staging areas as far as practicable from sensitive receptors. • Design haul routes to avoid sensitive receptors, to the extent practical. • If there are any occupied buildings with plaster or wallboard construction within 40 feet of construction equipment, a vibration control plan would be prepared prior to construction.			
3.14 Recreation Site-specific designs have not been conducted to determine which erosion protection measure is appropriate along each reach of the Parkway, certain assumptions can be made: • Access to the American River for	The following measures would be implemented to keep the public informed of construction activities to mitigate for effects to bike trail/recreation trail access: • Coordination with recreation user groups would occur prior to and during construction for input into mitigation measures that would reduce affects to the maximum extent practicable.	P,C	USACE	CVFPB Verify that notice is given about recreational impacts prior to closure.

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the purposes of erosion control construction would require some temporary closures of portions of the recreation trail during construction activities. • Haul trucks would use portions of the recreational trail to bring materials to the construction sites, reducing accessibility to recreationists. • Some areas within the Parkway itself would be construction staging areas. • The presence of construction equipment and haul trucks would reduce the quality of recreational experiences. Alternative 2 Possible closure of the Sacramento Bypass during portions of the hunting season.	• Advance notice would be given to recreation users informing them of anticipated activities and detours to reduce the effects. To ensure public safety: • Flaggers, • Signs restricting access would be posted before and during construction • Detour routes would be clearly marked, • Fences would be erected in order to prevent access to the project area. • In areas where recreational traffic intersects with construction vehicles, traffic control will be utilized in order to maintain public safety. • The public will have continued access to the Parkway and recreation facilities during construction, but bike and running trail users would likely be required to detour onto public roads or alternative trails. • If any access point needs to be closed during construction, notices will be posted providing alternative access routes.			Verify use of flaggers. Verify use of detour signs.
3.15 Visual Resources Vegetation loss and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River.	American River Trees will be planted along the outer portion of the rock trench where there is sufficient space. Sacramento River Trees will remain on the waterside lower third of the levee. The understory vegetation will be removed in order to place rock.	P, C, M	USACE	CVFPB Verify replanting of trees. Verify that lower one third of trees are not removed.

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	Sacramento Weir and Bypass Native trees and shrubs within the existing bypass would be avoided during construction as much as practicable to help minimize visual impacts. The loss of ground cover in the existing and expanded bypass would be mitigated by planting native grasses and forbs in areas disturbed by construction, except within the footprint of the extended weir. The loss of existing native trees and shrubs within the existing bypass, along the bank of the Sacramento River, and within small portions of the agricultural lands directly impacted by the project would be mitigated by planting native trees and shrubs within certain portions of the expanded bypass.			Verify tree mitigation.
3.16 Public Utilities and Services Temporary disruptions to utility services are possible particularly during relocation of utilities that penetrate the levee.	Consultation with all known service providers would take place prior to construction to identify specific infrastructure locations and appropriate protection measures. Consultation would continue during construction to ensure avoidance/protection of facilities to minimize service disruptions. Where feasible, replacement utility structures would be completed before demolition of existing facilities. Mitigation measures would include the following: • Notification of any potential interruptions in service shall be provided to the appropriate agencies and affected landowners. • Before the start of construction, utility locations shall be verified through field surveys and the use of the Underground Service Alert services. Any buried utility lines	D, P, C	USACE	CVFPB Verify coordination with appropriate service providers.

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	shall be clearly marked in the area of construction on the construction specifications in advance of any earthmoving activities. • Before the start of construction, a response plan shall be prepared to address potential accidental damage to a utility line. The plan shall identify chain of command rules for notification of authorities and appropriate actions and responsibilities to ensure the safety of the public and workers. Worker education training in response to such situations shall be conducted by the contractor. The response plan shall be implemented by the project proponent(s) and its contractors during construction activities. • Utility relocations shall be staged to minimize interruptions in service. • Construction activities will be coordinated with first responders within the study area so plans can be implemented to avoid response delays due to construction detours.			
3.17 Hazardous, Toxic, and Radiological Wastes No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction.	Borrow material would be tested prior to use to ensure that no contaminated soils are used in project.	P, C	USACE	CVFPB Verify that import soils are tested prior to use in project.
3.18 Socioeconomics, Population, and Environmental Justice Disruption to residents alongside	Mitigation for relocation of people and their homes would be compensated under the Federal Relocation Act.	D,P	USACE	CVFPB Verify that Federal

Notes:

D: To be implemented or included as part of project design. Includes pre-project permitting and agency coordination

P: To be implemented prior to construction being initiated prior (pre-construction), but not part of project design or permitting

C: To be implemented during project construction

M: To be implemented as ongoing maintenance after construction is complete

O: To be implemented as an operational practice after construction is complete

construction sites from traffic, noise, and dust. Acquisition of properties for levee easements.				relocation process is followed.

Notes:
D: To be implemented or included as part of project design. Includes pre-project permitting and agency coordination
P: To be implemented prior to construction being initiated prior (pre-construction), but not part of project design or permitting
C: To be implemented during project construction
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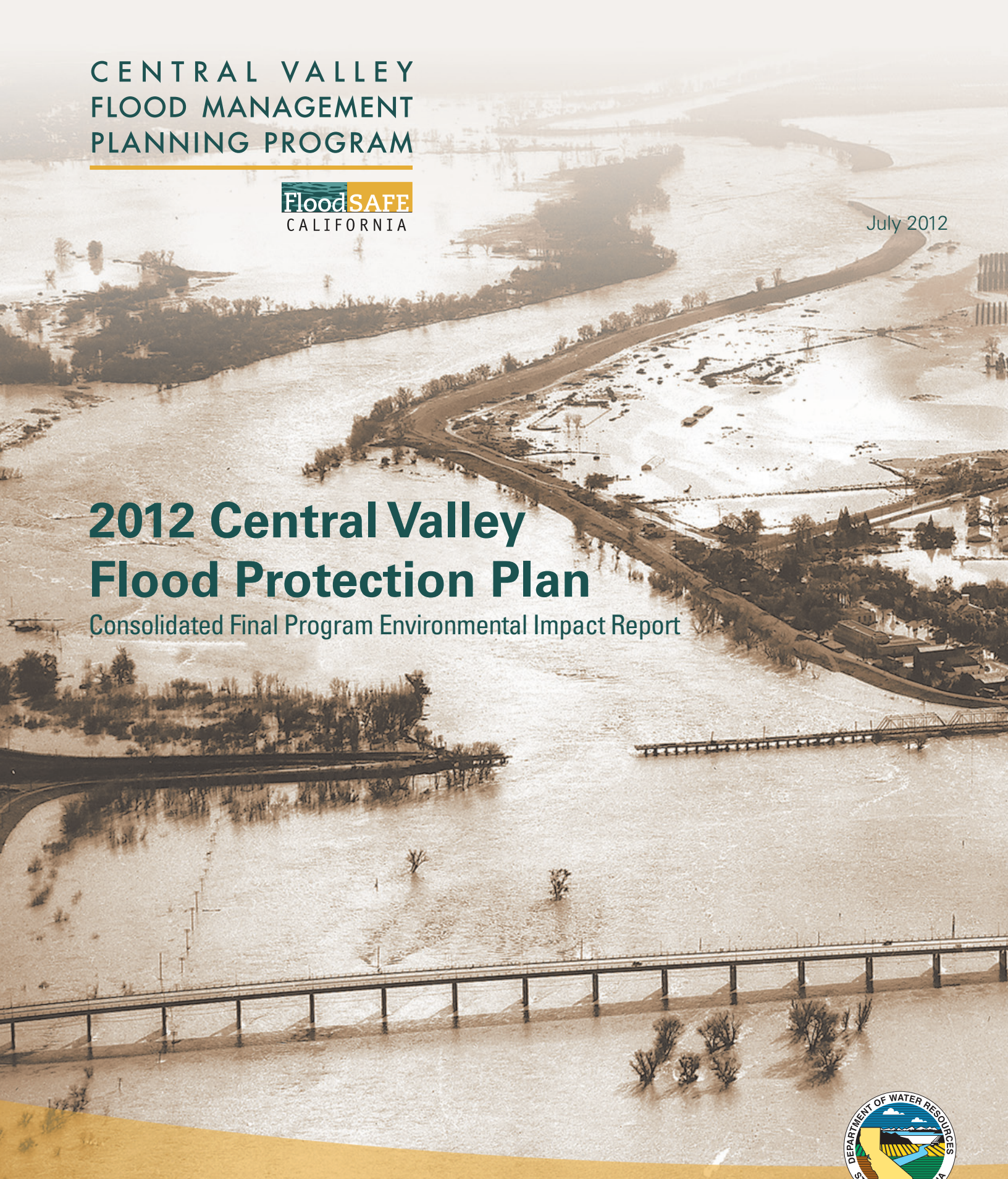
CENTRAL VALLEY
FLOOD MANAGEMENT
PLANNING PROGRAM

FloodSAFE
CALIFORNIA

July 2012



2012 Central Valley Flood Protection Plan

Consolidated Final Program Environmental Impact Report

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

PUBLIC SAFETY ENVIRONMENTAL STEWARDSHIP ECONOMIC STABILITY

Cover Photo: Feather River near Yuba City (December 1955)

The flood of December 1955 was one of the most widespread and destructive floods in Central Valley history. A levee break on the Feather River at Yuba City (shown) flooded about 6,000 homes and resulted in 38 confirmed deaths and millions in property damage.

Executive Summary

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EXECUTIVE SUMMARY

ES.1 Introduction

Historically, the Central Valley has experienced some of California's largest and most damaging floods. Floods have had devastating effects on life and property in the Central Valley and on the state's economic prosperity. The most recent large floods in the Central Valley, in 1986 and 1997, together caused more than $1 billion in damage (USACE 1997).

Despite the current flood management system in the Central Valley, the valley's residual flood risk remains among the highest in the country. Currently, even small flood events with a 5 percent chance of occurring annually can stress parts of the flood system.

Public awareness of flood risks was heightened by the catastrophic flooding in New Orleans associated with Hurricane Katrina in August 2005. That event caused estimated property damage exceeding $80 billion and took more than 1,800 lives.

"Residual Flood Risk" Residual risk is the portion of flood risk that remains after a flood control structure or works has been built. Risk remains because the likelihood exists for the design of the completed works to be surpassed by a flood event of sufficient intensity, resulting in structural failure.

In 2006, the California Department of Water Resources (DWR) launched FloodSAFE California, a multifaceted initiative to improve integrated flood management. In November of that year, the state's voters passed two important bond measures, Propositions 84 and 1E, which included approximately $3.3 billion in funds that could be used to support flood risk reduction efforts in the Central Valley.

In 2007, the California Legislature passed a package of several related flood bills, which included a requirement to prepare a Central Valley Flood Protection Plan (CVFPP). Additional requirements for the CVFPP were added in the Central Valley Flood Protection Act of 2008 (Senate Bill 5). That same year, DWR embarked on the Central Valley Flood Management Planning Program, which addresses flood management planning activities in the Central Valley that require leadership and participation by the State of California (State). The Central Valley Flood Management Planning Program is one of several programs managed by DWR under FloodSAFE California.

The CVFPP is a critical document intended to guide California's participation (and to influence federal and local participation) in managing flood risk along the Sacramento River and San Joaquin River systems. The CVFPP proposes a State Systemwide Investment Approach (SSIA) as its proposed program for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control (SPFC). The CVFPP is a program-level, rather than project-level, document. It articulates programs to further flood risk reduction in the Central Valley and suggests a range of potential

future projects that could help meet that goal. The CVFPP will be updated every 5 years, with each update providing the opportunity to update existing policies, programs, and suggested projects, or to add new ones.

After extensive outreach to stakeholders and the public, a draft of the CVFPP was released to the public on December 30, 2011. Pursuant to Section 9612 of the California Water Code, the Central Valley Flood Protection Board (Board) shall adopt the CVFPP by July 1, 2012.

This CVFPP program environmental impact report (PEIR) was developed to inform DWR, which is developing the CVFPP, and the Board, which will consider adopting the CVFPP, about potential program-level environmental effects and mitigation measures related to the components of the CVFPP. The PEIR is written so that DWR and the Board will be able to rely on this PEIR for future planning and feasibility studies pertinent to implementation.

This executive summary provides an overview of the CVFPP PEIR consistent with Section 15123(a) of the California Environmental Quality Act Guidelines (CEQA Guidelines), which states that an EIR "shall contain a brief summary of the proposed action and its consequences." As explained in Section 15123(b), the summary shall identify (1) each significant impact, with proposed mitigation measures and alternatives; (2) areas of controversy known to the lead agency; and (3) issues to be resolved in the EIR.

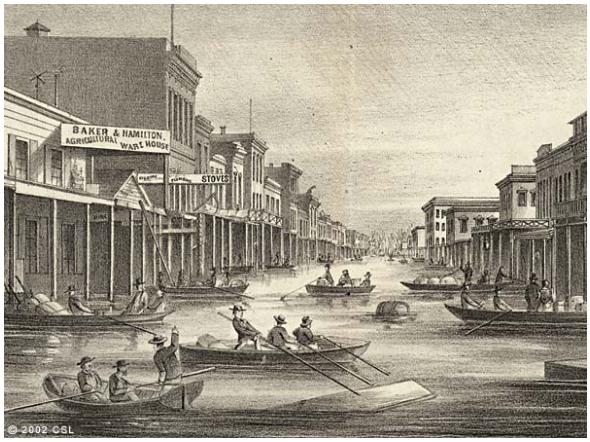
This draft PEIR (DPEIR) is being circulated for public review. Comments received during the public review will be considered by DWR and the Board, and responses to comments will be included in the final PEIR. Continued public outreach, including public hearings, will be conducted before the final PEIR is completed. See Section ES.9, "Next Steps for the PEIR," below, for additional information.

ES.2 History and Background of Flood Protection in the Central Valley

Before settlement associated with the Gold Rush began, the Central Valley routinely flooded, forming a vast inland sea. Flood management efforts in the Central Valley began toward the middle of the 19th century, when major settlement and land reclamation and cultivation began in California's two largest valleys. The drainage and levee construction originally undertaken by individual farmers shifted in the 1880s to collective efforts and financing by newly authorized levee and reclamation districts in both the Sacramento and San Joaquin valleys. Because individual public levee and reclamation districts were formed by landowners, flood control efforts were fundamentally local and uncoordinated. The system proved inadequate, especially for the Sacramento River system.

In lieu of building river levees to make the Sacramento River a single, ever-wider flood channel, a weir and bypass system known as the "Jackson Plan"

was conceived and formally adopted by the California Debris Commission in 1911. The Debris Commission was a federal body that had been created to address the effects of the deposition of mining debris on navigation. The bypass system proposed in the Jackson Plan consisted of weirs built to divert portions of the high Sacramento River flows from the river at different points into specially constructed, large-capacity flood channels to reduce flood stages in the river, and thereby to move floodwaters safely to the ocean. In 1911, the State authorized a means of funding the plan by creating a regional assessment district, the Sacramento–San Joaquin Drainage District, and a governing body for it, the State Reclamation Board. (The State Reclamation Board is now known as the Central Valley Flood Protection Board.) The plan, which became known as the Sacramento River Flood Control Project, was completed in 1960 by the U.S. Army Corps of Engineers (USACE).



1862 Flooding in Sacramento

The structures, such as levees and bypasses and other flood structures designed and primarily built by USACE in the watershed of the Sacramento and San Joaquin rivers, are known as the federal flood control facilities for the Central Valley. The levees that are part of federal flood control facilities are known as "project levees," which distinguishes them from levees that are not part of USACE's federal system of levees and other flood facilities in the Central Valley. These project levees are now called facilities of the SPFC. Construction of these facilities contributed to the loss of floodplain habitats and marshes over time.

About 45 percent of the levees in the Sacramento–San Joaquin Delta (Delta) are not project levees. The nonproject levees are maintained by local reclamation districts and are generally eligible for financial assistance from the State through the Delta Levees Subventions Program. The Delta Flood Protection Fund Act of 1988 substantially increased reimbursement opportunities for the local reclamation districts and added environmental mitigation and protection requirements for grant recipients. Multipurpose storage reservoirs on both the San Joaquin and Sacramento rivers that are not part of the federal flood control facilities also protect the valley from flooding.

Today, the Central Valley flood management system includes levees along the major rivers and streams of the valley floor and around the islands of the Delta, a major bypass system for the Sacramento River and its tributaries, several bypass segments along the San Joaquin River, and numerous reservoirs on almost all major rivers and streams draining to the Central Valley.

During major flood events, State, federal, and local agencies work together closely to forecast weather and runoff conditions, manage and coordinate flood releases from the reservoir system, patrol and conduct flood fights along the levee and bypass system, and operate the Sacramento Weir, drainage pumps, and other flood control structures.

Figure ES. 2-1 provides a chronology depicting the history of Central Valley flood management.

Figure ES. 2-1. Chronology of Flood Management–Related Actions in the Central Valley

Significant Flood Management Events

1849	California Gold Rush
1850	Federal Arkansas Act giving away "California Swamplands"
1850	California Statehood
1861	State Flood Control Act
	Reclamation District Act
1883	Federal Anti-Debris Act ends hydraulic mining
1911	State Reclamation Board Created
1933	Central Valley Project Authorized
2003	Paterno Decision
2005	DWR Flood Warning White Paper
2006	Propositions 1E and 84 Passed
2007	Flood Management Reform Legislation

Sacramento River Basin

1850	First Levee built in Sacramento
1917	Sacramento River Flood Control Project Authorized
1944	Shasta Dam was built
1955	Folsom Dam was built
1967	Oroville Dam was built
1969	New Bullards Bar Dam was built

San Joaquin River Basin

1944	Lower San Joaquin River and Tributaries Project
1949	Friant Dam Completed
1955	Bypasses and Levees authorized on the San Joaquin River above Merced River
1963	Camanche Dam was built
1964	New Hogan Dam was built
1967	New Exchequer Dam was built
1971	New Don Pedro Dam was built
1978	New Melones Dam was built
1993	Redbank/Fancher Creeks Project

1849 Sutter's Mill

1907 Flood in West Sacramento

1955 Folsom Dam was built

1997 Flood in Central Valley

1949 Friant Dam was built

1955 Flood in Visalia

1978 New Melones Dam was built

Over the past 150 years, funding levels for flood risk reduction activities in the Central Valley have varied considerably. Those funds have come from a variety of sources at the federal, State, and local levels, and have fluctuated as a result of factors such as competing priorities, changing levels of concern about flood risks, and economic concerns.

Geotechnical improvements to levees in the Pocket Area of Sacramento

As indicated above, in November 2006 California's voters passed two important general obligation bond measures, Propositions 84 and 1E, which provided approximately $3.3 billion for flood risk reduction activities in the Central Valley. Since the passage of Propositions 84 and 1E, DWR has been working with USACE and local agencies to improve flood management within areas protected by SPFC facilities. In the 5 years since these funds first became available, approximately $1.5 billion has been spent on a range of activities, the most important of which are summarized below.

A top priority was to repair portions of the levee system at critical risk of failure as a result of erosion or other factors. Since 2006, more than 120 critical levee erosion sites have been repaired, and a variety of conditions have been repaired at more than 220 other sites. DWR also undertook several major maintenance projects, including the removal of 3 million cubic yards of sediment from the bypasses, and rehabilitated seven flood system structures. More than 240,000 tons of rock have been stockpiled in the Delta to allow faster response to flood emergencies.

DWR also began extensive evaluations of the status of the flood system to provide the necessary factual support for flood planning efforts. To date, the department has collected topographic data and light detection and ranging (or LiDAR) data for 9,000 square miles along the flood system, conducted engineering and geotechnical evaluations for urban and nonurban levees, and developed a comprehensive medium-scale GIS data set of riparian vegetation for the Central Valley. DWR has also added about 50 flood forecasting and water supply gauging sites, developed the Flood Emergency Response Infor-

mation System, developed a forecast coordinated operations program for the Yuba-Feather River system, and updated hydrology information for Central Valley streams. Major products of these efforts include the *State Plan of Flood Control Descriptive Document* in 2009 and the *Flood Control System Status Report in 2011*.

These activities have included an increased understanding of and emphasis on habitat and other environmental factors in the management of the flood risk reduction system. DWR has assessed major fish passage barriers within the flood protection system, evaluated potential floodplain restoration opportunity areas, catalogued and summarized conservation objectives from 30 conservation planning efforts, prepared a public draft Conservation Framework, and implemented 12 Flood Corridor Program projects in the Central Valley, providing habitat conservation on more than 4,000 acres and agricultural land conservation on more than 500 acres. There has been enhanced environmental integration of emergency response activities, including an emergency response exercise conducted with environmental resource and regulatory agencies.

DWR has also taken steps to improve its planning processes and coordinate those activities with other maintaining and regulatory agencies. In 2005, DWR initiated and coordinated the Interagency Flood Management Collaborative Program, a working group of federal, State, and local officials from key regulatory and maintaining agencies that meets monthly to address issues of mutual concern. The department is developing several integrated flood management and environmental initiatives in partnership with resource and regulatory agencies, including a Corridor Management Strategy and the Small Erosion Repair Program (SERP). SERP will streamline the permitting process for small erosion repair projects, so that the repairs can be undertaken before further erosion occurs and requires a larger, more costly repair with greater impacts on the riverine habitat and the environment. SERP will help avoid duplicative permitting efforts that can delay repairs and divert resources from more pressing environmental issues. DWR is taking the lead in developing a statewide policy framework and draft approach for Regional Advance Mitigation Planning.

To assist local planning entities, DWR has prepared voluntary flood-related Building Standards Code specifications (California Code of Regulations, Title 24, Parts 2 and 2.5) for single-family residential occupancy groups R-3 and R-3.1, for adoption by cities and counties. It has initiated mapping of the Central Valley Levee Flood Protection Zones and sent flood-risk notification letters to 300,000 affected property owners in the Central Valley in 2010 and 2011.

During the past 5 years, the State, USACE, and local agencies have also been working on major projects to upgrade the State-federal flood management system in the Central Valley. These projects include the American River Common Features Project, to provide improved flood protection to areas protected

by levees along the following reaches: the American River downstream from Folsom Dam; the Sacramento River downstream from the American River; and the Natomas Basin. Other important projects include the following:

- Folsom Dam Modifications (as part of the Folsom Dam Joint Federal Project)
- Marysville Ring Levee Improvement Project
- Geotechnical improvements to levees in the Pocket Area of Sacramento
- Mid-Valley Area Levee Reconstruction Project
- South Sacramento Streams Project
- Three Rivers Levee Improvement Authority, Feather River Levee Improvement Project, Yuba County
- Three Rivers Levee Improvement Authority, Upper Yuba River Levee Improvement Project, Yuba County
- Levee District 1, Star Bend levee setback on the Feather River, Sutter County
- Reclamation District 2103, Bear River North Levee Rehabilitation Project, Sutter, Yuba, and Placer counties
- Reclamation District 17, 100-Year Seepage Area Project, San Joaquin River, San Joaquin County
- West Sacramento Area Flood Control Agency, Capital Outlay, City of West Sacramento
- West Sacramento Project, repair of two Yolo Bypass east bank levee slips in West Sacramento (under way)
- West Sacramento Setback Levee and Slurry Wall at River Mile 57.2 right bank constructed under the Sacramento River Bank Protection Project (under way)

These activities during the past 5 years have provided DWR with enhanced interagency relationships, improved planning and project implementation capabilities, and the information necessary to support the preparation of the CVFPP and this PEIR.

ES.3 Description of the Proposed Program

The SSIA is DWR's proposed program for sustainable, integrated flood management in areas currently protected by SPFC facilities. The SSIA described in the CVFPP is the proposed program evaluated in this PEIR. The proposed program includes broad management actions to improve the flood management system, policies, and institutions at a systemwide level, while enabling flexibility in addressing changing needs and funding scenarios. The program also integrates environmental conservation strategies and actions to improve

the flood management system's long-term sustainability while improving ecosystem function. At the same time, it provides additional options for addressing compliance with environmental regulations related to long-term operation and maintenance.

"Sustainable" A project is considered sustainable when it is socially, environmentally, and financially feasible for an enduring period. For the CVFPP, a sustainable project will also have the flexibility to adapt to potential future changes such as climate change.

Flooding poses different threats to the people, critical infrastructure, and properties within the valley's varied land uses. Consequently, the proposed program provides different approaches to improve flood protection depending on the land use and its requirements. These land use areas have been delineated in the proposed program as urban areas, small communities, and rural-agricultural areas. Briefly, the key features of the proposed program can be characterized as follows:

- Improve levees that protect existing urban and urbanizing areas (populations greater than 10,000) to achieve an urban level of flood protection (protection against a 0.5-percent-chance event), at minimum.
- Reduce flood risk in existing small communities (with populations less than 10,000), where feasible.
- Improve rural-agricultural area levees included in the proposed program to reflect the lower levels of development within these floodplains.
- Improve the overall ability of the SPFC to convey large flood events through modified (or potentially new) weirs, bypass systems, hydraulic structures, and easements.
- Improve ecological conditions on a systemwide basis, using integrated policies, programs, and projects.

Implementation of the proposed program would depend on both the collaboration and independent decision-making of federal, State, and local cooperating and regulatory agencies. Follow-on feasibility studies and CVFPP updates are expected to refine the proposed program and assess the potential costs, benefits, and impacts of site-specific implementation projects.

ES.3.1 Near-Term and Long-Term Management Activities

For purposes of the PEIR, proposed activities that are part of the proposed program are divided into near-term management activities (NTMAs) and long-term management activities (LTMAs). NTMAs are those management activities that would be initiated during the first 5 years after approval of the CVFPP, with many having the potential to be completed during that initial period; LTMAs are management activities that would be initiated at any time beyond 5 years after adoption of the CVFPP. In the PEIR, NTMAs are evaluated at a greater level of specificity than LTMAs for the following reasons:

- NTMAs are better defined and less conceptual than LTMAs, are more likely to be implemented in the short term (within the first 5 years after approval of the CVFPP), and are generally less complex.
- NTMAs have more secure funding sources than LTMAs.
- Environmental impacts of NTMAs can generally be evaluated more accurately than impacts of LTMAs.

NTMAs can consist of any of the following types of activities:

- Conveyance management activities:
    - » Sediment removal
    - » Levee repair, reconstruction, and/or improvements:
        - ◦ Raise levees by adding earthen material or constructing floodwalls.
        - ◦ Strengthen levees to enhance their integrity by improving the properties and geometry of embankment soils to resist slope and seepage failures.
        - ◦ Address seepage with seepage berms, stability berms, impermeable barrier curtains (slurry cutoff walls) in the levee and/or its foundation, and relief wells and toe drains.
        - ◦ Armor the landside of the levees to improve levee resiliency during overtopping episodes.
        - ◦ Construct small setback levees (generally less than 0.75 mile long).

San Joaquin River at Friant Dam

- Storage management activities:
    - » Change reservoir operations criteria to alter the timing, magnitude, and frequency of flood releases to downstream channels, providing reductions in river flood stage and volume.
        - ◦ Coordinate operation among different reservoirs to increase objective releases from reservoirs.
        - ◦ More effectively use weather forecasting in conjunction with reservoir operations.
        - ◦ Use weather forecasting to support more flexibility in short-term allocations of available storage space between water supply and flood control.
- Other management activities:
    - » Implement a vegetation management strategy.
    - » Purchase floodplain easements and/or other interests in land.
    - » Integrate conservation strategies to improve the overall sustainability of and ecosystem benefits provided by the flood management system.
    - » Refine flood emergency response, improve flood system operations and maintenance, continue floodplain risk management, conduct feasibility studies, and implement flood risk reduction projects in coordination and partnership with local and federal agencies.

All other types of CVFPP activities fall within the LTMA category and consist of the following types of activities:

- Widening floodways (through setback levees and/or purchase of easements)
- Constructing or modifying weirs and bypasses
- Improving and remediating levees
- Constructing new levees
- Removing some facilities from the SPFC
- Using long-term forecasts to improve operation of existing reservoirs
- Achieving protection of urban areas from a flood event with 0.5 percent risk of occurrence in any given year
- Achieving protection of small communities from a flood event with 1 percent risk of occurrence in any given year
- Protecting rural-agricultural area against floods by facilitating inspection and flood fighting, improving levee performance, and purchasing agricultural easements
- Changing policies, guidance, standards, and institutional structures
- Implementing additional and ongoing conservation elements

Construction of a new levee in the Natomas Basin of Sacramento

However, because NTMA-type activities would continue to be implemented in the CVFPP study area into the longer term time frame of the LTMAs (e.g., remediation of existing levees), LTMAs include a continuation of activities described as part of the NTMAs.

ES.3.2 Purpose of the Proposed Program

The broad purpose of the proposed program is to respond to the California Legislature's direction in Senate Bill 5 to develop and implement a sustainable, integrated flood management plan for the Central Valley. In taking an integrated flood management approach, the proposed program recognizes that flood management is connected to water resource management; land use planning; environmental stewardship; and long-term economic, environmental, and social sustainability. Integrated flood management also recognizes the importance of evaluating opportunities and potential impacts from a systemwide perspective, and the importance of coordinating across geographic and agency boundaries to effectively manage flood flows in any given hydrologic unit.

Much of the legacy flood management system is characterized by aging infrastructure, making it increasingly difficult for DWR and local maintaining agencies to carry out maintenance programs. The proposed program reflects the State's vision for modernizing the SPFC to address current challenges and future trends and to meet the proposed program's objectives.

The proposed program would be implemented over time by the State, federal agencies, and local agencies such as reclamation districts, municipal and regional flood management agencies, and cities and counties.

The CVFPP is part of a long-term planning effort and is to be updated every 5 years. As the first edition of the plan, the 2012 CVFPP does the following:

- Describes a broadly supported vision for improving flood management in the Central Valley
- Recommends initial management actions to reduce flood risks
- Identifies potential modifications to the flood management system for further study
- Describes a framework for implementing future improvements
- Describes a framework for developing a conservation strategy for the flood system

ES.3.3 Objectives of the Proposed Program

Eight program objectives were formulated to guide development of this PEIR and a reasonable range of alternatives to be evaluated in the PEIR. Five of these objectives address the underlying goals of the proposed program: a primary objective to improve flood risk management and supporting objectives to improve operations and maintenance, promote ecosystem functions, improve institutional support, and promote multi-benefit projects. The remaining three program objectives guiding this PEIR reflect direction provided in the authorizing legislation: maximize flood-risk reduction benefits within the practical constraints of available funds; adopt the CVFPP by July 1, 2012; and promote as feasible the multiple objectives provided in Section 9616 of the California Water Code. These objectives are presented below.

Primary Objective

- **Improve Flood Risk Management**—Reduce the chance of flooding and damages, once flooding occurs, and improve public safety, preparedness, and emergency response through the following:
    - » Identifying, recommending, and implementing structural and nonstructural projects and actions that benefit lands currently receiving protection from facilities of the SPFC.
    - » Formulating standards, criteria, and guidelines to facilitate implementation of structural and nonstructural actions for protecting urban areas and other lands of the Sacramento and San Joaquin river basins and the Delta.

Supporting Objectives

- **Improve Operations and Maintenance**—Reduce systemwide maintenance and repair requirements by modifying the flood management systems in ways that are compatible with natural processes, and adjust, coordinate, and streamline regulatory and institutional standards, funding, and practices for operations and maintenance, including significant repairs.
- **Promote Ecosystem Functions**—Integrate the recovery and restoration of key physical processes, self-sustaining ecological functions, native habitats, and species into flood management system improvements.
- **Improve Institutional Support**—Develop stable institutional structures, coordination protocols, and financial frameworks that enable effective and adaptive integrated flood management (designs, operations and maintenance, permitting, preparedness, response, recovery, and land use and development planning).
- **Promote Multi-Benefit Projects**—Describe flood management projects and actions that also contribute to broader integrated water management objectives identified through other programs.

Statutory Objectives

- **Maximize Flood Risk Reduction Benefits within the Practical Constraints of Available Funds**—Ensure that technically feasible and cost-effective solutions are implemented to maximize the flood risk reduction benefits given the practical limitations of available funding, and provide a feasible, comprehensive, and long-term financing plan for implementing the plan.
- **Adopt the CVFPP by July 1, 2012**—Complete all steps necessary to develop and adopt the CVFPP by July 1, 2012, or such other date as may be provided by the Legislature.
- **Meet Multiple Objectives Established in Section 9616 of the California Water Code, Wherever Feasible:**
    - » *Reduce the risk to human life, health, and safety from flooding, including protection of public safety infrastructure.*
    - » *Expand the capacity of the flood management system in the Sacramento–San Joaquin Valley to either reduce flood flows or convey floodwaters away from urban areas.*
    - » *Link the flood protection system with the water supply system.*
    - » *Reduce flood risks in currently nonurbanized areas.*
    - » *Increase the engagement of local agencies willing to participate in improving flood protection, ensuring a better connection between State flood protection decisions and local land use decisions.*

- *Improve flood protection for urban areas to the urban level of flood protection.*
- *Promote natural dynamic hydrologic and geomorphic processes.*
- *Reduce damage from flooding.*
- *Increase and improve the quantity, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine aquatic habitats, including the agricultural and ecological values of these lands.*
- *Minimize flood management system operations and maintenance requirements.*
- *Promote the recovery and stability of native species' populations and overall biotic community diversity.*
- *Identify opportunities and incentives for expanding or increasing use of floodway corridors.*
- *Provide a feasible, comprehensive, and long-term financing plan for implementing the CVFPP.*
- *Identify opportunities for reservoir reoperation in conjunction with groundwater flood storage.*

ES.4 Study Area

The proposed program would be implemented primarily in the Systemwide Planning Area (SPA) of the CVFPP. The SPA includes lands that receive protection from the SPFC and are subject to flooding under the current facilities and operation of the Sacramento–San Joaquin River Flood Management System, including lands with facilities that provide substantial systemwide benefits or that protect urban areas in the Sacramento–San Joaquin Valley. The SPA also includes lands with facilities that are not part of the SPFC, including federal and local reservoirs that have allocated flood storage.

Effects of management actions implemented in the SPA may extend beyond this area. Therefore, the PEIR study area is divided into three regions for describing the environmental setting and potential environmental effects of implementing the CVFPP. These areas are described below and illustrated in Figure ES. 4-1.

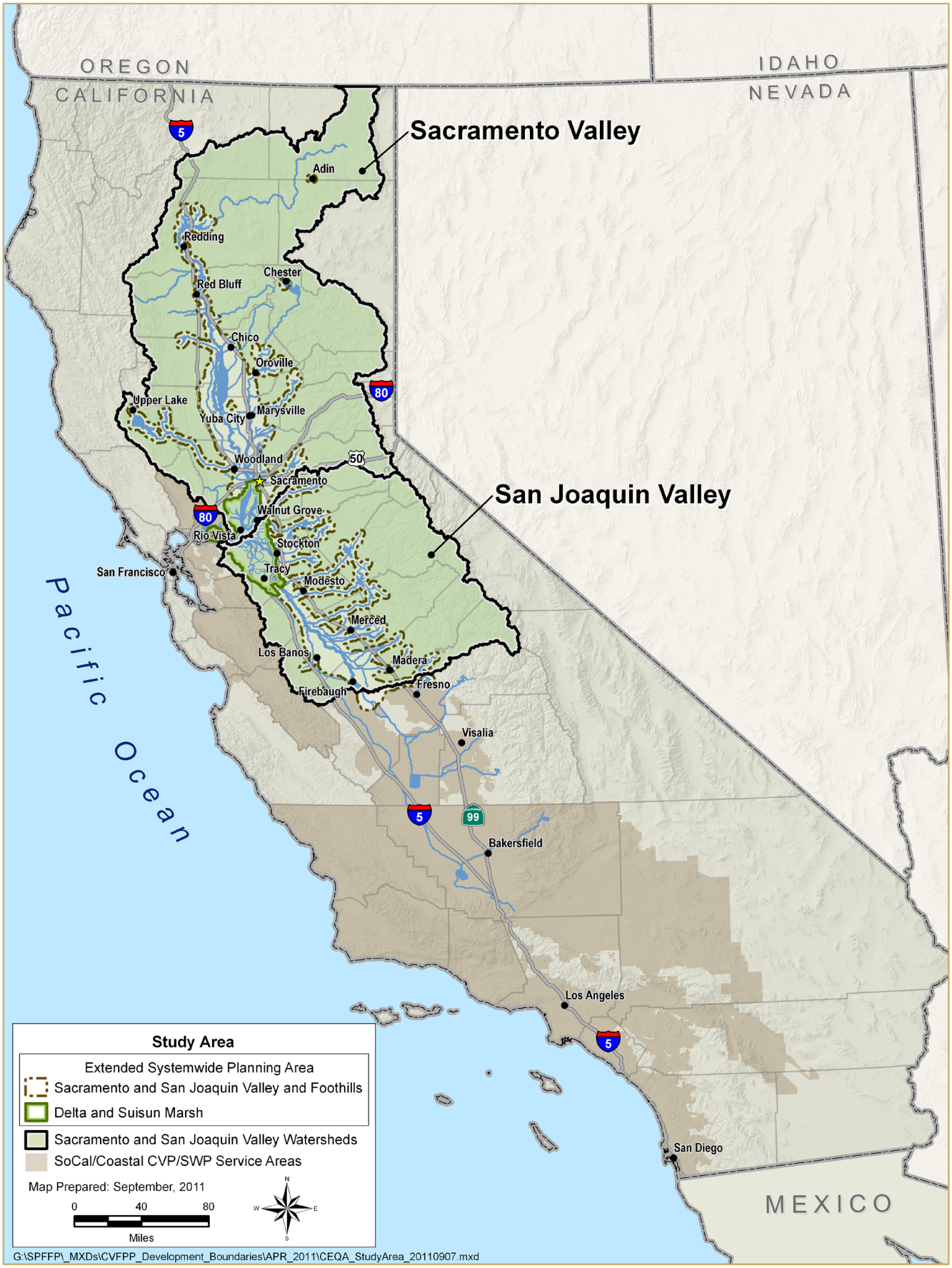


Figure ES. 4-1. PEIR Study Area

ES.4.1 Systemwide Planning Area Plus 2-Mile Buffer and Suisun Extension (Extended Systemwide Planning Area)

The Extended SPA includes a 2-mile-wide buffer around the SPA to provide the environmental context for direct and indirect impacts on areas adjacent to the SPA. Because of topographical and land use considerations, the buffer is 1 mile wide in urban areas and does not extend beyond the adjacent ridgeline along foothill waterways. The buffer is wider than 2 miles in the Suisun Marsh area so that the Extended SPA encompasses the hydrologically influenced areas. The Extended SPA is divided into two subregions:

- **Sacramento and San Joaquin Valley and Foothills**—This area consists of the Sacramento and San Joaquin valleys and the surrounding foothills along several major waterways. Most of the management actions would be implemented in this area.
- **Delta and Suisun Marsh**—This area encompasses the Delta and portions of Suisun Marsh where upstream management actions may affect water flows or quality. At Suisun Marsh, the boundary is at the west end of Montezuma Slough.

ES.4.2 Sacramento and San Joaquin Valley Watersheds

The Sacramento and San Joaquin Valley watersheds are the portions of the watershed upstream from the Extended SPA that may be affected by the management actions employed in these watersheds. These watersheds are discussed in less detail in this PEIR than the Extended SPA.

ES.4.3 SoCal/Coastal CVP/SWP Service Areas

The Southern California and coastal service areas of the Central Valley Project (CVP) and State Water Project (SWP) (referred to in this document as the "SoCal/coastal CVP/SWP service areas") consist of those portions of the CVP/SWP service areas that are not in the Extended SPA. These CVP/SWP service areas are located primarily in Southern California and the Central Coast areas and include CVP/SWP service areas in the Tulare Lake Basin. There are only limited mechanisms by which the SSIA might affect the environment in the SoCal/coastal CVP/SWP service areas, and these areas are discussed in less detail in this PEIR than are the Extended SPA and the Sacramento and San Joaquin Valley watersheds.

ES.5 Areas of Known Controversy and Issues To Be Resolved

Overcoming challenges to improving flood management in the Central Valley will require diligent collaboration, effective partnerships, and public outreach and participation. The CVFPP reflects the State's effort to take a balanced approach to achieving the objectives established in the Central Valley Flood Protection Act of 2008 and the primary and supporting goals defined in the initial phase of CVFPP formulation. Various areas of controversy and challenges associated with implementation of the CVFPP have been identified and are described briefly below.

- **Determining the appropriate level of public investment in flood protection.** Although $3.3 billion of funds were provided by Propositions 84 and 1E, substantial additional funds will be required to implement the proposed program. The State has a fundamental interest in promoting the safety of its people, sustainable economic growth, and a healthy ecosystem; however, all levels of government share the responsibility for managing flood risks. The allocation of finite public resources raises questions related to the level at which the State should invest in flood management and related activities, the degree to which such investments can and should maximize local and federal cost-sharing, and the extent to which State investments should accommodate local objectives. The amount of State funding available and the timing of the funding are also uncertain. Ultimately, although DWR has recommended a level of public investment reflected in the proposed program, the California Legislature and voters will make the final decisions regarding the amounts of State funds to be invested. Federal appropriations and local financial inputs will also be needed.
- **Relative level of expenditures in urban versus rural/agricultural areas.** Controversy exists regarding the focus and/or geographic distribution of flood management project expenditures within the program area. For example, if expenditures were to be allocated solely based on maximizing public safety, then a larger proportion of funding would be allocated to urban areas with concentrated populations. Similarly, if funding were to be allocated to multi-purpose projects that serve multiple needs (e.g., local flood protection, regional system improvements, ecosystem enhancement), then a wider variety of projects in geographically diverse areas would receive funding. Generally, local interests support investments in their local facilities. DWR, however, is required to take a broader statewide perspective and make difficult decisions to resolve these often-competing interests.
- **Financial responsibility for public investments.** Opinions differ regarding the financial responsibility for improving and maintaining the flood management system in the Central Valley. The "beneficiary pays" approach (i.e., only those with property in the specific flood protected area pay for system improvements) can be challenging, particu-

larly when the beneficiaries' capacity to fund improvements is limited. Debate continues regarding the responsibility of the State as a whole (including taxpayers residing outside the Central Valley) to contribute to improved flood management, when local areas primarily benefit from improved flood protection, which in turn supports the State and regional economy and infrastructure.

- **Requirements imposed on local planning entities by the 2007 California flood risk management legislation.** The 2007 flood legislation states that after the adoption of the CVFPP, local agencies within the Sacramento–San Joaquin Valley must amend their general plans and zoning ordinances, and must make certain findings related to the appropriate level of flood protection (200-year protection in urban and urbanizing areas and 100-year protection in nonurbanized areas) before making certain land use decisions. To make these findings, cities and counties will need information on floodplain extent (floodplain mapping) and frequency, which may not be readily available in all areas. Concern also has been raised about the financial burden placed on local cities and counties by these legislative requirements and the feasibility of the legislative timetable.
- **Issues raised by proposals to develop in floodplains.** There is controversy about the extent to which the State should discourage new development in floodplains, without infringing on the land use authority of local jurisdictions. Efforts by the State to effectively manage flood risks and associated liabilities in areas protected by the SPFC, especially in deep floodplains, may influence land uses and subsequently affect landowners, local governments, and developers.
- **Serving multiple benefits with flood system improvements.** Allocating investments to serve the State's interest in public safety while also accommodating other interests and needs, such as ecosystem sustainability and habitat enhancement, are not without challenges and controversy. Continued coordination with all affected stakeholders and agencies is necessary to implement flood management improvements that will serve multiple interests and achieve a balanced use of public funds, while meeting legislative requirements.
- **The appropriate level of vegetation management on levees.** In the wake of Hurricane Katrina, USACE has revisited its nationwide policies regarding vegetation management. USACE currently requires that all woody vegetation be removed from levees in the absence of a USACE-issued variance, if maintaining agencies such as DWR wish to retain eligibility for federal emergency repair funding under Public Law 84-99. This policy is memorialized in USACE's Engineering Technical Letter 1110-2-571 (ETL), *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures,* adopted April 10, 2009. (All references to the "ETL" in this chapter are specifically to ETL 1110-2-571.)

DWR does not believe that the science supports USACE's underlying assumption that all woody vegetation increases risks to public safety. In fact, in most circumstances, vegetation helps protect levees from erosion and other risk factors, while also providing important habitat values. Moreover, DWR has estimated that strict compliance with USACE's policy in the Central Valley could cost in excess of $10 billion, and would result in massive and likely unmitigable habitat losses. As a result, DWR has proposed a vegetation management strategy (VMS) that would retain all vegetation on the waterside slope of levees up to a line 20 feet below the levee crown (other than vegetation presenting a demonstrable risk, which would be removed); the VMS would limit vegetation management elsewhere to measures necessary for visibility and access. To further accommodate USACE's new policy, however, DWR is also proposing a life-cycle management (LCM) component of the VMS that would limit the recruitment of replacement trees on the upper waterside slope, crown, and landside of levees, which over time would reduce the amount of woody vegetation in those areas. Resource management agencies and environmental interests have expressed concerns about this LCM component.

- **Coordination with other collaborative processes and local planning efforts.** Multiple ongoing planning efforts in the Central Valley (e.g., the CALFED Bay-Delta Program, Bay Delta Conservation Plan, habitat conservation plans/natural communities conservation plans) overlap with the CVFPP in both geography and scope. Challenges exist when balancing the needs of these many efforts where jurisdictions and project timing overlap, and where the actions of one program may preclude (or limit) the actions of another.
- **Differing policies and guidance from permitting and implementing agencies.** Several agencies inform or oversee project permitting and implementation: DWR, the Board, USACE, local maintaining agencies, the California Department of Fish and Game, cities and counties, the State Water Resources Control Board, the regional water quality control boards, and the U.S. Fish and Wildlife Service and National Marine Fisheries Service. Each agency has its own requirements, guidance, and role in project implementation, and there are challenges associated with meeting the requirements of State and federal laws under the jurisdiction of these agencies.

ES.6 Alternatives to the Proposed Program

Development of the CVFPP involved formulating and evaluating substantially different preliminary alternatives to address CVFPP goals. The preliminary alternatives were used primarily to explore different potential physical changes to the existing flood management system and to assist in highlighting the need for policy changes or other management actions.

As described below, seven alternatives were considered for analysis in this PEIR:

- No-Project Alternative—Continued Operations Scenario
- No-Project Alternative—No Additional Activities Scenario
- Modified SSIA Alternative
- Achieve SPFC Design Flow Capacity Alternative
- Achieve SPFC Design Flow Capacity with Strict ETL Compliance Alternative
- Protect High-Risk Communities Alternative
- Enhance Flood System Capacity Alternative

ES.6.1 No Project Alternative—Continued Operations Scenario

Under the No-Project Alternative—Continued Operations Scenario, and without a systemwide flood management plan such as the CVFPP, current flood management trends in the Central Valley would likely continue. Projects that are planned or under way and supported by reasonably anticipated funds would commence and/or continue to completion. The Federal Emergency Management Agency would continue to remap the floodplains protected by the SPFC with less than 100-year flood protection. Existing partnerships among the federal government, the State, and local entities to implement flood risk reduction projects would continue. However, this alternative assumes that funding beyond that currently authorized under Propositions 84 and 1E would not be available, substantially constraining the scale of construction and other activities under this alternative. Local agencies' planning obligations that would be triggered by adoption of the CVFPP would not be triggered under this alternative, and system maintenance would still be challenged by the need to complete annual maintenance activities. The VMS, including the LCM component, would be implemented with or without the adoption of the CVFPP.

"100-Year Flood" is a shorthand expression for a flood that has a 1-in-100 chance of being exceeded in any given year. This may also be expressed as the 1-percent-annual-chance-of-exceedence flood, or "1-percent-annual-chance flood" for short. Similarly, a 200-year flood has a 1-in-200 (or 0.5-percent) chance of being exceeded in any given year.

ES.6.2 No-Project Alternative—No Additional Activities Scenario

The No-Project Alternative—No Additional Activities Scenario is similar to the No-Project Alternative—Continued Operations Scenario, except that this scenario does not assume that projects not already under way will be commenced, and further does not assume that funding will be forthcoming for projects other than those already commenced. This scenario also assumes that the component of the VMS reflected in *California's Central Valley Flood System Improvement Framework*, signed on February 27, 2009—vegetation management in the vegetation management zone for purposes of visibility

and access—will continue to be implemented by maintaining agencies. However, it assumes that the LCM component—long-term elimination of trees in the vegetation management zone—will not be adopted or applied. Under this scenario, some recruitment of new trees on SPFC levees will incidentally be prevented by maintenance undertaken for purposes of visibility and access, but less thoroughly and at a slower rate than would be the case with LCM, so that some trees likely would remain.

ES.6.3 Modified State Systemwide Investment Approach Alternative

The Modified SSIA Alternative is similar to the proposed program in that it is based on the urban protection provided by the Protect High-Risk Communities Alternative and adds some small-community protection, but with more limited construction activities than for other alternatives. The alternative also includes expanding the Yolo Bypass and widening Fremont Weir, but does not include any of the other bypass expansions and related improvements contained in the proposed program. This alternative presents a less construction-intensive alternative that addresses only the most critical stressors on public safety, operations and maintenance, and ecosystem function, while minimizing potential adverse environmental effects. Work would focus on repairing and improving existing levees in urban areas with only limited work on expanding floodways.

ES.5.4 Achieve SPFC Design Flow Capacity Alternative

The Achieve SPFC Design Flow Capacity Alternative focuses on addressing the condition of existing SPFC levees so that the channels convey their design flows with a high degree of reliability based on current engineering criteria. The system was largely constructed based on geometric criteria using available soil materials without extensive investigation of foundation conditions. The majority of SPFC levees do not meet current engineering criteria. This alternative addresses an element of the authorizing legislation (California Water Code, Section 9614(g)), which requires that DWR evaluate structural projects that could be undertaken to reconstruct SPFC facilities to bring each of the facilities of the SPFC to within its design standard. This alternative involves addressing levee conditions primarily in place, without making major changes to the footprint or operation of those facilities. Levee improvements would be made regardless of the areas they protect or the level of protection they provide. This alternative would provide little opportunity to incorporate benefits beyond flood management.

ES.6.5 Achieve SPFC Design Flow Capacity with Strict ETL Compliance Alternative

The Achieve SPFC Design Flow Capacity with Strict ETL Compliance Alternative is the same as the Achieve SPFC Design Flow Capacity Alternative but presents a different method of addressing the issue of vegetation on levees. The Achieve SPFC Design Flow Capacity with Strict ETL Compliance Alternative involves meeting two goals simultaneously:

1. Improve existing SPFC levees so that they convey their design flow capacities.
2. Ensure the strictest compliance with USACE guidance provided in the ETL.

This alternative assumes that DWR would not use USACE's associated draft policy guidance letter, *Process for Requesting a Variance from Vegetation Standards for Levees and Floodwalls; Additional Findings* (77 *Federal Register* 9637–9650, February 17, 2012). The variance process allows for retention of some woody vegetation on or near levees under certain very specific circumstances.

ES.6.6 Protect High-Risk Communities Alternative

The Protect High-Risk Communities Alternative evaluates improvements to levees to protect life safety and property for high-risk population centers, including urban and small communities. Most levees in rural-agricultural areas would remain in their existing configurations; however, new training levees, ring levees, or floodwalls immediately adjacent to the communities may be constructed. This alternative would provide a minor opportunity to incorporate benefits beyond flood management.

ES.6.7 Enhance Flood System Capacity Alternative

The Enhance Flood System Capacity Alternative involves seeking opportunities to achieve multiple benefits by enhancing the flood system's storage and conveyance capacity, protecting high-risk communities, and fixing levees in place in rural-agricultural areas. This alternative combines the features of other alternatives and provides greater capacity within flood conveyance channels to lower flood stages in most of the system.

ES.6.8 Alternatives Carried Forward for Evaluation

Two alternatives described above—the Achieve SPFC Design Flow Capacity with Strict ETL Compliance and Protect High-Risk Communities alternatives—were considered for further evaluation in the PEIR but were rejected. These alternatives were rejected because they failed to meet most of the basic program objectives, were determined to be infeasible, would not avoid or substantially lessen significant environmental impacts, and/or would be so similar to another alternative that they would not add to expand the range of alternatives evaluated in this PEIR.

The other five alternatives were carried forward for further analysis and evaluation in this PEIR. These alternatives were determined to meet most of the program objectives, were found to be feasible, would avoid or substantially lessen significant environmental impacts, would collectively provide a reasonable range of feasible alternatives to evaluate in this PEIR, and/or were specifically included in the CVFPP planning process by the California Legislature. These alternatives carried forward are the No-Project Alternative—Continued Operations Scenario, No-Project Alternative—No Additional Activities Sce-

nario, Modified SSIA Alternative, Achieve SPFC Design Flow Capacities Alternative, and Enhance Flood System Capacity Alternative. See Section ES.8, "Comparison of Environmental Impacts of the Proposed Program and Alternatives," below.

ES.7 Summary of Environmental Impacts of the Proposed Program

The PEIR impact analysis examines all potentially significant impacts that would occur with implementation of the CVFPP. Impacts and mitigation measures are described for NTMAs and LTMAs.

The impact analysis addresses construction, operations and maintenance, and policy actions for both activity categories. Construction-related, operational, and maintenance-related impacts would result in direct and indirect impacts, while policy actions would result only in indirect impacts.

Potential environmental impacts of the proposed program and associated mitigation measures are summarized in Table ES-1 at the end of this Executive Summary.

ES.8 Comparison of Environmental Impacts of the Proposed Program and Alternatives

This section compares the environmental impacts of each of the five retained alternatives (described above) with the impacts of the proposed program.

The CEQA Guidelines (Section 15126.6(d)) permit evaluation of the alternatives in less detail than for a proposed project. Consistent with Section 15126.6(d) of the CEQA Guidelines, the analysis below generally compares the environmental effects of the alternatives against the effects of the proposed program, focusing on whether the alternative would result in effects greater than, less than, or similar to those identified for the proposed program.

Table ES.8-1 provides a summary comparison of the impact levels of the proposed program, and alternatives when compared to the proposed program. The impact levels listed for the proposed program in Table ES.8-1 reflect the most substantial environmental effects identified for each environmental resource area.

Table ES. 8-1. Comparison of Impact Levels of the Proposed Program and the Alternatives

ENVIRONMENTAL RESOURCE	PROPOSED PROGRAM[1]	NO-PROJECT—CONTINUED OPERATIONS SCENARIO	NO-PROJECT—NO ADDITIONAL ACTIVITIES SCENARIO	MODIFIED SSIA	ACHIEVE SPFC DESIGN FLOW CAPACITIES	ENHANCE FLOOD SYSTEM CAPACITY
Aesthetics	Less than significant after mitigation	Similar	Similar	Lesser	Lesser	Greater
Agriculture and Forestry Resources	Potentially significant and unavoidable	Lesser	Lesser	Lesser	Lesser	Greater
Air Quality	Potentially significant and unavoidable	Similar	Lesser	Lesser	Lesser	Greater
Biological Resources—Aquatic	Potentially significant and unavoidable	Greater	Greater	Greater	Greater	Greater
Biological Resources—Terrestrial	Potentially significant and unavoidable	Greater	Greater	Greater	Greater	Greater
Climate Change and Greenhouse Gas Emissions	Less than significant	Greater	Greater	Similar	Greater	Unknown
Cultural and Historic Resources	Potentially significant and unavoidable	Lesser	Lesser	Lesser	Lesser	Greater
Energy	Less than significant	Lesser	Lesser	Lesser	Lesser	Similar
Geology, Soils, and Seismicity (Including Mineral and Paleontological Resources)	Potentially significant and unavoidable	Lesser	Lesser	Lesser	Lesser	Greater
Groundwater Resources	Less than significant after mitigation	Greater	Greater	Greater	Greater	Lesser
Hazards and Hazardous Materials	Less than significant after mitigation	Greater	Greater	Greater	Greater	Lesser
Hydrology	Less than significant after mitigation	Greater	Greater	Lesser	Greater	Lesser
Land Use and Planning	Significant and unavoidable	Lesser	Lesser	Lesser	Lesser	Greater

Table ES. 8-1. Comparison of Impact Levels of the Proposed Program and the Alternatives (contd.)

ENVIRONMENTAL RESOURCE	PROPOSED PROGRAM[1]	NO-PROJECT—CONTINUED OPERATIONS SCENARIO	NO-PROJECT—NO ADDITIONAL ACTIVITIES SCENARIO	MODIFIED SSIA	ACHIEVE SPFC DESIGN FLOW CAPACITIES	ENHANCE FLOOD SYSTEM CAPACITY
Noise	Less than significant after mitigation	Lesser	Lesser	Lesser	Similar	Similar
Population, Employment, and Housing	Less than significant	Greater	Greater	Greater	Greater	Lesser
Public Services	Less than significant	Greater	Greater	Similar	Greater	Greater
Recreation	Less than significant after mitigation	Lesser	Lesser	Similar	Lesser	Similar
Transportation and Traffic	Potentially significant and unavoidable	Lesser	Lesser	Similar	Similar	Greater
Utilities and Service Systems	Less than significant after mitigation	Greater	Greater	Similar	Greater	Similar
Water Quality	Less than significant after mitigation	Greater	Greater	Greater	Greater	Lesser

Source: Data compiled by AECOM in 2012

Notes:
[1] Impact categories listed for the proposed program provide the most severe impact category identified for the environmental issue area. If there are one or more significant and unavoidable impacts, then "Significant and unavoidable" or "Potentially significant and unavoidable" is placed in the column. If the most severe impact within the environmental issue area is "Less than significant after mitigation," then this designation is placed in the column. If every impact for the environmental issue area is less than significant, then "Less than significant" is placed in the column.

Key:
SPFC = State Plan of Flood Control
SSIA = State Systemwide Investment Approach

ES.9 Next Steps for the PEIR

The DPEIR is available for public review and comment for 45 days. Written comments must be received at the physical or e-mail address below no later than the close of business (5 p.m. Pacific time) on Friday, April 20, 2012:

Mary Ann Hadden, Staff Environmental Scientist
DWR, DFM
c/o MWH
3321 Power Inn Road, Suite 300
Sacramento, CA 95826
(916) 574-1431
DPEIRcomments@water.ca.gov

Please include "Comments on the March 2012 CVFPP DPEIR" in the subject line of e-mail or paper comments submitted.

All documents referenced in the DPEIR are available at MWH, 3321 Power Inn Road, Suite 300, Sacramento, California. The DPEIR is available on the following Web site where it may be viewed or downloaded: http://www.water.ca.gov/cvfmp/documents.cfm.

The DPEIR schedule is presented below, with public hearings indicated in italics.

Public Release Date of DPEIR	March 6, 2012
Public Hearing—Sacramento, Resources Building, Auditorium, 1416 Ninth Street	April 5, 2012 – 2 p.m.
Public Hearing—Marysville, Yuba County Government Office, Board of Supervisors Boardroom, 915 8th Street	April 6, 2012 – 2 p.m.
Public Hearing—Stockton, San Joaquin County Robert J. Cabral Agricultural Center, 2101 E. Earhart Avenue	April 9, 2012 – 2 p.m.
Public Hearing—Woodland, Yolo County Board of Supervisors Building, 625 Court Street	April 11, 2012 – 2 p.m.
End of 45-day DPEIR Public Comment Period	April 20, 2012 – 5 p.m.

Table ES-1. Summary of Impacts and Mitigation Measures of the Proposed Program

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
3.2 Aesthetics					
Impact VIS-1 (NTMA & LTMA): *Temporary, Short-Term Construction-Related Changes in Scenic Vistas, Scenic Resources, and Existing Visual Character*	LTS		N/A	LTS	
Impact VIS-2 (NTMA & LTMA): *Degradation of Scenic Vistas, Scenic Resources, and Existing Visual Character Resulting from Conveyance-Related Management Activities*	LTS		N/A	LTS	
Impact VIS-3 (NTMA & LTMA): *Degradation of Scenic Vistas, Scenic Resources, and Existing Visual Character Resulting from Storage-Related Management Activities*	LTS		N/A	LTS	
Impact VIS-4 (NTMA & LTMA): *New Sources of Substantial Light and Glare*	PS		Mitigation Measure VIS-4 (NTMA & LTMA): *Establish and Require Conformance to Lighting Standards, and Prepare and Implement a Lighting Plan* Not all measures listed below may be applicable to each management action. Rather, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action. The project proponent will ensure that the following measures are implemented where project activities occur in the vicinity of sensitive light receptors to reduce potentially significant adverse effects associated with light and glare: • If construction lighting is needed, contractors will be required to shield or screen lighting fixtures and direct lights downward onto the work site and prevent significant light spill onto adjacent properties. • Contractors will place and direct flood or area lighting needed for construction activities or for security so as not to significantly disturb adjacent residential areas, passing motorists, or other light-sensitive receptors. • The use of harsh mercury vapor, low-pressure sodium, or fluorescent bulbs or light fixtures that are of unusually high intensity or brightness will be prohibited unless there is no practicable alternative. • Where applicable and practicable, lighting fixtures will meet lighting standards of the local jurisdiction. Design features that will reduce the effects of nighttime lighting, namely directional shielding for all substantial light sources, will be included in the project designs. In addition, the use of automatic shutoffs or motion sensors for lighting features will be considered in the project designs to further reduce excess nighttime lighting. All nighttime lighting will be shielded to prevent the light from shining off the surface intended to be illuminated. • Materials with natural colors and low-reflection materials will be used on all new or replacement structures to the extent feasible so that the facilities appear more consistent with the existing character of the area and do not generate excessive glare.	LTS	
Impact VIS-5 (NTMA & LTMA): *Effects of Other NTMAs and LTMAs on Aesthetic Resources*	LTS		N/A	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
3.3 Agriculture and Forestland Resources					

Impact AG-1 (NTMA & LTMA): *Conversion of Substantial Amounts of Important Farmland to Nonagricultural Uses and Conversion of Land under Williamson Act Contracts to an Inconsistent Use Resulting from Conveyance-Related Management Activities*	PS		Mitigation Measure AG-1a (NTMA & LTMA): *Preserve Agricultural Productivity of Important Farmland to the Extent Feasible*
			
			In a May 4, 2005, memorandum to California Resources Agency departments, boards, and commissions, the Secretary stated that "in selecting and developing resource-related projects, departments under the Resources Agency should consider ways to reduce effects on productive agricultural lands" and encouraged departments to incorporate, where appropriate, the strategies identified in the CALFED Bay-Delta Program (CALFED) EIR to reduce the impact of the CALFED Ecosystem Restoration Program on agricultural land and water use.
			
			The measures listed below include the applicable strategies identified in the CALFED EIR and some additional measures. Not all measures listed below may be applicable to each management action. Rather, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action.
			
			The project proponent will ensure that the following measures are implemented as applicable to reduce effects and preserve agricultural productivity on Important Farmland:
			• Site projects and project footprints to minimize the permanent conversion of Important Farmland to nonagricultural uses.
			• Identify and implement project design features that will benefit flood management, agriculture, and natural resources.
			• When selecting sites and methods for repair, reconstruction, and improvement of flood control facilities, minimize the splitting or fragmentation of parcels that are to remain in agricultural use.
			• Maximize contiguous parcels of agricultural land of a size sufficient to support their efficient use for continued agricultural production.
			• Where the construction or operation of a facility could limit access to ongoing agricultural operations, maintain a means of reasonably convenient access to these agricultural properties as part of project design, construction, and implementation.
			• At borrow sites to be returned to agricultural production, remove and stockpile, at a minimum, the upper 2 feet of topsoil and replace the topsoil after project completion as part of borrow site reclamation. Borrow site reclamation for agricultural production will also take into account the potential unique characteristics of soils for production of certain crops (e.g. clay pan soils for rice).
			• In areas permanently disturbed by program activities, and where topsoil is removed as part of project construction (e.g., stripping topsoil under a levee foundation) and not reused as part of the project, make the topsoil available to less productive agricultural lands that could benefit from the introduction of good-quality soil. By agreement between the project proponent or landowners of affected properties and the recipient(s) of the topsoil, the recipient(s) would use the topsoil for agricultural purposes.
			• Relocate and/or replace wells, pipelines, power lines, drainage systems, and other infrastructure that are needed for ongoing agricultural uses and would be affected by project construction or operation.
			• Minimize disturbance of Important Farmland and continuing agricultural operations during construction by implementing the following measures:
			  ◆ To the extent possible, locate construction laydown and staging areas on sites that are fallow, already developed or disturbed, or to be discontinued for use as agricultural land.
			  ◆ Use existing roads to access construction areas to the extent possible.
			• Coordinate with growers to develop appropriate construction practices to minimize construction-related impairment of agricultural productivity. Practices may include coordinating the movement of heavy equipment and implementing traffic control measures.
			• Support the testing and application of alternative crops (i.e., agroforestry or energy crops) on idle farmland.
			• Before an NTMA [or LTMA] is implemented, search the CNDDB to determine whether sensitive communities, habitats, and species observation records may be present in or near the project area. These communities, habitats, and species occurrences will be identified, mapped, and quantified as deemed appropriate. The project proponent, assisted by the primary engineering and construction contractors, will coordinate with a qualified biologist to ensure that implementation of NTMAs [or LTMAs] minimizes direct and indirect disturbance of sensitive communities, habitats, and species to the extent feasible. In consultation with USFWS and DFG, the project proponent will develop measures to minimize and, where appropriate, compensate for construction-related effects on sensitive communities, habitats, and species.
				PSU	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
			Mitigation Measure AG-1b (NTMA & LTMA): *Minimize Impacts on Williamson Act–Contracted Lands, Comply with Government Code Sections 51290–51293, and Coordinate with Landowners and Agricultural Operators* The project proponent will consider the following mitigation measures and implement them, as applicable, to reduce effects on lands under Williamson Act contracts: • The project proponent will comply with applicable provisions of California Government Code Sections 51290–51295 with regard to acquiring lands under Williamson Act contract. Sections 51290(a) and 51290(b) specify that State policy, consistent with the purpose of the Williamson Act to preserve and protect agricultural land, is to avoid locating public improvements and any public utilities improvements in agricultural preserves, whenever practicable. If such improvements must be located within a preserve, they will be located on land that is not under contract, if practicable. • More specifically, the project proponent will comply with the following basic requirements stated in the California Government Code: ◆ Whenever it appears that land within a preserve or under contract may be required for a public improvement, DOC and the city or county responsible for administering the preserve must be notified (Section 51291(b)). ◆ Within 30 days of being notified, DOC and the city or county must forward comments, which will be considered by the proponent of the public improvement (Section 51291(b)). ◆ A public improvement may not be located within an agricultural preserve unless findings are made that (1) the location is not based primarily on the lower cost of acquiring land in an agricultural preserve and (2) for agricultural land covered under a contract for any public improvement, no other land exists within or outside the preserve where it is reasonably feasible to locate the public improvement (Sections 51291(a) and 51291(b)). If the land is acquired for the purpose of flood damage reduction measures, the project proponent(s) is exempt from the findings required in California Government Code Section 51292 (Section 51293(e)(1)). ◆ The contract is normally terminated for lands acquired by eminent domain or in lieu of eminent domain (Section 51295). ◆ DOC must be notified within 10 working days upon completion of the acquisition (Section 51291(c)). ◆ DOC and the city or county must be notified before completion of any proposed work of any significant changes related to the public improvement (Section 51291(d)). ◆ If, after acquisition, the acquiring public agency determines that the property would not be used for the proposed public improvement, DOC and the city or county administering the involved preserve must be notified before the land is returned to private ownership. The land will be reenrolled in a new contract or encumbered by an enforceable restriction at least as restrictive as that provided by the Williamson Act (Section 51295). • The project proponent will coordinate with landowners and agricultural operators to sustain existing agricultural operations, at the landowners' discretion, until the individual agricultural parcels are needed for project construction.	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
			Mitigation Measure AG-1c (NTMA & LTMA): *Establish Conservation Easements Where Potentially Significant Agricultural Land Use Impacts Remain after Implementation of Mitigation Measures AG-1a (NTMA) and AG-1b (NTMA)* As discussed in Mitigation Measures AG-1a (NTMA) and AG-1b (NTMA), in general, where there is a reduction or termination of agricultural activities to undertake flood protection, environmental protection, or other conservation measures, project proponents should consider other measures before considering purchasing easements or other measures of compensation (collectively referred to as "easements" below). If after implementing all other applicable measures, the proposed project could still result in a potentially significant environmental impact, easements should be considered. Easements are most likely appropriate where there would be serious degradation or elimination of the physical conditions or natural processes that provide the land's resource qualities for agriculture. In this situation, there would normally also be other impacts on the environment. Where easements are applicable, the following factors will be considered: • Where easements are considered for other resources such as terrestrial biological resources, purchase of easements should be coordinated where possible so that agricultural resources are also addressed. For example, if it were determined that a project would permanently terminate agricultural activities on a piece of land that served as Swainson's hawk foraging habitat, if an easement on another property were determined appropriate to address losses of Swainson's hawk foraging habitat, the replacement land could also support the same kind of agricultural activity as the original converted property. • Applicable methods established in the area of the specific project activity will be considered. Methods for compensation may include but are not limited to establishing agricultural conservation easements, paying in-lieu fees toward agricultural conservation easements, supporting agricultural land trusts, and participating in habitat conservation plans or natural communities conservation plans that include conservation of agricultural lands. The appropriate ratio of purchase or establishment of agricultural conservation easements relative to conversion of Important Farmland will be established on a case-by-case basis for each project. Depending on the specifics of the impact, available agricultural conservation programs in various locations, and local or regional regulatory standards, there are some circumstances where less than a 1-to-1 compensation ratio may be appropriate, and other circumstances where greater ratios may be required. Where conservation easements are established by the project proponent, they may be held by land trusts, local governments, or other appropriate agencies that are responsible for ensuring that these lands are maintained in agricultural use. When determining whether effects on agricultural land warrant purchase of an easement, the following factors should be considered: • Whether the change would affect the use of the land for agricultural purposes (i.e., ceasing agricultural activities and allowing land to be fallowed or be used for resource restoration in such a way that land could be returned to agricultural production) • Whether the change would permanently take land out of production (i.e., depositing sediment on agricultural lands) • Whether the land could be used for agricultural production but has not been or is not likely to be able to be used for such purposes because of flooding, bad soils, lack of dependable water supplies, or other reasons • Whether the land is currently being used for agricultural production and would not be able to be used for similar purposes in the future because of the project, but the project would provide benefits to nearby or other land that could be or is being used for agricultural purposes • Whether the land is currently being used for agricultural production and would not be able to be used for similar purposes in the future because of the project, but the land is not Prime Farmland, Unique Farmland, or Farmland of Statewide Importance • Whether the land is currently being used for agricultural production and would not be able to be used for similar purposes in the future because of physical changes brought about by the project, and the land is Prime Farmland, Unique Farmland, or Farmland of Statewide Importance • Whether thse land would be converted to a use that would reduce ancillary environmental benefits		
Impact AG-2 (NTMA & LTMA): *Conversion of Important Farmland to Nonagricultural Uses and Conversion of Land under Williamson Act Contracts to an Inconsistent Use Resulting from Storage-Related Management Activities*	LTS		N/A	LTS	
Impact AG-3 (NTMA &LTMA): *Effects of Other NTMAs [& LTMAs] on Important Farmland and Williamson Act Contract Land*	PS		**Mitigation Measure AG-3 (NTMA & LTMA):** *Implement Mitigation Measures AG-1a (NTMA), AG-1b (NTMA), and AG-1c (NTMA)*	PSU	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact AG-4 (NTMA & LTMA): *Conversion of Forest Land to Nonforest Uses Resulting from Conveyance-Related Management Activities*	S		Mitigation Measure AG-4 (NTMA & LTMA): *Implement Mitigation Measure BIO-T-1a (NTMA), "Conduct Biological Resources Surveys to Quantify Sensitive Natural Communities in Project Areas, and Avoid, Minimize, and, Where Appropriate, Compensate for Construction-Related Effects"*	LTS	
Impact AG-5 (NTMA & LTMA): *Conversion of Forest Land to Nonforest Uses Resulting from Storage-Related Management Activities*	LTS		N/A	LTS	
Impact AG-6 (NTMA & LTMA): *Effects of Other NTMAs [& LTMAs] on Forest Land*	PS		Mitigation Measure AG-6 (NTMA & LTMA): *Implement Mitigation Measure BIO-A-2b (NTMA), "Ensure Full Compensation for Losses of Riparian Habitat Functions and Values Caused by Implementing the Vegetation Management Strategy Along Levees"*	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
3.4 Air Quality					

Impact AQ-1 (NTMA & LTMA): *Construction-Related Emissions of Criteria Air Pollutants and Ozone Precursors Resulting from Conveyance and Other Components that Could Exceed Local CEQA Thresholds of Significance*	PS		Mitigation Measure AQ-1 (NTMA & LTMA): *Implement Measures to Reduce Construction-Related Emissions*
			
			The following measures will be considered during project-level evaluation of specific management actions. Not all measures listed below may be applicable to each management action. Rather, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action.
			
			The mitigation measures described below are grouped according to whether they address construction in general, fugitive dust emissions, or exhaust emissions.
			
			GENERAL CONSTRUCTION MITIGATION
			The following measures are designed to reduce all construction-related emissions:
			• Comply with and implement applicable air district rules and regulations that pertain to construction activities (e.g., asphalt ROG requirements, administrative requirements, fugitive dust management practices). As applicable, implement construction-related requirements from air districts or local governments with authority over the project at the commencement of and during each construction activity.
			• Do not use open burning to dispose of any excess materials generated during site preparation or other project activities.
			
			FUGITIVE DUST EMISSIONS
			The following measures may be used to reduce fugitive dust emissions:
			• Submit a dust control plan to the local air district, and obtain approval of the plan before the grading permit is issued. Implement the plan during construction. The dust control plan will specifically identify measures that would demonstrate that earth-moving activities in areas of the site would comply with applicable requirements of the local air district.
			• Phase long-duration construction activities to reduce the size of the disturbed area at any given time.
			• Water all exposed surfaces three times a day or sufficiently to prevent visible dust emissions from exceeding 20 percent opacity beyond the construction boundaries.
			• Apply water, nontoxic chemical stabilizers, or dust suppressants or use tarps or other suitable material (e.g., vegetative ground cover) in all disturbed areas that will not be used for 10 days or more.
			• Suspend excavation and grading activities when winds exceed 15 mph.
			• Restrict the speed of construction vehicles to 15 mph on any unpaved surface.
			• Prevent carryout and trackout of fugitive dust on construction vehicles. Methods to limit carryout and trackout include using wheel washers; sweeping any trackout on adjacent public streets at the end of each workday; and lining access points with gravel, mulch, or wood chips.
			• Cover access roads within 100 feet of paved roads with a 6- to 12-inch layer of wood chips or mulch or a 6-inch layer of gravel to reduce the generation of road dust and road dust carryout onto public roads.
			• Clean up carryout and trackout using any of the following methods:
			  ◆ Manually sweeping and picking up
			  ◆ Operating a rotary brush or broom accompanied or preceded by sufficient wetting to limit visible dust emissions to 20 percent opacity
			  ◆ Operating a PM_{10}-efficient street sweeper that has a pickup efficiency of at least 80 percent
			  ◆ Flushing with water if curbs or gutters are not present and if using water would not either result in a source of trackout material, result in adverse impacts on stormwater drainage systems, or violate any National Pollutant Discharge Elimination System permit program
			• Cover or wet the filled cargo compartment of material transport trucks to limit visible dust emissions during transport, and maintain at least 2 feet of freeboard from the top of the container.
			• Clean or cover the cargo compartment of empty material transport trucks before they leave the site.
			• Install sandbags or other erosion control measures on sites with a slope greater than 1 percent to prevent runoff of silt to public roadways.
			• Limit the number of areas subject to excavation, grading, and other ground-disturbing activities at any given time.
				PSU	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
			EXHAUST EMISSIONS The following measures may be used to reduce exhaust emissions: • Develop a comprehensive construction-activity management plan to minimize the amount of large construction equipment operating at any given time. • Implement a shuttle service to and from retail services and food establishments during lunch hours, or employ a catering service to bring lunch to the project site. • Use diesel-powered construction equipment that meets CARB's 1996 or newer certification standard for off-road heavy-duty diesel engines. • Schedule construction truck trips during nonpeak traffic hours to reduce peak-hour emissions and traffic congestion to the extent feasible. • Use alternative-fueled (e.g., compressed natural gas (CNG), liquefied natural gas (LNG), propane, biodiesel) or electricity-powered construction equipment, where feasible. Project-specific analysis should confirm that using any alternative fuel would not increase NO_x emissions. • Install diesel oxidation catalysts, catalyzed diesel particulate filters, or other applicable air district–approved emission reduction retrofit devices where feasible. • Use the newest equipment available to try to maintain a Tier 1 fleet equipment average. The following measures from Mitigation Measure CLM-1a (NTMA) in Section 3.7, "Climate Change and Greenhouse Gas Emissions," could help to further reduce exhaust emissions of criteria air pollutants and ozone precursors: • *BMP 6*. Minimize idling time by requiring that equipment be shut off after 5 minutes when not in use (as required by the State airborne toxics control measure (Title 13, Section 2485 of the California Code of Regulations)). Provide clear signage that posts this requirement for workers at the entrances to the site and provide a plan for the enforcement of this requirement. • *BMP 7*. Maintain all construction equipment in proper working condition and perform all preventative maintenance. Required maintenance includes compliance with all manufacturer's recommendations, proper upkeep and replacement of filters and mufflers, and maintenance of all engine and emissions systems in proper operating condition. Maintenance schedules shall be detailed in an air quality control plan prior to commencement of construction. • *BMP 8*. Implement a tire inflation program on jobsite to ensure that equipment tires are correctly inflated. Check tire inflation when equipment arrives on-site and every 2 weeks for equipment that remains on-site. Check vehicles used for hauling materials off-site weekly for correct tire inflation. Procedures for the tire inflation program shall be documented in an air quality management plan prior to commencement of construction. • *BMP 9*. Develop a project-specific ride share program to encourage carpools, shuttle vans, transit passes, and/or secure bicycle parking for construction worker commutes.		
Impact AQ-2 (NTMA & LTMA): *Potential for Construction-Related Emissions of Criteria Air Pollutants and Ozone Precursors Resulting from Storage-Related NTMAs [& LTMAs] to Exceed Local CEQA Thresholds of Significance*	LTS		N/A		LTS

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact AQ-3 (NTMA & LTMA): *Potential for Long-Term Operational and Maintenance-Related Emissions of Criteria Air Pollutants and Ozone Precursors to Exceed Local CEQA Thresholds of Significance*	LTS	PS	**Mitigation Measure AQ-3 (LTMA):** *Implement Measures to Reduce Operational Emissions* The following measures will be considered during project-level evaluation of specific management actions. Not all measures would be applicable to each management activity. Rather, these measures serve as an overlying mitigation framework to be used when individual projects are evaluated. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action. The following measures may be implemented to reduce exhaust emissions from vehicles and equipment where operations and maintenance activities for specific projects exceed applicable emissions thresholds: • Develop and implement a comprehensive maintenance-activity management plan to miniize the amount of vehicle travel associated with maintenance actions. • Develop and implement a worker trip reduction plan to achieve average vehicle ridership of 1.5 persons or greater where applicable. • Maintain all equipment (including maintenance trucks) to the manufacturers' specifications. The equipment should be checked by a certified mechanic on a regular basis. • Minimize idling time either by shutting off equipment when it is not in use or by reducing the time of idling to no more than 5 minutes. Provide clear signage regarding idling at locations visible to maintenance staff. • Schedule maintenance trips during nonpeak traffic hours to reduce peak-hour emissions and traffic congestion to the extent feasible. • Use alternative-fueled (e.g., CNG, LNG, propane), electricity-powered, or catalyst-equipped diesel vehicles where feasible. The following measures from Mitigation Measure CLM-1b (NTMA) in Section 3.7, "Climate Change and Greenhouse Gas Emissions," could help to further reduce operational emissions of criteria air pollutants and ozone precursors: • Implement all current standards and/or requirements as part of any DWR sustainability plan or guidelines. • Use renewable energy generated on site (i.e., solar, wind, hydroelectric) where feasible. • Use alternative fuels for maintenance vehicles and equipment. • Use energy-efficient equipment for operation and maintenance of proposed facilities (e.g., pumps, hydraulic equipment, maintenance equipment). Equipment and operation of equipment will conform to U.S. Department of Energy best practices, Consortium for Energy Efficiency initiatives and guidance, and National Electrical Manufacturers Association standards where feasible. • Require proposed buildings to exceed California Building Standards Code Title 24 energy efficiency standards by 20 percent or more.	N/A	PSU
Impact AQ-4 (NTMA & LTMA): *Construction-Related and Operational Emissions from Conveyance and Other NTMAs [or LTMAs] that Could Result in Cumulatively Considerable Net Increases in Criteria Air Pollutants for Which the Project Region is Nonattainment under Applicable Federal or State Ambient Air Quality Standards*	PS		**Mitigation Measure AQ-4 (NTMA & LTMA):** *Implement Mitigation Measure AQ-1 (NTMA)*	PSU	
Impact AQ-5 (NTMA & LTMA): *Potential for Construction-Related and Operational Emissions from Storage-Related NTMAs [& LTMAs] to Result in Cumulatively Considerable Net Increases in Criteria Air Pollutants for Which the Project Region is Nonattainment under Applicable Federal or State Ambient Air Quality Standards*	LTS		N/A	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact AQ-6 (NTMA & LTMA): *Potential Construction-Related Exposure of Sensitive Receptors to Substantial Pollutant Concentrations through Diesel PM and Naturally Occurring Asbestos or Potential Generation of Substantial Concentrations of TACs during Operations*	PS		Mitigation Measure AQ-6 (NTMA & LTMA): *Implement Strategies to Protect Sensitive Receptors from Substantial Construction-Related Emissions of Naturally Occurring Asbestos* Not all measures listed below may be applicable to each management action. Rather, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action. It will be assumed that any construction within one-half mile of State-identified NOA areas is operating in serpentine or ultramafic rock and will comply with all requirements outlined in CARB's Asbestos Air Toxic Control Measures for Construction, Grading, Quarrying, and Surface Mining Operations. These requirements include all of the following: • Prepare and implement an asbestos dust mitigation plan, which must be approved by the local air district before construction begins and must be implemented at the commencement and maintained throughout the duration of construction and grading activities in known NOA areas. • Prepare and implement an asbestos health and safety program in known NOA areas, if required under California Code of Regulations Title 8, Section 1529(4), Asbestos. The asbestos dust mitigation plan, as required by Title 17, Sections 93105(e)(2) and 93105(e)(4) of the California Code of Regulations, will identify dust mitigation practices that are sufficient to ensure that no equipment or operations emit dust that is visible and crossing property lines. The plan will also identify trackout prevention and control measures, control measures for disturbed surface areas and storage piles that would remain inactive for more than 7 days, postconstruction stabilization measures, and asbestos monitoring measures, if required. Examples of these measures include wetting, covering, or crusting the surface; applying chemical dust suppressants or stabilizers; installing wind barriers; enforcing speed limits in construction areas; controlling truck spillage; and establishing vegetative covers. In addition, the asbestos dust mitigation plan will include recordkeeping and reporting requirements that will be used to document the results of any air monitoring, geologic evaluation, and asbestos bulk sampling. The asbestos health and safety program will be implemented if permissible exposure limits for airborne asbestos are found to be exceeded within the study area. Implementation will include applicable measures to protect construction employees as defined under Title 8, Section 1529(g) of the California Code of Regulations, and any additional measures required by the California Occupational Safety and Health Administration to reduce exposure of construction employees to airborne asbestos.	LTS	
Impact AQ-7 (NTMA & LTMA): *Potential for Construction-Related and Operational Generation of Odors that Could Affect a Substantial Number of People*	LTS		N/A	LTS	
3.5 Biological Resources–Aquatic					
Impact BIO-A-1 (NTMA & LTMA): *Potential Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Siltation and Degradation of Water Quality during Construction or Operations and Maintenance Activities*	LTS		N/A	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact BIO-A-2 (NTMA & LTMA): *Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Loss of Overhead Cover and Instream Woody Material as Part of the Vegetation Management Strategy*	PS		Mitigation Measure BIO-A-2a (NTMA & LTMA): *Secure Applicable State and/or Federal Permits and Implement Permit Requirements* Not all measures listed below may be applicable to each management action. Rather, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action. The project proponent will ensure that the following measures are implemented to reduce the effects of repairing, reconstructing, and improving levees on trees within stream zones, shaded riverine aquatic habitat, IWM, listed fish species, and designated critical habitat: • A Section 1602 streambed alteration agreement will be obtained from DFG before any trees are removed from a stream zone that is under DFG jurisdiction unless the activity is implemented by USACE. The project proponent will comply with all terms and conditions of the streambed alteration agreement, including measures to protect habitat or to restore, replace, or rehabilitate any habitat. • The project proponent will consult or coordinate with USFWS and NMFS as required under the federal ESA, and with DFG as required under the CESA, regarding potential impacts on listed fish species, including the loss of habitat. The project proponent will implement any additional measures developed through the ESA and CESA consultation processes, including the conditions of Section 7 biological opinions, Section 10 HCPs, and Section 2081 permits. Where an existing approved HCP, NCCP, or similar plan covers an NTMA [or LTMA] and provides for compliance with applicable State or federal regulations, the project proponent may participate in and comply with the terms of such a plan to achieve the permit compliance measures listed above. Any mitigation plantings in the floodway will not be permitted if they would result in substantial increases in flood stage elevations, or alter flows in a manner that would have a substantial adverse effect on the opposite bank. Mitigation Measure BIO-A-2b (NTMA & LTMA): *Ensure Full Compensation for Losses of Riparian Habitat Functions and Values Caused by Implementing the Vegetation Management Strategy Along Levees* DWR will coordinate with the Board and levee maintenance agencies tasked with implementing the vegetation management strategy to develop and implement a plan to record data on riparian vegetation lost or removed due to implementation of the vegetation management strategy, and to ensure adequate compensation for losses of riparian habitat functions and values. Although this mitigation measure is written as if a single plan is prepared, multiple plans addressing individual regions, watersheds, river corridors, or other geographic subdivisions are also acceptable. The plan will be completed and suitable for implementation before the start of riparian habitat removal under the vegetation management strategy. The plan will include mechanisms to, at a minimum, record and track the acreage, type, and location of riparian habitat to be removed through implementation of the vegetation management strategy or lost over time through LCM. The plan will also address compensation for the loss and degradation of riparian habitat through the enhancement, restoration, or creation of riparian habitat in other locations. Assessment of the value of lost or degraded habitat and of compensation habitat will take into account issues such as the differing functions of waterside and landside riparian habitat, continuity and connectivity of habitat, types of riparian habitat removed vs. type of compensation habitat (e.g., riparian scrub vs. cottonwood riparian forest), and ability of habitat to support special-status species. DWR will track habitat compensation efforts and only authorize implementation of vegetation removal under the vegetation management strategy at a rate and in locations consistent with the volume and type of compensation habitat that has been established. This habitat compensation tracking program will be included in the program MMRP prepared to support this PEIR. The plan must, at a minimum, meet the following basic performance standard: • Authorized losses of habitat do not exceed the function and value of available compensation habitat. DWR will coordinate with USFWS, NMFS, and DFG during preparation and implementation of the plan to incorporate into the plan appropriate compensation for effects on special-status species from vegetation management along the levee system. Various mechanisms may be employed to provide compensation habitat under the plan, as long as the performance standard identified above is met. The mechanisms include but are not limited to the following: • Implementation of the CVFPP Conservation Strategy Framework • Participation in existing NCCPs, HCPs, or other conservation plans • Purchase of habitat credits at an established mitigation bank • Habitat restoration implemented by a levee maintenance agency or other entity Any mitigation plantings in the floodway will not be permitted if they would result in substantial increases in flood stage elevations, or alter flows in a manner that would have a substantial adverse effect on the opposite bank	PSU	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact BIO-A-3 (NTMA & LTMA): *Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Loss of Overhead Cover and Instream Woody Material during Construction*	S		Mitigation Measure BIO-A-3 (NTMA & LTMA): *Inventory and Replace Shaded Riverine Aquatic Habitat* The project proponent will require that the following measures be implemented to reduce the effects of program construction activities on special-status fish, fish movement, nursery sites, riparian habitat, designated critical habitat, and EFH. These measures may already be incorporated into the conditions of permits identified above in Mitigation Measure BIO-A-2a. • An inventory of shaded riverine aquatic habitat will be conducted before construction activities begin. Any shaded riverine aquatic habitat that is removed will be replaced, with replacement to occur on site when feasible. This includes IWM and other instream structures, overhead shade, and shallow-water habitat. • Mitigation credits may be purchased from a public or private mitigation bank approved by DFG, USFWS, and/or NMFS. The final number of credits to be purchased will be determined by agency staff. • A mitigation and monitoring plan will be developed and implemented to ensure that the proposed bank treatments and any off-site mitigation treatments fully compensate for losses of shaded riverine aquatic habitat. On-site revegetation is the preferred method of compensation, and could reduce the impact to a less-than-significant level, and even potentially to a beneficial level. If on-site compensation is not feasible, off-site mitigation will be established either before or as soon as feasible after existing vegetation is removed, or mitigation bank credits will be purchased before existing vegetation is removed. As much of the mitigation habitat as feasible will be created at or near the project site. If off-site mitigation is necessary, a location that does not currently support riparian vegetation and is capable of supporting riparian habitats will be preferred. Revegetation requirements may be accomplished as part of implementation of the CVFPP Conservation Framework. Any mitigation plantings in the floodway will not be permitted if they would result in substantial increases in flood stage elevations, or alter flows in a manner that would have a substantial adverse effect on the opposite bank.	LTS	SU
Impact BIO-A-4 (NTMA & LTMA): *Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Designated Critical Habitat, and Essential Fish Habitat Caused by an Increase in Hydrostatic Pressure, Underwater Noise, and Vibrations during Construction*	PS		Mitigation Measure BIO-A-4 (NTMA & LTMA): *Conform to NMFS Guidelines for Pile-Driving Activities* Several measures may be effective in reducing potential impacts on listed fish species, either by decreasing the level of underwater sound or by decreasing the number of fish exposed to the sound. The project proponent and construction contractors will implement the following measures to the extent feasible, as construction activities and site-specific conditions allow: • Use fewer piles, smaller piles, or a different type of pile to minimize the number and/or intensity of pile hammer impacts. • Drive piles when species of concern are not present, as determined either from surveys or by known migration and use patterns for species occurring in the project area. • Use a vibratory hammer rather than an impact hammer. • Use a cushioning block between the hammer and pile. • Use a confined or unconfined air bubble curtain. • Drive piles during periods of reduced currents. Pile-driving activities at project sites will be monitored to ensure that the effects of pile driving on listed fish species are minimized. If any injury or mortality to fish is observed, DFG, NMFS and/or USFWS will be immediately notified and in-water pile driving will cease.	LTS	
Impact BIO-A-5 (NTMA & LTMA): *Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by Rock Placement*	PS		Mitigation Measure BIO-A-5 (NTMA & LTMA): *Implement Mitigation Measures BIO-A-2a (NTMA) and BIO-A-2b (NTMA)*	PSU	
Impact BIO-A-6 (NTMA & LTMA): *Effects on Special-Status Fish, Fish Movement, Nursery Ground Usage, Riparian Habitat, Designated Critical Habitat, and Essential Fish Habitat Caused by the Increased Availability of Floodplain Habitat Generated by Setback Levees*	PS		Mitigation Measure BIO-A-6 (NTMA & LTMA): *Design and Implement Floodplain Habitat to Minimize Stranding* To avoid or minimize the potential for fish stranding associated with the creation of new floodplain habitat, the existing topographic and hydrologic characteristics of the floodplain will be examined to define the flooding regime, drainage patterns, water depths, and potential risks of fish stranding. Potential floodplain habitat will slope to a main channel or slough to facilitate complete drainage and avoid depressions or other low-lying floodplain features that may strand fish. Periodic recontouring (e.g., filling and excavation) of floodplain surfaces may be required to avoid stranding fish.	LTS	
Impact BIO-A-7 (LTMA): *Effects on Passage by Special-Status Fish and Fish Movement*	N/A	B	N/A	N/A	B

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	NTMAs	LTMAs		NTMAs	LTMAs
3.6 Biological Resources–Terrestrial					
Impact BIO-T-1 (NTMA & LTMA): *Construction-Related Effects on Sensitive Natural Communities and Habitats*	S		Mitigation Measure BIO-T-1a (NTMA & LTMA): *Conduct Biological Resources Surveys to Quantify Sensitive Natural Communities in Project Areas, and Avoid, Minimize, and, Where Appropriate, Compensate for Construction-Related Effects* Not all measures listed below may be applicable to each management action. Rather, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action. The project proponent will ensure that applicable elements of the following measures are implemented to reduce construction-related effects of proposed NTMAs [or LTMAs] on sensitive natural communities. Where measures below call for field surveys, the project proponent may be able to rely on previous surveys that were conducted for the project area if these surveys meet the applicable agency guidelines. • Before an NTMA [or LTMA] is implemented, the CNDDB will be searched and other sources (which may include species experts, species recovery plans, and other monitoring or research studies) will be consulted to determine whether sensitive communities, habitats, and species observation records may be present in or near the project area. These communities, habitats, and species occurrences will be identified, mapped, and quantified as deemed appropriate. The project proponent, assisted by the primary engineering and construction contractors, will coordinate with a qualified biologist to ensure that implementation of NTMAs [or LTMAs minimizes direct and indirect disturbance of sensitive communities, habitats, and species to the extent feasible. In consultation with USFWS and DFG, the project proponent will develop measures to minimize and, where appropriate, compensate for construction-related effects on sensitive communities, habitats, and species. • Before an NTMA [or LTMA] is implemented and if the project so warrants, waters of the United States will be delineated according to methods established in the USACE wetlands delineation manual and Arid West Supplement (Environmental Laboratory 1987, 2008). The delineation will map and quantify the acreage of wetland habitats in the area, and will be submitted to USACE for verification. Not all projects involving construction activities may require a delineation of waters. • If wetlands are found within the proposed construction site or any other area to be disturbed, a wetland delineation report will be prepared and submitted to USACE. After USACE verifies the acreage of waters and wetlands, the project proponent will determine how many acres of waters of the United States and waters of the State would be affected by the NTMA [or LTMA]. The verified wetland delineation, field observation, and as needed, hydraulic modeling will be used to make this determination. Where feasible, impacts will be avoided and minimized by establishing a buffer around wetlands and waterways. • The project proponent will replace, restore, or enhance the acreage of all wetlands, other waters of the United States, and waters of the State that cannot be avoided and will be removed and/or degraded. Thus, the project will achieve "no net loss" of wetland functions and values, in accordance with the requirements of USACE and the Central Valley RWQCB. Wetland habitat will be restored, enhanced, and/or replaced at an acreage and location agreed upon by the project proponent, USACE, and the Central Valley RWQCB, as appropriate. The acreage, location, and methods will be determined during the Section 401 and Section 404 permitting processes, and will be based on a USACE-verified wetland delineation. Methods to be used will be approved by the agency with jurisdiction over the area. • In consultation with the appropriate resource agency (typically DFG), native woodland areas will be identified, mapped, and quantified as deemed appropriate. The project proponent, assisted by the primary engineering and construction contractors, will coordinate with a qualified biologist to ensure that construction activities of NTMAs [& LTMAs] minimize disturbance of native woodlands, including riparian habitats, to the extent feasible. Temporary fencing will be installed during construction to prevent avoidable disturbance of native trees that are located adjacent to construction areas. In consultation with DFG, the project proponent will develop measures to minimize and, where appropriate, compensate for effects on native woodlands. • Protected areas that are managed by federal, State, and local governments or agencies and private entities will be identified, mapped, and quantified as deemed appropriate. The project proponent will coordinate with the appropriate government or agency manager to minimize disturbance of the protected habitats, to the extent feasible.	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
			Mitigation Measure BIO-T-1b (NTMA & LTMA): *Minimize Construction-Related Effects on Critical Habitat and Compensate for Unavoidable Adverse Effects* Before an NTMA [or LTMA] is implemented, USFWS-designated critical habitat in the project area will be identified, mapped, and quantified by a qualified biologist. The project proponent will consult with USFWS to develop and implement measures to avoid, minimize, and, where necessary, compensate for construction-related effects on primary constituent elements and potential adverse modification of critical habitat. Compensation would likely consist of enhancement, restoration, and/or creation of habitat types and vegetation communities that serve as primary constituent elements for the critical habitat affected. Compensation habitat would be enhanced/restored/created within the geographic range of critical habitat for the species in question.		
Impact BIO-T-2 (NTMA & LTMA): *Construction-Related Effects on Water Quality in Sensitive Natural Communities and Special-Status Species' Habitats*	LTS		N/A	LTS	
Impact BIO-T-3 (NTMA & LTMA): *Construction-Related Effects on Special-Status Plants and Wildlife*	S		Mitigation Measure BIO-T-3a (NTMA & LTMA): *Conduct Focused Surveys for Special-Status Plants and Wildlife, and Avoid Impacts* Not all measures listed below may be applicable to each management action. Rather, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action. The project proponent will verify whether species survey and avoidance protocols have been established for species that might be affected by the specific project, or will coordinate with the appropriate regulatory agency (e.g., USFWS or DFG) to determine an acceptable alternative method for surveying and avoiding effects on a species. To avoid effects of proposed construction activities on special-status plants and wildlife, the project proponent will ensure that the following measures are implemented before commencement of ground-disturbing activities. Where measures below call for field surveys, the project proponent may rely on previous surveys that were conducted for the project area if these surveys meet the applicable agency guidelines. If avoidance consistent with these measures cannot be achieved, the project proponent will implement the minimization and compensation measures included in Mitigation Measure BIO-T-3b described below. Where surveys for special-status species may be necessary, the project proponent may be able to rely on previous surveys that were conducted for the project area if these surveys meet the applicable agency guidelines. • The CNNDB will be searched to determine whether any records describe species observations and indicate the presence of habitat for those species in or near the project area. These habitats and species occurrences will be identified, mapped, and quantified as deemed appropriate. The project proponent, assisted by the primary engineering and construction contractors, will coordinate with a qualified biologist to ensure that disturbance of sensitive communities, habitats, and species is minimized during construction to the extent feasible. In consultation with USFWS and DFG, the project proponent will develop measures to minimize and, where appropriate, compensate for construction-related effects on sensitive habitats and special-status species. • A qualified botanist will conduct surveys for special-status plants (as listed in Table 3.6-3) with potential to occur in appropriate habitat within the project area. The surveys will follow applicable guidelines established by USFWS and/or DFG, and will be conducted at the appropriate time of year when the target species would be clearly identifiable. If no special-status plants have the potential to occur in the project area or none are found during focused surveys, no further action is required. If special-status plants are found, areas of occupied habitat will be identified. The construction contractor will avoid these areas where feasible. Temporary fencing will be installed to protect all occupied habitat that is located adjacent to construction areas but can be avoided. • A qualified biologist will conduct a survey in areas where elderberry shrubs could occur within 100 feet of construction and inundation areas. Surveys and stem counts will follow the USFWS conservation guidelines for the valley elderberry longhorn beetle (USFWS 1999). If elderberry shrubs are found, the project proponent will implement avoidance measures that are consistent with the USFWS conservation guidelines for this species (USFWS 1999). Where feasible, effects will be avoided by establishing and maintaining a 100-foot-wide buffer around elderberry plants. Where a 100-foot buffer is not feasible, effects may be minimized by providing a minimum setback, with a buffer around elderberry plants measuring at least 20 feet wide.	LTS	

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	NTMAs	LTMAs		NTMAs	LTMAs
			• Protocol surveys of all potential nesting trees and habitat in the area will be completed during the raptor nesting season (generally February 15–September 15 but may be adjusted for individual species), particularly if any construction activity is to occur during that season. Potential nesting trees and other nesting habitats (e.g., grasslands for northern harriers and burrowing owls) that are within one-half mile of proposed activity will be surveyed. To avoid the loss of active raptor nests, if the project proponent elects to remove trees suitable for nesting, the trees will be removed during the non-nesting season (generally between September 15 and February 15), to the extent practicable. Where feasible and depending on the species (particularly for Swainson's hawk), construction activities within one-quarter mile of active nests will be avoided during the raptor nesting season. Other nesting raptors may tolerate a much smaller buffer (e.g., one-tenth mile). • Surveys for other special-status wildlife listed in Table 3.6-4 with potential to occur in the project area will be conducted by a qualified biologist at the appropriate time of year when the target species would be clearly identifiable. Not all wildlife species require surveys, because their presence may be assumed based on habitat components and known locality records or they clearly will not be present in the area. USFWS and DFG will be consulted to determine for which species surveys should be conducted; appropriate species protocols will be followed. Occupied and potentially suitable habitat will be avoided where feasible by installing temporary exclusionary fencing. • If potentially suitable aquatic habitat for giant garter snake is identified, a buffer area of 200 feet will be established around the aquatic habitat, where feasible. These buffers will be indicated by temporary fencing, high-visibility flagging, or other equally effective means. • If nesting areas for pond turtles are identified, a buffer area of 300 feet will be established between the nesting site and nearby wetlands, where feasible. (The nesting site may be adjacent to wetlands or extend up to 400 feet away from wetland areas in uplands.) These buffers will be indicated by temporary fencing if construction has begun or will be established before nesting periods are ended (the period from egg laying to emergence of hatchlings is normally April to November). • Preconstruction surveys for special-status bat species will be conducted to determine the presence of roosts. When colonial roosting sites located in trees or structures must be removed, removal will occur outside of the nursery and/or hibernation seasons. Unless otherwise approved by DFG, such removal will occur during dusk and/or evening hours after bats have left the roosting site. When hibernation sites are identified on the project site, nursery and hibernation sites will be sealed before the hibernation season (November–March). Additional measures, such as monitoring and on-site mitigation roosts, will be implemented, as feasible (see H.T. Harvey & Associates 2004). • Participation in and compliance with an existing approved HCP, NCCP, or similar plan applicable to an NTMA [or LTMA] may replace the specific survey and avoidance actions listed above if all of the following conditions are met: • The existing approved HCP, NCCP, or similar plan is applicable to the NTMA [or LTMA]. • The NTMA [or LTMA] is within the permit area. • The NTMA [or LTMA] is a covered activity under the existing plan. • The plan addresses methods to identify, avoid, minimize, and compensate for effects on special-status species. **Mitigation Measure BIO-T-3b (NTMA & LTMA):** *If Avoiding Construction-Related Effects on Special-Status Plants and Wildlife is Infeasible, Minimize and, Where Appropriate, Compensate for Effects on Special-Status Species and Loss of Habitat* If the focused surveys described above in Mitigation Measure BIO-T-3a have been completed and avoiding effects on special-status species is infeasible, the project proponent will coordinate with the appropriate regulatory agency (e.g., USFWS or DFG) to determine acceptable methods for minimizing or compensating for effects on a species. Various minimization and compensation measures are described below. The CVFPP Conservation Strategy Framework may be a suitable source of compensation habitat. The project proponent will ensure that the following measures are implemented to minimize and compensate for effects of proposed levee improvements on special-status plants and wildlife: • If special-status plants cannot be avoided, the project proponent will coordinate with USFWS and/or DFG (depending on which agency has jurisdiction over the particular species) to determine appropriate minimization and compensation measures. Some local plans and policies, if applicable to the project being implemented, may require that the project proponent completely avoid effects on a special-status plant species or pay a fee to mitigate impacts. Where feasible and applicable, the project proponent will consult and/or coordinate with local agencies on these plans and policies. In some instances, sensitive plants may be relocated to an area approved by DFG or USFWS.	

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	NTMAs	LTMAs		NTMAs	LTMAs
			• If ground-disturbing activities are to occur within 20 feet of the dripline of an elderberry shrub, minimization and compensation measures consistent with the USFWS conservation guidelines (USFWS 1999) will be implemented. These measures include transplanting elderberry shrubs and planting compensatory elderberry seedlings and associated native plantings. • If an active raptor nest is found, a biologist, in coordination with DFG, will determine an appropriate buffer that minimizes the potential for disturbing the nest. Setbacks will be marked by brightly colored temporary fencing. Based on the coordination with DFG, no construction activities will begin in the buffer area until a qualified biologist has confirmed that the nest is no longer active or that the birds are not dependent on it. A qualified biologist will monitor construction to ensure that project activities will not substantially adversely affect the nesting pair or their young. The size of the buffer may vary, depending on the nest location, nest stage, construction activity, and monitoring results. If establishing the buffer becomes infeasible or construction activities result in an unanticipated nest disturbance, DFG will be consulted to determine the appropriate course of action. • Minimization and compensation measures for other special-status wildlife species will be developed in consultation with DFG and/or USFWS. DFG and USFWS provide standardized minimization measures for several species; for example, the giant garter snake has specific minimization measures, such as restrictions on the construction season and a requirement for biological surveys and monitoring. Participation in and compliance with an existing approved HCP, NCCP, or similar plan applicable to an NTMA [or LTMA] may replace the specific minimization and compensation actions listed above if all of the following conditions are met: • The existing approved HCP, NCCP, or similar plan is applicable to the NTMA [or LTMA]. • The NTMA [or LTMA] is within the permit area. • The NTMA [or LTMA] is a covered activity under the existing plan. • The plan addresses methods to identify, avoid, minimize, and compensate for effects on special-status species. All construction-related activities will be subject to all applicable permitting requirements. The mitigation measures described above, when combined with applicable permit requirements, must, at a minimum, meet the following basic performance standard: • Authorized losses of habitat will not exceed the function and value of available compensation habitat. DWR will also track these habitat compensation efforts as part of the MMRP for this PEIR. These measures will be designed to ensure that construction activities will not result in a substantial reduction in the population size or range of any special-status plants or wildlife. **Mitigation Measure BIO-T-3c (NTMA & LTMA):** *Secure Applicable State and/or Federal Permits and Implement Permit Requirements* The project proponent will ensure that the following measures are implemented to reduce construction-related effects of proposed levee or other repairs, remediation, and improvements on trees and shrubs within stream zones, listed plant and wildlife species, and wetlands: • A streambed alteration agreement, as required under Section 1602 of the California Fish and Game Code, will be obtained from DFG before any vegetation is removed from a stream zone under DFG jurisdiction unless the activity is being implemented by USACE. The project proponent will comply with all terms and conditions of the streambed alteration agreement, including measures to protect habitat or to restore, replace, or rehabilitate any habitat. • The project proponent will consult or coordinate with USFWS under the federal ESA and DFG under the CESA regarding potential impacts on listed plant and wildlife species and associated critical habitat. The project proponent will implement any additional measures developed through the ESA and CESA consultation processes, including conditions of Section 7 biological opinions and Section 2081 permits. • Before ground-disturbing activities begin on a project reach that contains waters of the United States, authorization for fill of such waters will be secured from USACE through the Section 404 permitting process. This permitting process will include providing compensatory mitigation for affected wetlands to ensure no net loss of wetland functions and values. Participation in and compliance with an existing approved HCP, NCCP, or similar plan applicable to an NTMA [or LTMA] may be used to achieve the permit compliance measures listed above if all of the following conditions are met: • The existing approved HCP, NCCP, or similar plan is applicable to the NTMA [or LTMA]. • The NTMA [or LTMA] is within the permit area. • The NTMA [or LTMA] is a covered activity under the existing plan. • The plan provides for compliance with applicable State or federal regulations.		
Impact BIO-T-4 (NTMA & LTMA): *Construction-Related Effects on Wildlife Movement*	PS		**Mitigation Measure BIO-T-4 (NTMA & LTMA):** *Implement Mitigation Measures BIO-T-1a (NTMA), BIO-T-3a (NTMA), BIO-T-3b (NTMA), and BIO-T-3c (NTMA)*	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact BIO-T-5 (NTMA & LTMA): *Potential for Construction-Related Effects to Conflict with Local Plans and Policies*	PS		**Mitigation Measure BIO-T-5a (NTMA & LTMA):** *Implement Mitigation Measures BIO-T-1a (NTMA), BIO-T-3a (NTMA), BIO-T-3b (NTMA), and BIO-T-3c (NTMA)* **Mitigation Measure BIO-T-5b (NTMA & LTMA):** *Identify Local Plans and Policies and Develop Strategy to Maintain Plan Consistency, Minimize Effects, or Compensate for Construction-Related Effects on Local Plans* Before an NTMA [or LTMA] is implemented, the project proponent will identify applicable local conservation plans in the area and evaluate the plans to determine whether the NTMA [or LTMA] is within the plan area. As feasible, the project proponent will consider developing a strategy to maintain plan consistency and will consult and/or coordinate with the appropriate entity or plan administrator to develop and implement measures to avoid, minimize, and where necessary, compensate for effects on local plans. In some instances, the NTMA [or LTMA] may be a covered activity under the plan.	LTS	
Impact BIO-T-6 (NTMA & LTMA): *Effects of Reservoir Operational Criteria Changes on Sensitive Natural Communities and Habitats, Special-Status Plants and Wildlife, Wildlife Movement, and Local Plans and Policies*	LTS		N/A	LTS	
Impact BIO-T-7 (NTMA & LTMA): *Effects of the Vegetation Management Strategy on Sensitive Natural Communities and Habitats, Special-Status Plants and Wildlife, and Wildlife Movement*	PS		**Mitigation Measure BIO-T-7a (NTMA & LTMA):** *Implement Applicable Elements of Mitigation Measures BIO-T-1a (NTMA), BIO-T-3a (NTMA), BIO-T-3b (NTMA), and BIO-T-3c (NTMA) to Minimize Impacts during Vegetation Removal* **Mitigation Measure BIO-T-7b (NTMA & LTMA):** *Implement Mitigation Measure BIO-A-2b (NTMA), "Ensure Full Compensation for Losses of Riparian Habitat Functions and Values Caused by Implementing the Vegetation Management Strategy Along Levees"*	PSU	
Impact BIO-T-8 (NTMA & LTMA): *Effects of Other Management Activities on Sensitive Natural Communities and Habitats, Special-Status Plants and Wildlife, Wildlife Movement, and Local Plans and Policies*	B		N/A	B	
3.7 Climate Change and Greenhouse Gas Emissions					
Impact CLM-1 (NTMA & LTMA): *Net Construction-Related and Operational Greenhouse Gas Emissions*	LTS		**Mitigation Measure CLM-1a (NTMA & LTMA):** *Implement Greenhouse Gas–Reducing Construction BMPs* DWR has developed preconstruction, construction, and final design BMPs for reduction of GHG emissions. These preconstruction and final design and construction BMPs are designed to ensure that individual projects are evaluated and their unique characteristics taken into consideration when determining if specific equipment, procedures, and or material requirements are feasible and efficacious for reducing GHG emissions from the project. As applicable and appropriate, the following BMPs would be applied: • *BMP 1*. Evaluate project characteristics, including location, project work flow, site locations, and equipment performance requirements, to determine whether specifications of the use of equipment with repowered engines, electric drive trains, or other high-efficiency technologies are appropriate and feasible for the project or specific elements of the project. • *BMP 2.* Evaluate the feasibility and efficacy of performing on-site material hauling with trucks equipped with on-road engines. • *BMP 3.* Ensure that all feasible avenues have been explored for providing an electrical server drop to the construction site for temporary construction power. When generators must be used, use alternative fuels, such as propane or solar, to power generators to the maximum extent feasible. • *BMP 4.* Evaluate the feasibility and efficacy of producing concrete on-site and specify that batch plants be set up on-site or as close to the site as possible. • *BMP 5.* Evaluate the performance requirements for concrete used on the project, and specify concrete mix designs that minimize GHG emissions from cement production and curing while preserving all required performance characteristics. • *BMP 6.* Minimize idling time by requiring that equipment be shut off after 5 minutes when not in use (as required by the State airborne toxics control measure, Title 13, Section 2485 of the California Code of Regulations). Provide clear signage that posts this requirement for workers at the entrances to the site and provide a plan for the enforcement of this requirement. • *BMP 7.* Maintain all construction equipment in proper working condition and perform all preventative maintenance. Required maintenance includes compliance with all manufacturer's recommendations, proper upkeep and replacement of filters and mufflers, and maintenance of all engine and emissions systems in proper operating condition. Maintenance schedules shall be detailed in an air quality control plan prior to commencement of construction.	LTS	N/A/TS

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	NTMAs	LTMAs		NTMAs	LTMAs
			• *BMP 8.* Implement a tire inflation program on jobsite to ensure that equipment tires are correctly inflated. Check tire inflation when equipment arrives on-site and every 2 weeks for equipment that remains on-site. Check vehicles used for hauling materials off-site weekly for correct tire inflation. Procedures for the tire inflation program shall be documented in an air quality management plan prior to commencement of construction. • *BMP 9.* Develop a project-specific rideshare program to encourage carpools, shuttle vans, transit passes, and/or secure bicycle parking for construction worker commutes. • *BMP 10.* Reduce electricity use in temporary construction offices by using high-efficiency lighting and requiring that heating and cooling units be Energy Star compliant. Require that all contractors develop and implement procedures for turning off computers, lights, air conditioners, heaters, and other equipment each day at close of business. • *BMP 11.* For deliveries to project sites where the haul distance exceeds 100 miles and a heavy-duty class 7 or class 8 semi-truck or 53-foot or longer box-type trailer is used for hauling, a SmartWay certified truck will be used to the maximum extent feasible. • *BMP 12.* Minimize the amount of cement in concrete by specifying higher levels of cementitious material alternatives, larger aggregate, longer final set times, or lower maximum strength where appropriate and while preserving all required performance characteristics. • *BMP 13.* Develop a project-specific construction debris recycling and diversion program to achieve a documented 50 percent diversion of construction waste. Mitigation Measure CLM-1b (NTMA & LTMA): *Implement Greenhouse Gas–Reducing Operational Practices* Incremental operational GHG emissions would likely be reduced in the near term relative to existing conditions through the replacement of older equipment, buildings, and vehicles. Even so, although Impact CLM-1 (NTMA [or LTMA]) would be less than significant, the project proponent will implement the measures listed below—where needed, feasible, and appropriate—to minimize operational GHG emissions for replacement and new CVFPP facilities associated with NTMAs [or LTMAs]. Not all mitigation measures listed below may be applicable to each management action. Rather, these mitigation measures serve as an overlying mitigation framework to be utilized for specific management actions. The applicability of mitigation measures would vary based on the lead agency, location, timing, and nature of each management action. • Implement all current standards and/or requirements as part of any DWR sustainability plan or guidelines. • Use renewable energy generated on site (i.e., solar, wind, hydroelectric). • Use alternative fuels for maintenance vehicles and equipment. • Use energy-efficient equipment for operation and maintenance of proposed facilities (e.g., pumps, hydraulic equipment, maintenance equipment). Equipment and operation of equipment will conform to U.S. Department of Energy best practices, Consortium for Energy Efficiency initiatives and guidance, and National Electrical Manufacturers Association standards where possible. • Require proposed buildings to exceed California Building Standards Code Title 24 energy efficiency standards by 20 percent or more.		
3.8 Cultural and Historic Resources					
Impact CUL-1 (NTMA & LTMA): *Potential Damage to or Destruction of Known Archaeological Resources from Ground Disturbance or Other Construction-Related Activities*	PS		Mitigation Measure CUL-1a (NTMA & LTMA): *Conduct Cultural Resource Studies and Avoid Effects on Known Archaeological Resources* To minimize potential adverse effects on prehistoric and historic-era archaeological resources, the project proponent will conduct cultural resource studies before project approval (where feasible and appropriate) to identify the presence of such resources at all project sites. Where field surveys cannot be completed before project approval, such as in locations where access permission has not been received, field surveys will be completed before ground disturbance begins. These archaeological studies and surveys will be conducted by professionals who meet the Secretary of the Interior's standards for archaeology professionals. Should resources eligible for listing in the NRHP and CRHR be identified within the study area, effects on those resources resulting from any NTMA [or LTMA] will be avoided, if feasible. Methods of avoidance may include redesigning or relocating the project, such as moving an access road around an archaeological site instead of through it. Where avoidance is not feasible, see Mitigation Measure CUL-1b (NTMA [& LTMA]) below.	LTS	

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	NTMAs	LTMAs		NTMAs	LTMAs
			Mitigation Measure CUL-1b (NTMA & LTMA): *Conduct Additional Evaluations and Recover Sufficient Data to Compensate for Damage to or Destruction of Known Archaeological Sites* If a substantial adverse change to an archaeological resource that has been determined as eligible for listing in the NRHP or the CRHR cannot be avoided, the project proponent will deploy a qualified archaeologist to conduct additional research and other tasks. These tasks will include preparing a research design; conducting additional archival and historical research, when appropriate; conducting an archaeological excavation; analyzing artifacts, features, and other attributes of the resource; and preparing a technical report documenting the methods and results of the investigation in accordance with the California Office of Historic Preservation's Guidelines for Archaeological Research Design (1991). The purpose of this work will be to recover a sufficient quantity of data to compensate for damage to or destruction of the resource. The procedures to be employed in this data recovery program will be determined in consultation with responsible agencies and interested parties, such as Native American tribes, as identified by the Native American Heritage Commission, as appropriate. The approved measures must be implemented before construction activities occur at the archaeological site. An alternative method to mitigate impacts on archaeological sites considered eligible for listing in the NRHP and CRHR is to have the primary construction contractor for the project proponent cap the site with soil, gravels, rock, or appropriate vegetation to protect the deposit. For example, sites subject to inundation and water-level fluctuations may be protected from erosion by application of a layer of gravel/rock or soil, or both. A layer of soil (i.e., sterile fill) may also be placed over a site where construction of a building is planned, such that all construction activities will occur in the fill material. For sites located in areas subject to looting, vegetation such as blackberry brambles or wild rose may be planted over the site as a useful deterrent, but only in areas where operations and maintenance of facilities would not be impaired by the deterrent vegetation. If capping an archaeological site proves necessary, the project proponent will provide the materials and labor, regularly monitor and evaluate the efficacy of the mitigation, and refresh the protection, when necessary.		
Impact CUL-2 (NTMA & LTMA): *Potential Damage to or Destruction of Previously Undiscovered Buried Archaeological Resources from Ground Disturbance or Other Construction-Related Activities*	PS		**Mitigation Measure CUL-2 (NTMA & LTMA):** *If Cultural Resources Are Discovered, Immediately Halt Construction and Implement an Accidental-Discovery Plan* Should cultural resources such as structural features, unusual amounts of bone or shell, artifacts, human remains, or architectural remains be encountered during construction activities, work will be suspended immediately at the location of the find and within a 50-foot radius. A qualified archaeologist will conduct a field investigation of the specific site and recommend mitigation necessary to protect or recover any cultural resource determined by the archaeologist to represent a historical resource or unique archaeological resource. Based on the archaeologist's recommendations, the project proponent will develop measures in consultation with responsible agencies and, as appropriate, interested parties such as Native American tribes. The approved mitigation must be implemented before construction activities resume at the archaeological site, as identified by the Native American Heritage Commission. All of the steps identified above will be detailed in an accidental-discovery plan developed before construction so that all parties are aware of the process that must be implemented should buried archaeological resources be uncovered during construction. Construction monitoring by a qualified archaeologist in areas determined particularly sensitive for buried archaeological remains will be implemented by project proponents when warranted, as recommended by the archaeological professional. Reasons for providing an archaeological monitor may include but are not limited to the previous identification of buried cultural deposits in the project vicinity or the previous recordation of an archaeological site that could not be recently identified on the ground surface. Furthermore, some landforms, such as mounded areas in floodplains adjacent to water courses, are more likely to be sensitive for buried resources. Large-scale projects involving a great deal of ground disturbance (e.g., lengthy levee construction) could benefit from geoarchaeological studies to determine those areas most likely to contain buried cultural deposits. Discoveries of human remains will be treated as described in Mitigation Measure CUL-5c (NTMA [& LTMA]), below.		LTS
Impact CUL-3 (NTMA & LTMA): *Potential Damage or Disturbance to or Change in Significance of Built-Environment Resources*	PS		**Mitigation Measure CUL-3a (NTMA & LTMA):** *Conduct Cultural Resources Studies and Avoid Effects on Built-Environment Resources* In areas potentially containing historic resources, the project proponent will ensure that architectural history studies and surveys will be conducted by professionals who meet the Secretary of the Interior's professional standards, to identify the presence of built-environment resources within a particular project location. Should buildings or structures that are eligible for listing in the NRHP or CRHR be identified within the study area, impacts on those resources resulting from any NTMA [or LTMA] will be avoided, if feasible. Project relocation and redesign are appropriate avoidance measures. For example, should constructing a new levee require removal of a historic farmhouse, realigning the levee away from the structure would avoid a significant adverse change to the structure. If avoidance is not feasible, see Mitigation Measure CUL-3b (NTMA [& LTMA]) below.		LTS

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			Mitigation Measure CUL-3b (NTMA & LTMA): *Follow the Secretary of the Interior's Standards for the Treatment of Historic Properties* In some cases, completely avoiding an element of the built environment that qualifies as a historical resource or historic property may not be feasible, and the feature must be altered as part of project implementation. In such a scenario, any program-related alterations to historic-era buildings or structures, including relocations, will conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties and Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings (1995). The project proponent will develop and implement any plans necessary to mitigate alterations to historic properties in accordance with these standards. The plans will be submitted to the SHPO for approval before project implementation. If these standards cannot be met, see Mitigation Measure CUL-3c (NTMA) below.		
	PS		**Mitigation Measure CUL-3c (NTMA & NTMA):** *Record Built-Environment Resources to Historic American Buildings Survey and Historic American Engineering Record Standards* In some cases, avoiding or relocating a building or structure considered eligible for the NRHP or CRHR may not be feasible, and that resource must be demolished. These situations are expected to be rare occurrences. However, in such a scenario, the project proponent will retain a qualified architectural historian to document the affected historical built-environment resource according to Historic American Buildings Survey (HABS) or Historic American Engineering Record (HAER) standards, as appropriate. HABS and HAER documentation packages will be entered into the Library of Congress, as well as the appropriate Information Center of the California Historical Resources Information System.	PSU	
Impact CUL-4 (NTMA & LTMA): *Potential Damage or Disturbance to Traditional Cultural Properties during Ground Disturbance or Other Construction-Related Activities*	PS		**Mitigation Measure CUL-4a (NTMA & LTMA):** *Conduct Cultural Resources Studies and Avoid Effects on TCPs* In areas potentially containing traditional cultural properties, an ethnographer or archaeologist who meets the Secretary of the Interior's standards as a professional cultural resource specialist will consult with appropriate populations (Native Americans or otherwise) before approval of any project and identify the presence of any TCPs at the project location. Native American TCPs may be identified by an ethnographer who has worked intensively with community members (often, but not always, elders) possessed of considerable knowledge about places important to the community. Should TCPs be identified in the project area, they will be avoided by project redesign or relocation, if feasible. As an example, the proposed location of a water-monitoring device may be moved to another, still appropriate, place along a stream bed to avoid a section of the creek bank that is a TCP for medicinal plants, thereby avoiding a substantial adverse change to the resource. If avoidance is not feasible, see Mitigation Measure CUL-4b (NTMA [& LTMA]) below.	LTS	
			Mitigation Measure CUL-4b (NTMA & LTMA): *Consult with Native American Communities and Implement Appropriate Measures to Mitigate Effects on TCPs* Effects to TCPs are expected to be rare occurrences. However, where an identified TCP cannot be fully avoided by a proposed project, the project proponent will engage in early, meaningful consultation with Native American communities, as identified by the Native American Heritage Commission, to identify ways to mitigate impacts on TCPs. For example, if TCP locations that presently support plant species cultivated and harvested by Native American communities for traditional medicines and foods, or for uses such as basketry, are slated for destruction to make way for planned construction, the project proponent may work with the Native American community associated with the TCP to identify other nearby locations that can support these same plants. The project proponent can then take steps to enhance existing plant populations at those locations or provide materials and labor to cultivate new plants, with assistance from the Native American community. Working with local Native American communities to develop interpretive programs is another measure to mitigate impacts on TCPs. Programs may include developing signage, constructing visitor centers describing locations that have sacred or other special meaning to Native Americans, developing and implementing management plans for important cultural resources, or establishing conservation easements to protect culturally important places.	PSU	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact CUL-5 (NTMA & LTMA): *Potential Damage or Disturbance to Human Remains, Including Those Interred Outside of Formal Cemeteries, during Ground Disturbance or Other Construction-Related Activities*	PS		**Mitigation Measure CUL-5a (NTMA & LTMA):** *Conduct Cultural Resources Studies and Avoid Effects on Human Remains* The project proponent will ensure that archaeological and historical studies and surveys will be conducted by professionals who meet the Secretary of the Interior's standards, to identify the presence of human remains within a particular project location. Should human remains be identified within the study area, impacts on those remains resulting from any NTMA [or LTMA] will be avoided, if feasible. Project relocation and redesign are appropriate avoidance measures. For example, should construction of a new maintenance facility be proposed at a place known to contain human remains, relocation of the facility would avoid disturbing the burials. However, if avoidance is not feasible, see Mitigation Measures CUL-5b (NTMA [& LTMA]) and/or CUL-5c (NTMA [& LTMA]) below, as applicable. **Mitigation Measure CUL-5b (NTMA & LTMA):** *Relocate Known Cemeteries* The project proponent will consult with the entity (county, city, or private) that has jurisdiction over the cemetery, and with interested parties as appropriate, to identify a satisfactory place to relocate human remains that would provide protection from future disturbance. Similarly, if Native American burials are known to exist in an archaeological site, the project proponent will work with the appropriate tribe, as identified by the Native American Heritage Commission, to identify a satisfactory location for reinterment of burials in a protected location. **Mitigation Measure CUL-5c (NTMA & LTMA):** *Immediately Halt Construction If Human Remains Are Discovered and Implement a Burial Treatment Plan* Construction activities have the potential to result in unanticipated effects on buried human remains where there is no surface indication of their presence. Under these circumstances, the project proponent will adhere to the requirements described in Section 7050.5 of the California Health and Safety Code and PRC Section 5097.98: • If human remains are uncovered during ground-disturbing activities, potentially damaging excavation must halt in the area of the remains and the local county coroner must be notified. The coroner is required to examine all discoveries of human remains within 48 hours of receiving notice of a discovery on private or state lands (Health and Safety Code, Section 7050.5(b)). • If the coroner determines that the remains are those of a Native American, he or she must contact the NAHC by phone within 24 hours of making that determination (Health and Safety Code, Section 7050(c)). • In turn, under the provisions of PRC Section 5097.98, NAHC will identify a Most Likely Descendant (MLD). The MLD designated by the NAHC will have at least 48 hours to inspect the site and propose treatment and disposition of the remains and any associated grave goods. For large projects (e.g., new levee construction) or projects where a high probability of encountering human remains exists, a burial treatment plan will be developed by the project proponent in consultation with local Native American tribes before construction. During this process, all parties will be made aware of the actions required should buried Native American human remains be uncovered during construction. The plan will detail all of the activities identified above and include treatment preferences identified by the MLD. Smaller, localized projects do not require a burial treatment plan. Examples of such projects are modifications of existing facilities and projects that do not involve ground disturbance (e.g., purchases of easements, structure modifications). However, should human remains be uncovered during these project activities, treatment of the remains will strictly follow the requirements in Section 7050.5 of the California Health and Safety Code and PRC Section 5097.98.	LTS	
3.9 Energy					
Impact ENRG-1 (NTMA & LTMA): *Inefficient, Wasteful, or Unnecessary Consumption of Energy during Construction-Related Activities*	LTS		N/A	LTS	
Impact ENRG-2 (NTMA & LTMA): *Inefficient, Wasteful, or Unnecessary Consumption of Energy during Operational and Maintenance-Related Activities*	LTS		N/A	LTS	
Impact ENRG-3 (NTMA & LTMA): *Reduced Generation of Renewable Energy as a Result of Altered Flow Releases at Hydropower Facilities Caused by Changes in Reservoir Operations*	LTS		N/A	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
3.10 Geology, Soils, and Seismicity (Including Mineral and Paleontological Resources)					
Impact GEO-1 (NTMA & LTMA): *Exposure of People or Structures to Risks Related to Fault Rupture, Ground Shaking, Liquefaction, or Landslides*	B		N/A	B	
Impact GEO-2 (NTMA & LTMA): *Potential Localized Soil Erosion and Inadvertent Permanent Soil Loss as a Result of Construction or Operation and Maintenance Activities*	LTS		N/A	LTS	
Impact GEO-3 (NTMA & LTMA): *Potential risks of Damage to Infrastructure Associated with Expansive Soils*	LTS		N/A	LTS	
Impact GEO-4 (NTMA & LTMA): *Potential Use of Septic Tanks or Alternative Wastewater Disposal Systems in Areas with Unfavorable Soils*	NI		N/A	LTS	
Impact GEO-5 (NTMA & LTMA): *Potential Loss of Availability of a Known Mineral Resource of Value*	LTS		Mitigation Measure GEO-5 (LTMA): *Minimize Loss of Mineral Resources through Siting and Design* When designing bypasses or setback levees or purchasing easements, the project proponent will consider a range of locations and configurations to minimize the potential to eliminate access to locally valuable mineral resources.	LTS	PSU
Impact GEO-6 (NTMA & LTMA): *Possible Damage to or Destruction of Unique Paleontological Resources*	PS		Mitigation Measure GEO-6 (NTMA & LTMA): *Prepare a Paleontological Resources Assessment and, If Necessary, Conduct Construction Worker Personnel Education, Stop Work If Paleontological Resources Are Encountered during Earthmoving Activities, and Implement Recovery Plan* If an NTMA [or LTMA] involves excavation in native soil (e.g., not imported fill) that has the potential to contain fossils (e.g., greater than 11,000 years old), an assessment of the paleontological sensitivity of rock formations in the excavation area will be conducted. The project proponent will retain the services of a paleontologist to perform an evaluation that includes all of the following: • A determination of the specific rock formations present at the project site • A records search of the applicable paleontological resources database to identify past fossil finds in the area • A field visit (if necessary as determined by the paleontologist) • A determination as to the paleontological sensitivity of the rock formations in areas proposed for excavation using SVP (1995) guidelines Studies conducted for past projects in the same area that meet these criteria may be used to fulfill this requirement. No further mitigation will be required for excavation activities in rock formations that are determined to be of low paleontological sensitivity. Before earthmoving activities begin for any project phase in rock units that have moderate to high paleontological sensitivity, the project proponent will retain a qualified paleontologist or archaeologist to train all construction personnel involved in earthmoving activities, including the site superintendent, regarding the following: • The possibility of encountering fossils • The appearance and types of fossils likely to be seen during construction • The proper notification procedures to follow if fossils are encountered In addition, as determined by the paleontologist in consultation with the project proponent, full-time monitoring during earthmoving activities may be required in areas of high paleontological sensitivity. If a paleontological resource potentially qualifying as unique or significant (as defined above in "Thresholds of Significance") is discovered during earthmoving activities, the construction crew will immediately cease work in the vicinity of the find and notify the project proponent. The project proponent will retain a qualified paleontologist to evaluate the resource, and if it is confirmed to qualify as a unique or significant resource, a qualified paleontologist will prepare a recovery plan in accordance with SVP guidelines (1995). The recovery plan may include but will not be limited to further field surveys in the vicinity of the find, sampling and data recovery procedures, museum storage coordination for any specimen recovered, further monitoring of earthmoving activities, and a report of findings. The project proponent will ensure implementation of the recovery plan. Construction activities can resume at locations where unique or significant paleontological resource are discovered after the resource has been recovered and moved from the work site.	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
3.11 Groundwater Resources					
Impact GRW-1 (NTMA & LTMA): *Potential Localized Degradation of Groundwater Quality Related to Construction, Operation, and Maintenance Activities*	LTS		N/A	LTS	
Impact GRW-2 (NTMA & LTMA): *Degradation of Groundwater Quality Resulting from Decreased Natural Recharge or Increased Pumping due to Reduced Water Supplies from Changes to Reservoir Operational Criteria*	LTS		N/A	LTS	
Impact GRW-3 (NTMA & LTMA): *Depletion of Groundwater Levels Resulting from Decreased Natural Recharge or Increased Pumping due to Reduced Water Supplies from Changes to Reservoir Operational Criteria*	LTS		N/A	LTS	
Impact GRW-4 (NTMA & LTMA): *Modification of Groundwater Flows Resulting in Decreased Natural Recharge to Regional or Local Groundwater Supplies or Reduced or Delayed Local Drainage*	LTS		N/A	LTS	
Impact GRW-5 (LTMA): *Degradation of Water Quality or Adverse Rise in Groundwater Elevation as a Result of Groundwater Banking*	N/A	PS	**Mitigation Measure GRW-5a (LTMA):** *Develop and Implement Groundwater Management Plans or Expand Existing Groundwater Management Plans, Including Defining Basin Management Objectives, Groundwater Monitoring Plans, and Conditions under Which Corrective Actions Are Taken* Formalized groundwater management plans will be developed or expanded by the project proponent to guide management of groundwater basins where managed groundwater recharge and/or groundwater banking projects are to occur. These plans will include quantifiable basin-management objectives and groundwater monitoring plans to allow for management of the basin in a manner that minimizes adverse effects on groundwater. The plans will identify conditions to be evaluated using groundwater monitoring data and will describe corrective actions that may be taken, such as modifications to groundwater banking operations. **Mitigation Measure GRW-5b (LTMA):** *Conduct Phase I Environmental Site Assessments* Phase I Environmental Site Assessments will be conducted by the project proponent at all sites before groundwater banking activities begin to prevent the degradation of water quality associated with recharging water in a potentially contaminated aquifer or exposing rising groundwater to contaminated soils.	N/A	LTS
3.12 Hazards and Hazardous Materials					
Impact HHM-1 (NTMA & LTMA): *Hazards from Routine Transport, Use, or Disposal and Reasonably Foreseeable Accidental Release of Hazardous Materials*	LTS		N/A	LTS	
Impact HHM-2 (NTMA & LTMA): *Accidental Release and Use of Hazardous Materials within One-Quarter Mile of an Existing or Proposed School*	PS		**Mitigation Measure HHM-2 (NTMA & LTMA):** *Conduct a Site-Specific Analysis to Determine the Proximity of School Sites, Notify and Consult with Affected Schools, and Implement Storm Water Pollution Prevention Plan and Best Management Practices as Required* The project proponent will determine whether the site of any existing or proposed school is located within one-quarter mile of each site-specific NTMA or LTMA that would require construction activities. If no school sites are located within this distance, no further mitigation is required. If existing or proposed schools are located within one-quarter mile, the project proponent will notify each affected school (or the school district in which the school is located) in writing, and will consult with appropriate school or district personnel about the types of activities that would occur and their estimated timing. The project proponent will provide examples of the types of hazardous materials that could be used during proposed activities. The written notification will be provided at least 30 days before the commencement of any construction activities within one-quarter mile of the school or at least 30 days before any future project-specific CEQA document is certified or adopted, whichever is earlier. The project proponent will also be required by law to design and implement spill prevention and cleanup measures (i.e., best management practices (BMPs)) as part of the storm water pollution prevention plan (SWPPP) prepared for each site-specific NTMA or LTMA (see Section 3.13, "Hydrology," for a discussion of relevant BMPs and the SWPPP process), which would help to reduce the potential for adverse impacts during project construction.	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact HHM-3 (NTMA & LTMA): *Exposure of People and the Environment to Existing Hazardous Materials, Including Sites on the Cortese List*	PS		**Mitigation Measure HHM-3a (NTMA & LTMA):** *Search for Contaminated Sites Potentially Affected by Site-Specific Projects and Avoid Contact with or Clean Up Contaminated Areas* Before construction begins on any site-specific project that involves earth-moving activities, a Phase I Environmental Site Assessment (ESA) will be completed. An existing Phase I ESA can be used to complete this requirement if it covers the project area and has been completed within 5 years of initiation of the project's environmental analysis, and land uses on the project site have not changed since completion of the Phase I ESA that would alter the potential for contamination to be present. The Phase I ESA will include a database search to determine whether site-specific work would take place within the boundary of any facilities included on the Cortese List or other recorded contaminated or potentially contaminated sites. If so, the project proponent will do one of the following: 1. Coordinate with the appropriate federal, State, or local agency to determine whether the contamination issue has been resolved by the responsible party. OR 2. Determine whether a qualified hazardous materials specialist has found, through soil and groundwater testing, that previously documented contamination would be sufficiently distant from project construction areas to ensure that the site's known hazardous materials would not be encountered or threaten the safety of construction workers, the public, or the environment. However, if evidence of existing contamination is found on the site, the nature of this contamination will be evaluated in the Phase I ESA and appropriate action will be recommended. Such action may involve further study through completion of a Phase II ESA. If the contamination is sufficient to exceed applicable regulatory thresholds, then the project proponent will ensure cleanup of the site, consistent with regulatory requirement. Cleanup of contaminated sites will be completed before construction is initiated in the contaminated location. In the case of projects that could put the contaminated site in contact with surface waters, cleanup will be completed before levees or other features are modified in a manner that would allow surface waters to reach the contaminated site. **Mitigation Measure HHM-3b (NTMA & LTMA):** *Locate Oil and Gas Wells and Transmission Lines Potentially Affected by Site-Specific Projects, and Coordinate with Owner/Operators to Avoid Disturbance* Before construction begins on any site-specific project, the project proponent will search appropriate State and local databases to determine whether any oil or natural gas wells or transmission pipelines are located within the specific project site. If any wells or pipelines are found, the project proponent will notify and coordinate with the owner/operators of the wells and pipelines to ensure that such facilities are properly flagged in the field and avoided during construction. **Mitigation Measure HHM-3c (NTMA & LTMA):** *Train Construction Workers on Hazardous Materials, Stop Work Near Contaminated Soils, and Determine and Implement an Avoidance or Cleanup Strategy* Before construction begins on any site-specific project, the project proponent will train construction workers on the potential to encounter hazardous materials and proper notification procedures. Such training will specify that work in the vicinity must cease and a qualified hazardous materials specialist must be consulted if stained or odorous soils; underground storage tanks; or abandoned or closed wells, mines, or septic systems are encountered. The project proponent will also notify the appropriate federal, State, and/or local agencies. A variety of steps may be taken at the discretion of the project proponent. Among those steps are the following: • Avoid the area containing the stained/odorous soils or infrastructure. • Perform a Phase I ESA to determine the nature, extent, and level of hazard to the public and construction workers if construction needs to occur in the exact location of the soils or infrastructure. • Clean up the area or coordinate with the owner of the affected parcel to perform cleanup activities. Should the project proponent elect to clean up activities on its own, all hazardous substances encountered will be removed and properly disposed of by a licensed contractor in accordance with federal and State regulations.	LTS	

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	NTMAs	LTMAs		NTMAs	LTMAs
Impact HHM-4 (NTMA & LTMA): *Creation of Safety Hazards, Including Bird Strike, in the Vicinity of a Public or Private Airstrip*	PS		Mitigation Measure HHM-4 (NTMA & LTMA): *Prepare Site-Specific Impact Assessments and, If Necessary, Coordinate with Affected Airport(s) to Prepare and Implement Wildlife Hazard Management Plan(s)* Future CEQA documents related to the proposed program will include analyses of bird strike hazards in those situations where NTMAs or LTMAs would increase the amount of bird habitat or the amount of inundated floodplain within the following distances: • 5,000 feet from airports serving piston-powered aircraft • 10,000 feet from airports serving turbine-powered aircraft • 5 statute miles from airports where the wildlife attractant may cause hazardous wildlife movement into or across the approach or departure airspace Each analysis will consider the size of the airport, the species of birds likely to be present near the proposed improvements, the proximity to any known migratory bird corridors (e.g., the Pacific Flyway), and the number of previously documented bird-strike incidents at the airport (if any). The analysis will determine whether the project-related increase in bird habitat would be substantial compared to existing bird habitat that is already present in the airport vicinity. If the results of the site-specific analysis determine that the impact would be significant, the project proponent will consult and coordinate with the affected airport operator to determine whether a wildlife hazard management plan is required. If required, the project proponent will coordinate with the affected airport to prepare and implement such a plan pursuant to 14 CFR Part 139. The wildlife hazard management plan will identify the hazardous wildlife attractants on or near the airport, the appropriate damage management techniques to minimize the wildlife hazard, and prioritize the management measures. The plan will be prepared in consultation with a wildlife biologist. Bird control techniques may include but are not limited to maintaining grass at a height of less than 8 inches, preventing growth of large emergent plants (e.g., cattails), installing barriers between water features and nearby vegetated areas, installing signs prohibiting feeding of birds, removing nesting materials, and hazing birds to discourage them from using water features.	LTS	
Impact HHM-5 (NTMA & LTMA): *Exposure to Substantial Hazard from Wildland Fires*	LTS		N/A	LTS	
Impact HHM-6 (NTMA & LTMA): *Increased Human Health Hazards Associated with Vector-Borne Diseases*	PS		Mitigation Measure HHM-6 (NTMA & LTMA): *Implement Workplace Precautions against Vector-Borne Diseases and Coordinate with and Support Local Vector Control District Programs* The project proponent will implement the following workplace precautions against vector-borne diseases at the construction sites of future site-specific projects: • Conduct construction worker personnel training that covers the potential hazards and risks associated with exposure to and protection from vector-borne diseases such as West Nile virus. Instruct personnel in the use of proper construction apparel and warn them against handling any dead animals (particularly birds) with bare hands. • Inspect work areas and eliminate sources of standing water that could provide breeding habitat for mosquitoes. For example, eliminate uncovered, upright containers that could accumulate water, and fill or drain potholes or other areas where water is likely to accumulate. • Provide insect repellent for worker use at construction sites. As recommended by the Centers for Disease Control and Prevention (CDC), the insect repellent should contain active ingredients that have been registered with EPA for use as insect repellents on skin or clothing such as diethyl(meta)toluamide (DEET) or picaridin (KBR 3023) (CDC 2010). • Notify the appropriate city or county health department about dead birds found at any project site. In addition, the project proponent will coordinate with and support local vector control districts in implementing their vector control activities at the time of future site-specific projects, as appropriate and feasible. Support will include but will not be limited to the following actions: • Inform the appropriate vector control district about implementation of site-specific projects. Provide information requested to support vector control activities along waterways affected by those site-specific projects in a manner that could increase exposure to vector-borne diseases. • Implement applicable BMPs from the DPH publication entitled *Best Management Practices for Mosquito Control on California State Properties* (DPH 2008).	LTS	

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	NTMAs	LTMAs		NTMAs	LTMAs
3.13 Hydrology					
Impact HYD-1 (NTMA & LTMA): *Increased Erosion and Siltation from Modifying the Flood Conveyance System*	LTS		Mitigation Measure HYD-1 (LTMA): *Identify and Implement Measures to Minimize Downstream Erosion and Siltation* Before a project is approved and implemented, the project proponent will perform an analysis of the new facilities to determine whether the facility will experience or cause elsewhere an erosion or siltation problem. To the extent possible, the facility will be designed to avoid or minimize these effects. Where avoidance is not feasible, the project proponent will address any erosion or siltation impacts through bank protection measures on- or off-site depending on where the increase erosion or siltation may occur. Measures could include moving levee foundations landward away from the eroding bank, maintaining waterside vegetation, dredging to remove siltation, or installing rock revetments, riprap, or other engineered structures along the eroding banks to reduce further erosion and protect the foundation of the levee. These measures will be implemented or funded by the project proponent.	LTS	
Impact HYD-2 (NTMA & LTMA): *Increased Flooding from Modifying the Flood Conveyance System*	LTS		N/A	LTS	
Impact HYD-3 (NTMA & LTMA): *Placement of Housing within a 100-Year Flood Hazard Area*	B		N/A	LTS	
Impact HYD-4 (NTMA & LTMA): *Modification of the Flood Conveyance System in a Way that Would Redirect Flood Flows and Increase Flood Risk or Exposure of People or Structures to a Risk of Loss, Injury, or Death Involving Flooding*	LTS		N/A	LTS	
Impact HYD-5 (NTMA & LTMA): *Increased Risk of Inundation by Seiche*	LTS		N/A	LTS	
Impact HYD-6 (NTMA & LTMA): *Reduced Long-Term Water Supplies from Reservoir Operational Criteria Changes*	LTS		N/A	LTS	
3.14 Land Use and Planning					
Impact LU-1 (NTMA & LTMA): *Physical Division of an Established Community as a Result of Conveyance-Related Management Activities*	LTS		N/A	LTS	
Impact LU-2 (NTMA & LTMA): *Physical Division of an Established Community as a Result of Storage-Related Management Activities*	NI		N/A	NI	
Impact LU-3 (NTMA & LTMA): *Physical Division of an Established Community as a Result of Policies Associated with the Required Level of Flood Protection*	LTS		N/A	LTS	
Impact LU-4 (NTMA & LTMA): *Physical Division of an Established Community as a Result of Other NTMAs [& LTMAs]*	LTS		N/A	LTS	
Impact LU-5 (NTMA & LTMA): *Alterations of Land Uses or Patterns of Land Use as a Result of Conveyance-Related Management Activities that Could Cause a Substantial Adverse Physical Environmental Effect*	S		Mitigation Measure LU-5a (NTMA &LTMA): *Provide Financial Compensation for Property Loss and Relocation Assistance to Compensate for the Removal and Displacement of Residential Land Uses* The project proponent will provide financial compensation for property loss and relocation expenses to any person displaced because of the acquisition of real property, as required by the State of California Relocation Assistance Act (Chapter 16, Section 7260 et seq. of the California Government Code). Before an offer is made to each property owner, all real property to be acquired will be appraised to determine its fair market value. The project proponent will assist eligible property occupants in finding comparable replacement housing and will pay for actual, reasonable moving costs consistent with applicable State and federal law.	LTS (removal of residences)	SU

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	NTMAs	LTMAs		NTMAs	LTMAs
			Mitigation Measure LU-5b (NTMA & LTMA): *Implement Mitigation Measure AG-1a (NTMA), "Preserve Agricultural Productivity of Important Farmland to the Extent Possible"* **Mitigation Measure LU-5c (NTMA & LTMA):** *Implement Mitigation Measure AG-1c (NTMA), "Establish Conservation Easements Where Potentially Significant Agricultural Land Use Impacts Still Occur after Implementation of Mitigation Measures AG-1a and AG-1b"*	SU (agricultural land use pattern changes)	
			Mitigation Measure LU-5d (NTMA & LTMA): *Implement Mitigation Measure REC-1 (NTMA), "Replace Displaced Recreational Facilities and Access"* **Mitigation Measure LU-5e (NTMA & LTMA):** *Implement Mitigation Measure REC-2 (NTMA), "Avoid Construction Activities and Staging near Recreational Facilities and Time Such Activities to Avoid the High-Use Recreation Season"* **Mitigation Measure LU-5f (LTMA):** *Implement Mitigation Measure REC-7 (LTMA), "Replace Displaced Recreational Facilities"*	LTS (recreational land use changes)	
Impact LU-6 (NTMA & LTMA): *Alterations of Land Uses or Patterns of Land Use as a Result of Storage-Related Management Activities that Could Cause an Adverse Physical Environmental Effect*	LTS		N/A	LTS	
Impact LU-7 (NTMA & LTMA): *Alterations of Land Uses or Patterns of Land Use as a Result of Policies Related to the Required Level of Flood Protection that Would Cause a Substantial Adverse Physical Environmental Effect*	TS		N/A	TS	
Impact LU-8 (NTMA & LTMA): *Alterations of Land Uses or Patterns of Land Use as a Result of Other NTMAs [& LTMAs] that Would Cause a Substantial Adverse Physical Environmental Effect*	S		**Mitigation Measure LU-8 (NTMA & LTMA):** *Implement Mitigation Measure LU-5b (NTMA)*	SU	

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	NTMAs	LTMAs		NTMAs	LTMAs
3.15 Noise					
Impact NOI-1 (NTMA & LTMA): *Exposure of Sensitive Receptors to Temporary and Short-Term Construction-Related Noise*	PS (construction noise)		**Mitigation Measure NOI-1 (NTMA & LTMA):** *Implement Noise-Reducing Construction Practices* Not all measures listed below may be applicable to each management action. Instead, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action. The project proponent will implement the following measures during construction activities when noise-sensitive receptors are located nearby and could be subject to substantial construction noise in excess of applicable standards or substantially greater than existing conditions. • Equipment will be operated, stored, and/or maintained as far away as practical from sensitive noise receptors. • Construction equipment will be properly maintained per manufacturers' specifications and fitted with the best available noise suppression devices (e.g., mufflers, silencers, wraps). All impact tools will be shrouded or shielded, and all intake and exhaust ports on power equipment will be muffled or shielded. • Equipment that is quieter than standard equipment will be used in the vicinity of sensitive noise receptors. For example, electrically powered equipment will be used instead of internal combustion equipment where use of such equipment is a readily available substitute that accomplishes program tasks in the same manner as internal combustion equipment. • Construction equipment operating in the vicinity of sensitive noise receptors will not be left idling for extended periods between construction activities. • To the greatest extent feasible, construction activities will limit the use of "alarms" (e.g., backup indicators) on construction equipment in the vicinity of sensitive noise receptors. One mechanism to achieve this objective is by providing adequate turning movement distance such that construction and delivery vehicles can turn around without having to operate in reverse. • Construction equipment will be inspected before first use at a project site located near sensitive noise receptors and at least once during construction for compliance with noise reduction measures. • To the greatest extent feasible, construction outside of normal construction hours will be minimized or avoided completely when located in the vicinity of sensitive noise receptors. Except under extreme circumstances (as in the case of construction of a slurry cutoff wall, which must be in continuous operation), construction activities will be limited to normal construction hours or hours identified in applicable local noise regulations. • Where stationary construction equipment would result in exceedence of noise standards at a nearby sensitive receptor, temporary noise barriers will be installed where feasible between the stationary construction operation and the sensitive receptor. • Speed limits will be established and enforced for construction traffic.	LTS	
	LTS (construction traffic noise)		**Mitigation Measure NOI-1b (LTMA):** *Minimize Construction-Related Traffic Noise* Where the project-specific noise analysis conducted as part of CEQA review for a project indicates that noise from construction traffic could exceed applicable standards at a sensitive receptor, an additional individual traffic noise analysis will be prepared. The individual traffic noise analysis will be conducted as haul routes are determined to establish existing average noise conditions and model the noise contribution from project construction. The traffic noise analysis will take into account daily traffic volumes, fleet mixes (percentages of automobiles, medium-duty trucks, and heavy-duty trucks during daytime, evening, and nighttime hours), and vehicle speeds along designated haul-route roadways. If the individual traffic noise analysis also concludes that applicable noise standards are exceeded at a sensitive receptor, the analysis will identify additional measures to reduce noise levels at sensitive receptors and these measures will be implemented by the project proponent. Measures could include (but would not be limited to) using alternative traffic routes, splitting trips among multiple routes, or directing noisier vehicles to use less noisesensitive routes.		

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact NOI-2 (NTMA & LTMA): *Exposure of Sensitive Receptors to, or Generation of, Excessive Groundborne Vibration*	PS		Mitigation Measure NOI-2 (NTMA & LTMA): *Implement Vibration-Reducing Construction Practices* Not all measures listed below may be applicable to each management action. Instead, these measures serve as an overlying mitigation framework to be used for specific management actions. The applicability of measures listed below would vary based on the lead agency, location, timing, and nature of each management action. The project proponent will implement the following measures before and during construction activities that occur within 300 feet of a receptor sensitive to vibration disturbance: • A disturbance coordinator will be designated, and this person's contact information will be posted in a location near the construction site that is clearly visible to the nearby receptors most likely to be disturbed. The disturbance coordinator will manage complaints and concerns resulting from activities that cause vibrations. The severity of the vibration concern will be assessed by the disturbance coordinator and, if necessary, evaluated by a qualified noise and vibration control consultant. • Vibration monitoring will be conducted before and during construction-generated vibration activities occurring within 100 feet of historic structures. Every attempt will be made to limit construction-generated vibration levels in accordance with Caltrans's recommendations during pile driving and other groundborne noise- and vibration-generating activities in the vicinity of historic structures. • If estimated or recorded vibration levels meet or exceed levels that could damage an adjacent historic feature, the adjacent historic features will be covered or temporarily shored, as necessary, to protect them from vibrations. • For pile driving required within 100 feet of residences or other occupied structures, alternative installation methods (e.g., pile cushioning, jetting, predrilling, cast-in-place systems, resonance-free vibratory pile drivers) will be used where feasible to reduce the number and amplitude of blows required to seat the pile. If the estimated vibration levels exceed levels that could damage the structures, they will be covered or temporarily shored, as necessary, to protect them from vibrations. • Pile-driving activities conducted within 300 feet of sensitive receptors will occur during daytime hours to avoid causing sleep disturbance during evening and nighttime hours.		LTS

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact NOI-3 (NTMA & LTMA): *Exposure of Sensitive Receptors to Operational Noise*	PS		Mitigation Measure NOI-3 (NTMA & LTMA): *Implement Design Techniques to Reduce Operational Noise* The project proponent will implement the following measures during operation: • Stationary noise sources (e.g., water pumps) will be located as far away from sensitive receptors as feasible. • Design techniques to reduce noise (e.g., structure encasing, installation below grade) will be implemented for stationary noise sources (e.g., water pumps) in the vicinity of sensitive receptors. If noise modeling indicates that noise reduction techniques are sufficient to allow the stationary noise source to be located closer to sensitive noise receptors and still not violate applicable noise standards, then the facility may be located closer to the receptor.	LTS	
3.16 Population, Employment, and Housing					
Impact PEH-1 (NTMA & LTMA): *Inducement of Population Growth, Either Directly or Indirectly, through an Increase in Regional Economic Output Resulting from Construction or Operations Activities*	LTS		N/A	LTS	
Impact PEH-2 (NTMA & LTMA): *Displacement of Existing Housing or People through Changes in Land Use or Policy Changes*	LTS		N/A	LTS	
Impact PEH-3 (NTMA & LTMA): *Changes in Employment, Either Directly or Indirectly, through Changes in Land Use or Policy Changes*	LTS		N/A	LTS	
3.17 Public Services					
Impact PS-1 (NTMA & LTMA): *Physical Effects Resulting from the Need for New or Altered Law Enforcement or Fire Protection Facilities and Services*	LTS		N/A	LTS	
3.18 Recreation					
Impact REC-1 (NTMA & LTMA): *Substantial Permanent Displacement of or Decreased Access to Recreational Facilities Caused by Levee Reconstruction, Improvements, or Setbacks*	PS		Mitigation Measure REC-1 (NTMA & LTMA): *Replace Displaced Recreational Facilities and Access* Where recreational facilities or access must be displaced by levee reconstruction or improvements, facilities and access will be restored on site as part of the project design. If the facilities or access cannot be replaced at the project site, they will be replaced as close as possible to the original project site. Alternatively, existing facilities could be expanded to meet the demand for recreational opportunities lost with the removal of the facility at the project site, or to compensate for the loss of access resulting from project implementation. Where new facilities must be constructed or existing facilities are expanded, these actions will undergo necessary environmental review and mitigation will be implemented as appropriate. Please also see Impact Rec-6 (NTMA) below regarding environmental effects of new facilities.	LTS	
Impact REC-2 (NTMA & LTMA): *Temporary Decrease in Opportunities for Recreation or Access to Recreational Facilities during Construction of Conveyance or Storage Improvements*	LTS		Mitigation Measure REC-2 (NTMA & LTMA): *Minimize Construction Activities and Staging near Recreational Facilities and Time Such Activities to Avoid the High-Use Recreation Season* Where feasible, the project proponent will avoid placing construction staging areas or borrow areas near recreational facilities or popular use areas, and will avoid using key recreation access routes as access and haul routes for construction. Where avoiding facilities is not possible, construction will be scheduled to minimize temporary closure or access restrictions or other temporary adverse effects on recreation facilities. Numerous factors must be considered in the siting and timing of construction activities and selection of access and haul routes; for some projects, however, opportunities may exist to select from among several options those that would have the smallest effect on recreation Where feasible, the project proponent will schedule construction activities to avoid the high-use recreation season for the potentially affected areas. This frequently will not be possible for major repairs or upgrades because those major construction activities typically occur during the dry season (May through October). However, in some cases it may be possible to focus construction activity during the months when recreational activity would be least affected. In addition, the project proponent will avoid scheduling construction activities on weekend days, where feasible, to help minimize effects on recreational activities.	LTS	
Impact REC-3 (NTMA & LTMA): *Reduced Functionality of Recreational Facilities and Decreased Opportunities for Recreation at Reservoirs as a Result of Changes in Reservoir Operational Criteria*	LTS		N/A	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact REC-4 (NTMA & LTMA): *Boat Navigation Hazards and Passage Restrictions for Recreational Boat Traffic Resulting from Construction Activities Conducted from Barges in Waterways*	PS		Mitigation Measure REC-4 (NTMA & LTMA): *Maintain Safe Boat Passage and Provide Appropriate Safety Measures to Minimize Navigation Hazards Associated with Construction Equipment and Activity in Waterways* The project proponent will establish construction exclusion zones around barges and other equipment in waterways to keep boats from approaching too closely. The project proponent will follow all standard U.S. Coast Guard practices for navigation safety and communications, and will ensure that barges and other construction equipment are lit at night to avoid potential boat collisions. The objectives of this mitigation measure are to maintain safe boat passage in affected waterways to the maximum extent possible, and to minimize boat traffic delays, particularly in high-traffic areas. Stopping boat traffic may be necessary for brief periods (for example, while material or equipment is being transferred to or from a barge); however, the expectation is that with appropriate caution, boat traffic will be able to navigate past construction sites at most times. Boats may be required to reduce speeds in the vicinity of the barge for safe passage. The period of time when boat traffic must be restricted will be minimized to the extent feasible.	LTS	
Impact REC-5 (NTMA & LTMA): *Decrease in Quality of Terrestrial and Water-Based Recreation as a Result of Removal of Woody Vegetation from Levees*	LTS		N/A	LTS	
Impact REC-6 (NTMA & LTMA): *Environmental Effects Associated with Construction of Recreational Facilities and Access to Replace Facilities Displaced by Management Activities*	LTS		N/A	LTS	
Impact REC-7 (LTMA): *Substantial Displacement of or Decreased Access to Recreational Facilities Caused by Conveyance-Related and Other Management Activities*	N/A	PS	Mitigation Measure REC-7 (LTMA): *Replace Displaced Recreational Facilities* This mitigation measure would be similar to Measure REC-1 (NTMA) as described above, but mitigation would be required at a broader range of recreational facilities and sites, beyond those associated with levees. Specifically, mitigation would be required at reservoirs, within bypasses, and at areas outside the present flood control system (for example, where a new bypass is constructed).	N/A	LTS
3.19 Transportation and Traffic					
Impact TRN-1 (NTMA & LTMA): *Temporary Increases in Traffic from Construction Activities*	PS		Mitigation Measure TRN-1 (NTMA & LTMA): *Implement Measures to Reduce Construction Traffic* To minimize impacts on traffic circulation and roadway capacity, including emergency vehicle access, the project proponent will implement the following measures: • Require construction contractors to limit truck trips to less than 50 trips per hour on any affected roadway during the morning and afternoon or evening peak-hour periods, if feasible. • Before construction of major projects that could exceed this threshold, prepare a traffic management plan that identifies the number of truck trips, time of day for truck arrivals and departures, limits on the number of truck trips, and traffic circulation control measures. Control measures typically include advertising planned lane closures, installing warning signage, providing a flagperson to direct traffic flows when needed, and implementing methods to maintain continued access by emergency vehicles. During project construction, access to existing land uses will be maintained at all times where feasible, with detours used as necessary during road closures. • Submit the traffic management plan to the appropriate city or county public works, fire, police, and sheriff's departments for comments. • Implement the traffic management plan and feasible recommendations by the appropriate departments.	LTS	PSU
Impact TRN-2 (NTMA & LTMA): *Removal or Temporary Disruption of Current Transportation Infrastructure*	PS		Mitigation Measure TRN-2 (NTMA & LTMA): *Provide Detours for Closed or Disrupted Routes* If the effects of a project on roadways will be temporary, the project proponent will provide easily recognizable detour signs and prepare and implement a traffic management plan to minimize traffic, including bicycle, impacts, in consultation with the local transportation agency. If management actions require removal of transportation infrastructure, efforts will be undertaken to make sure that a convenient transportation alternative option is available for travel. For effects on rail lines, the project proponent will work with the respective rail owner to maintain maximum use of the line.	LTS	PSU
Impact TRN-3 (NTMA & LTMA): *Increased Hazards due to Construction and Temporary Design Feature*	LTS		N/A	LTS	

EIR SECTION AND IMPACT(S)	LEVELS OF SIGNIFICANCE BEFORE MITIGATION[a]		MITIGATION MEASURE	LEVELS OF SIGNIFICANCE AFTER MITIGATION[b]	
	NTMAs	LTMAs		NTMAs	LTMAs
Impact TRN-4 (NTMA & LTMA): *Closure or Reduction in Capacity of an Emergency Response or Evacuation Route*	PS		Mitigation Measure TRN-4 (NTMA & LTMA): *Minimize Effects of Reduction or Closure of an Emergency Response or Evacuation Route* Before the start of construction, all emergency response agencies will be consulted to determine the impacts of the project on their emergency response and evacuation routes. If routes cannot be maintained, then the passage blockage will occur during periods of minimum demand, such as by working at night or maintaining emergency evacuation routes during periods of most likely use (flood season).	LTS	
Impact TRN-5 (NTMA & LTMA): *Conflict with Adopted Policies, Plans, or Programs regarding Public Transit, Bicycle, or Pedestrian Facilities*	LTS		N/A	LTS	
3.20 Utilities and Service Systems					
Impact UTL-1 (NTMA & LTMA): *Potential Disruption of Utility Service and Modification or Relocation of Utility Infrastructure from Project Construction Activities*	PS		Mitigation Measure UTL-1 (NTMA & LTMA): *Verify Utility Locations, Coordinate with Utility Providers, Prepare and Implement a Response Plan, and Conduct Worker Training with Respect to Accidental Utility Damage* Before construction begins, the project proponent and its primary contractors will coordinate with applicable regulatory agencies and utility providers to implement orderly relocation of utilities that need to be removed or relocated. The project proponent and its primary contractors will implement all of the following measures: • The appropriate agencies and affected landowners will be notified of any potential interruptions in service. • Before the start of construction, the locations of utilities will be verified through field surveys and the use of Underground Service Alert services. Any buried utility lines will be clearly marked in areas where construction activities would take place and on the construction specifications before any earth-moving activities begin. • Many of the Board's encroachment permits for utility facilities contain clauses requiring the owner to remove and/or relocate the facility at the owner's expense. If necessary, infrastructure will be removed, relocated to safer locations, or made flood resistant in coordination with all potential service providers known to have, or potentially having, utility infrastructure in the project area. • If necessary, infrastructure will be flood-proofed (e.g., raised on piers) in coordination with all transmission providers known to have infrastructure in the project area. • Before the start of construction, a response plan will be prepared to address the potential for accidental damage to a utility. The plan will identify chain-of-command rules for notifying authorities and appropriate actions and responsibilities to ensure the safety of the public and workers. The construction contractor will conduct worker education training on responding to situations when utility lines are accidentally damaged. The project proponent and its contractors will implement the response plan during construction activities. • Utility relocations will be staged to minimize interruptions in service.	LTS	
Impact UTL-2 (NTMA & LTMA): *Potential Disruption of Utility Service and Modification or Relocation of Utility Infrastructure from Project Operation*	B		N/A	B	
Impact UTL-3 (NTMA & LTMA): *Increased Generation of Solid Waste during Project Construction*	LTS		N/A	LTS	
3.21 Water Quality					
Impact SWQ-1 (NTMA & LTMA): *Temporary Construction-Related Effects on Water Quality that Would Not Cause Violations of Existing Water Quality Standards or Otherwise Substantially Degrade Water Quality*	LTS		N/A	LTS	
Impact SWQ-2 (NTMA & LTMA): *Modification of Reservoir Operations that Would Not Cause Violations of Existing Water Quality Standards or Otherwise Substantially Degrade Water Quality*	LTS		N/A	LTS	
Impact SWQ-3 (NTMA & LTMA): *Alteration of Floodplain Inundation Patterns that Could Result in Substantial Erosion and Adversely Affect Water Quality*	PS		Mitigation Measure SWQ-3 (NTMA & LTMA): *Conduct and Comply with Phase I Environmental Site Assessments* The project proponent will conduct a Phase I Environmental Site Assessment to determine the presence of any hazardous materials at all sites where new floodplain would be exposed to inundation. Project proponents of subsequent site-specific projects will implement all the recommended actions and measures identified in the Phase I Environmental Site Assessment. In addition, the project proponent will be required to comply with the federal and California endangered species acts and incorporate associated measures into the project design/planning features.	LTS	

Notes:

N/A Either impact mechanism, need for mitigation, and/or determination of significance after mitigation is not applicable

[a] Impact Significance before Mitigation
B Beneficial
NI No impact
LTS Less than significant
PS Potentially significant
S Significant
TS The impact is too speculative to make a significance determination

[b] Impact Significance after Mitigation
B The impact would be beneficial and no mitigation is required; therefore, the impact would remain beneficial.
LTS The impact would be less than significant and no mitigation is required; therefore, the impact would remain less than significant, whether or not mitigation has been provided to further reduce the impact.
SU Significant and unavoidable
PSU Potentially significant and unavoidable
TS The impact is too speculative to make a significance determination

Although some impacts are identified as significant and unavoidable or potentially significant and unavoidable in Table ES-1, these impact conclusions may or may not apply to any given project, as most projects would result in less-than-significant impacts after mitigation, but some projects may not, as described in Chapter 3.0 and summarized in Section 6.3 "Significant and Unavoidable Impacts."

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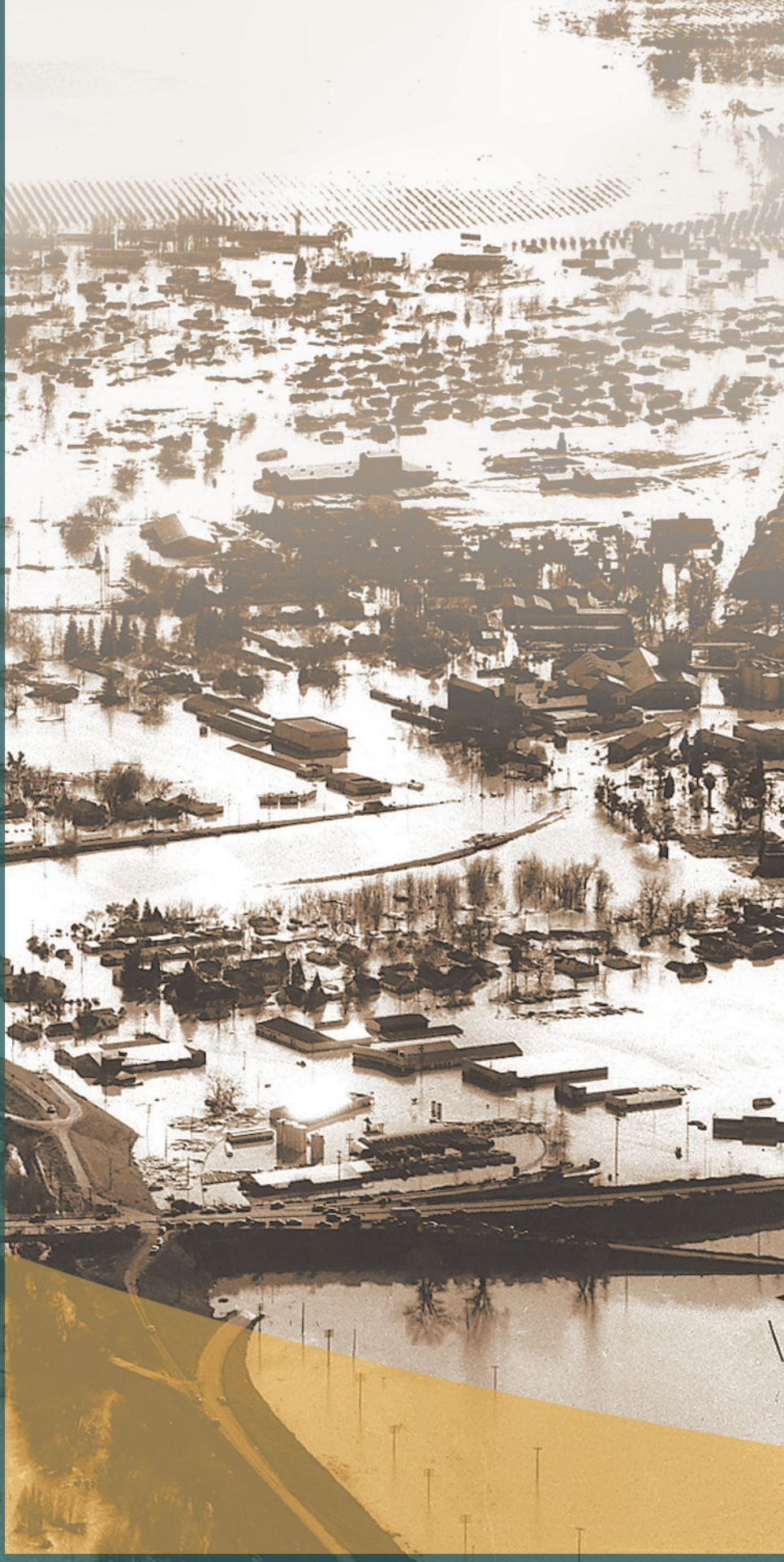
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